TRUCK, CARGO, WITH CRANE, HEAVY, MC3 – MACK

MEDIUM AND HEAVY GRADES OF REPAIR

This instruction is authorised for use by command of the Chief of Army. It provides direction, mandatory controls and procedures for the operation, maintenance and support of equipment. Personnel are to carry out any action required by this instruction in accordance with EMEI General A 001.

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INTRODUCTION

1. This EMEI supplement contains instructions for removing, repairing, replacing and installing the crane components of the Truck, Cargo, With Crane, Heavy, MC3 – Mack (Mack). This supplement should be read in conjunction with the latest EMEI Vehicle G 704 and G 704-1. For warranty provisions, refer to the User Handbook.

2. It is vitally important that dirt and other foreign matter is not allowed to enter the hydraulic system during repairs. Dirt, or fluid other than clean hydraulic fluid, in the system will cause almost immediate failure. Plug or protect openings to prevent dirt entering the system. Use plastic plugs or covers only for this purpose. Do not use cloth or paper as plugs or covers.

ASSOCIATED PUBLICATIONS

3. Reference may be necessary to the latest version of the following documents:

- **a.** Defence Road Transport Instruction;
- **b.** Australian Army Books: Record Book for Service Equipment GM 120;
- **c.** Complete Equipment Schedule (CES):
  - **(1)** CCES 19236 – Truck, Cargo, With Crane, Heavy, MC3 (Mack);
  - **(2)** SCES 11653 – Truck, Cargo, With Crane, Heavy, MC3 (Mack); and
  - **(3)** SCES (AMK) 11654 – Truck, Cargo, With Crane, Heavy, MC3 (Mack).
- **d.** Repair Parts Scale 02162;
- **e.** Provisional Block Scale 2406/29;
- **f.** EMEI Vehicle A029 – Vehicles – General – Servicing of B Vehicles, Trailers, Stationary Equipment, Auxiliary and Small Engines – Servicing Instruction;
- **g.** EMEI Vehicle A119-21 – Repair Limits – Truck, Medium, MC2 (Unimog), and Heavy, MC3 All Types – Repair of Vehicle Under Warranty – General Instruction;
- **h.** EMEI Vehicle G 710 – Truck, Cargo, With Crane, Heavy, MC3 – Mack – Data Summary;
- **i.** EMEI Vehicle G 702 – Truck, Cargo, Heavy, MC 3 – Mack – Technical Description;
- **j.** EMEI Vehicle G 712 – Truck, Cargo, With Crane, Heavy, MC3 – Mack – Technical Description;
- **k.** EMEI Vehicle G 703 – Truck, Cargo, Heavy, MC 3 – Mack – Light Grade Repair;
- **l.** EMEI Vehicle G 713 – Truck, Cargo, With Crane, Heavy, MC3 – Mack – Light Grade Repair;
- **m.** EMEI Vehicle G 704 – Truck, Cargo, Heavy, MC 3 – Mack – Medium Grade Repair;
- **n.** EMEI Vehicle G 704-1 – Truck, Cargo, Heavy, MC 3 – Mack – Heavy Grade Repair;
- **o.** EMEI Vehicle G 709 – Truck, Cargo, Heavy, MC 3 – Mack – Servicing Instruction; and
- **p.** EMEI Vehicle G 719 – Truck, Cargo, With Crane, Heavy, MC3 – Mack – Servicing Instruction.

ROTABLE ITEM IDENTIFICATION

4. Table 1 lists the identification location for rotable items.

Table 1 Rotable Item Identification

Item	Location
Chassis no.	Right-hand rear frame, above intermediate axle
Chassis nameplate	Left-hand door inside cab
Engine no.	Right-hand top of timing gear housing
Front axle no.	Left rear of axle housing
Transmission no.	Left-hand side
Transfer case	Right-hand rear
Intermediate axle no.	Right-hand front of carrier housing
Rear axle no.	Right-hand front of carrier housing
Injection pump identification	Side of the pump
Crane	Located on the crane body
Power take off (hydraulic pump)	Right-hand side
Hydraulic pump	Rear face of the pump
Cab upper section	Rear inner left-hand upper panel
Cab lower section	Left-hand door opening gusset

SAFETY

5. The following warnings are to be adhered to when carrying out repairs to the crane.

WARNING

All industrial safety, work practices and equipment operating and maintenance instructions pertaining to this EMEI are to be adhered to.

WARNING

Before working on the hydraulic system, ensure that the hydraulic fluid is sufficiently cool to avoid burns.

WARNING

Before working on components of the hydraulic system, ensure that no residual pressure remains in the system by operating the relevant control levers.

WARNING

Chemical substances are to be stored, used and handled in accordance with MOHS, MSDS and EMEI workshop E series.

CAUTION

Do not use adhesive tape to seal hydraulic hose or pipe openings. The adhesive on most tapes is soluble in oil and can cause contamination. Use protective caps, plugs, or covers and remove them before installation.

6. Prevent dirt and foreign objects from entering any component. Place clean temporary covers on all exposed openings. All open hoses and lines are to be protected with plastic or metal caps or plugs.

7. Protect the equipment from dust and inclement weather when performing any of the tasks contained in this manual. If practical, perform these tasks in a sheltered or enclosed area.

8. When disconnecting electrical connectors, hoses and fittings, remove clamps as required, gaining slack and avoiding damage to connectors and fittings.

9. Discard all used gaskets, seals, split pins, tab washers, lock-pins, nyloc nuts and lock-washers. Discard all contaminated lubricants drained from the equipment.

10. Use only those lubricants specified in the EMEI Vehicle G 709 and the User Handbook when replenishing lubricants.

11. Any fastening or fittings being tightened to prescribed torques are to have dry, clean threads unless thread sealants are specified. Thread sealants are to be applied to dry, clean, oil-free threads.

SPECIAL TOOLS

12. The special tools listed in Table 2 are required for the designated test procedures.

Table 2 Special Tools

Part No/Item Name	Para No.	Use
70 000 kPa (10 000 psi) pressure gauge	57	Hydraulic component pressure testing
45 L/min (10 gal/min) flow meter	57	Hydraulic component flow rate testing
3 500 kPa (500 psi) pressure gauge	106	Hydraulic component pressure testing
3650766 Interface Kit	125	Troubleshooting the SPACE system

MECHANICAL SYSTEM

WARNING

Before removing hydraulic hoses and components, ensure that the hydraulic fluid is sufficiently cool to avoid burns.

WARNING

Before commencing removal of hydraulic components, place a warning sign not to operate the crane on or near the vehicle controls.

WARNING

Before working on components of the hydraulic system, ensure that no residual pressure remains in the system by operating the relevant control levers.

CRANE POWER TAKE-OFF (PTO)

13. Removal. To remove the crane PTO, proceed as follows:

CAUTION

Both the PTO and adaptor housings are quite brittle and easily damaged unless handled carefully.

a. Remove the hydraulic pump/PTO protective guard.

b. Wash the area around the PTO and hydraulic pump and blow dry with compressed air.

c. Remove the hydraulic hoses, then seal the hoses and the ports in the hydraulic pump with plastic plugs.

d. Remove the air line from the PTO selector housing.

e. Remove the six nuts and washers securing the PTO and adaptor to the transmission.

f. Remove the PTO and pump assembly and the adaptor housing from the transmission.

g. Remove all traces of gasket residue from the mounting surfaces.

14. Disassembly. To disassemble the crane PTO, proceed as follows:

a. Match mark the pump, the selector housing and the PTO housing to ensure their correct positioning during reassembly.

b. Remove the four nuts and washers securing the pump to the PTO and remove the pump.

c. Remove the four socket-head bolts securing the selector housing to the PTO and remove the selector housing (Figure 1).

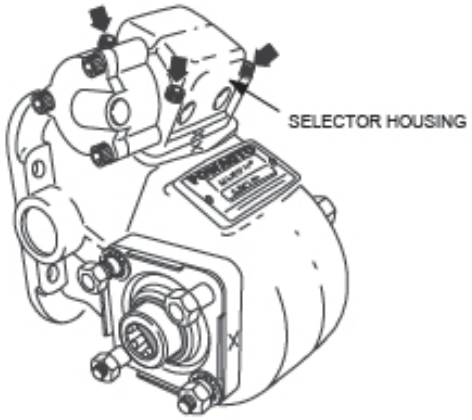


Figure 1 Socket-Head Bolt Location

d. Remove a welsh plug from one end of the idler shaft.

e. Remove the circlip (furthest from the end of the idler shaft from which the welsh plug was removed) and slide it along the shaft. Install the PTO housing in a press and remove the idler shaft using the press and a suitable adaptor (Figure 2).

NOTE

As the shaft is pressed out of the housing, it will cause the gear, thrust washer and circlip to slide along the shaft and will also remove the other welsh plug and a roller bearing.

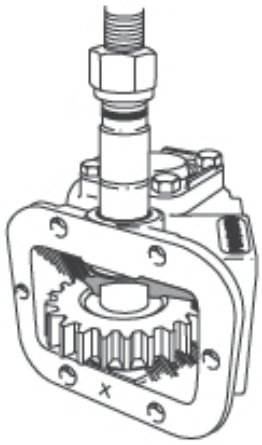


Figure 2 Removing the Idler Shaft

f. Lift the second circlip from the groove and continue to press the shaft out until the circlips, the thrust washers and the gear can be removed.

NOTE

When the gear is removed from the shaft, a steel ball will drop out of an indent within the gear bore. This ball acts as a key locking the gear and shaft together, but still allowing the gear to move lengthways along the shaft.

g. To remove the remaining needle roller bearing from the housing, press the shaft back in the opposite direction.

h. Remove the four bolts securing the drive shaft bearing cover plate to the housing and remove the cover plate and gasket (Figure 3).

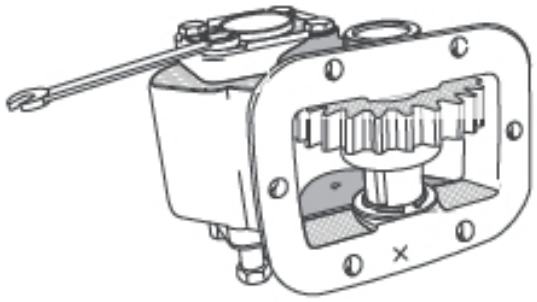


Figure 3 Removing the Bearing Cover Plate

i. Remove the circlip from the groove in the drive shaft and slide it along the shaft, then remove the bearing cups by hand.

j. Remove the bearing cone from the shaft at the end opposite the output using a suitable puller. Ensure that the puller is pulling against the inner race and not the cage.

k. Slide the gear and circlip off the shaft while withdrawing the shaft, complete with the other bearing, from the housing.

l. Position the drive shaft in a press then press the remaining bearing off the shaft.

15. Cleaning and Inspection. To clean and inspect the crane PTO, proceed as follows:

a. Clean all parts thoroughly with a suitable cleaning agent then blow dry with compressed air. Ensure that all gasket residue is removed.

b. Inspect the housing for damage or cracking. Replace if necessary.

c. Check the gears for cracked, chipped or worn teeth. Check the splines in the drive gear bore for wear. Replace gears as necessary.

d. Check the idler shaft bearing surfaces for pitting or wear and check the channel in the idler shaft for wear. Replace the idler shaft as necessary.

e. Check the internal and external splines on the drive shaft for wear. Replace the drive shaft as necessary.

f. Check the condition of the bearings. Replace as necessary.

16. Reassembly. To reassemble the crane PTO, proceed as follows:

a. Place the drive shaft in a press. Position the bearing on the output end of the shaft with the taper facing away from the splines, then press the bearing onto the shaft until it butts firmly against the shoulder. Remove the shaft from the press.

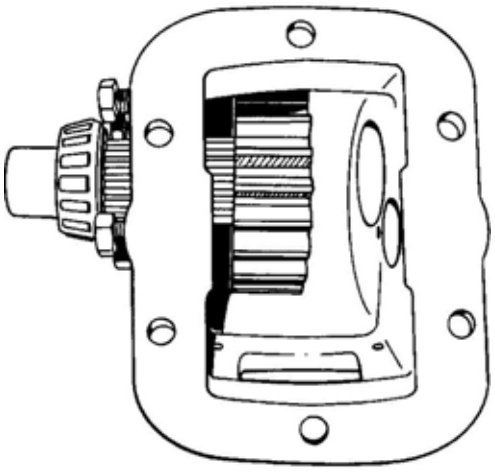


Figure 4 Installing the Drive Shaft And Gear

b. Install a circlip onto the drive shaft, then position the shaft partially in the housing ensuring that the output end of the shaft is on the correct side of the housing. Install the drive gear in the housing and align it with the drive shaft. Feed the drive shaft into the housing and through the drive gear (Figure 4).

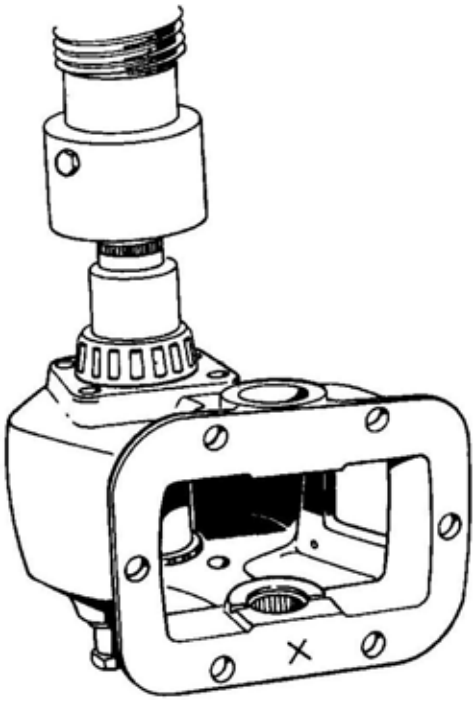


Figure 5 Installing the Drive Shaft Bearing

c. Place the housing and shaft in a press. Position a bearing, with the taper facing away from the splines, on the drive shaft at the end opposite the output, then press the bearing onto the shaft, as shown in Figure 5, until it butts firmly against the shoulder. Remove the housing from the press.

d. Lubricate the bearings with OEP-220 then install the bearing cups into the housing.

e. Install the bearing cover and gaskets. Install the cover retaining bolts and torque them to 34 N.m to 38 N.m.

f. Position the idler shaft partially into the housing. Install a thrust washer and a circlip onto the shaft. Insert the steel ball into the detent in the idler gear, then position the idler gear in the housing. Align the channel in the idler shaft with the steel ball in the idler gear (Figure 6), then push the idler shaft further into the housing and into the idler gear (Figure 7). Install the second circlip into the groove on the idler shaft, then position the thrust washer on the shaft. Push the idler shaft into the housing, butting the thrust washer against the housing. Position the first thrust washer against the housing and insert the first circlip into the groove in the idler shaft.

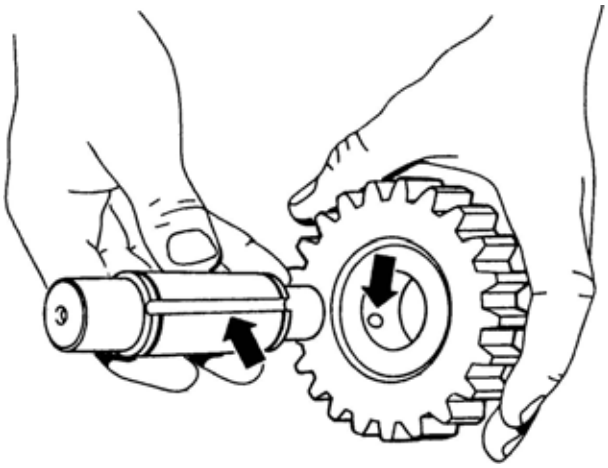


Figure 6 Channel and Steel Ball

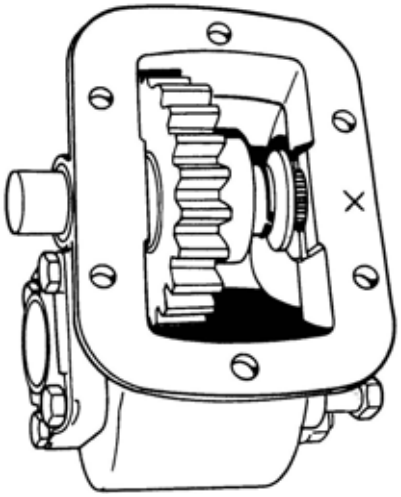


Figure 7 Installing the Idler Shaft and Gear

g. Lubricate the needle roller bearings then press them into the housing on both ends of the idler shaft. Install the welsh plugs.

h. Lubricate the gears and bearings of the PTO liberally with clean OEP-220, then place a protective cover over the PTO and set it aside.

Air Operated Selector

17. Disassembly. To disassemble the air operated selector, proceed as follows:

WARNING

Before removing the selector housing air inlet cover, ensure that the circlip used to retain the selector fork to the piston is in place. The selector fork, if properly retained, will prevent the piston flying out of the cylinder under spring pressure and causing injury when the air inlet cover is removed.

a. Remove the three socket-head bolts from the air inlet cover, shown in Figure 8, and remove the cover. Discard the O-ring.

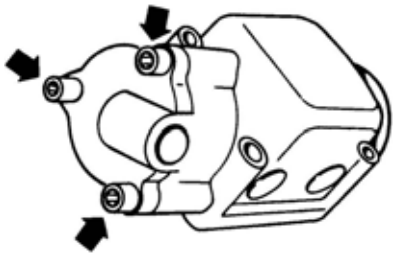


Figure 8 Air Inlet Cover Retaining Bolts

NOTE

Spring pressure will cause the piston to protrude from the housing when the cover is removed.

b. Push the piston into the cylinder bore by hand and remove the circlip retaining the selector fork to the piston from its groove (Figure 9).

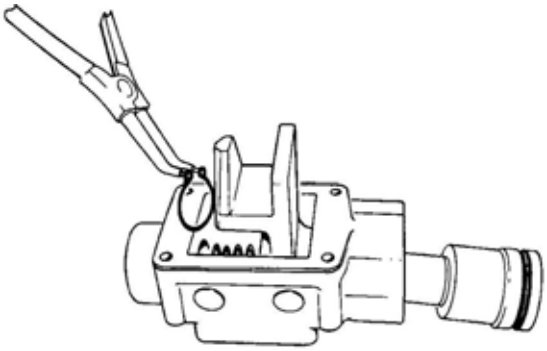


Figure 9 Removing the Circlip

c. Gradually release the pressure on the piston allowing the piston to move up the bore. Feed the circlip and selector fork off as the piston and return spring are removed.

d. Remove the selector fork and circlip from the housing, taking note as to which way the step in the fork is facing. Discard the circlip.

e. Remove and discard the piston O-ring (Figure 10).

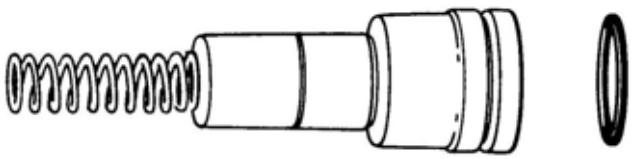


Figure 10 Piston and O-Ring

18. Cleaning and Inspection. To clean and inspect the air operated selector, proceed as follows:

a. Clean all parts with a suitable cleaning agent and blow dry with compressed air.

b. Inspect the housing, cylinder bore and piston for excessive wear or scoring. Replace parts as necessary.

c. Inspect the selector fork for damage or wear and replace if necessary.

d. Check the return spring for breaks, cracking or wear. Replace the spring as necessary.

19. Reassembly. To reassemble the air operated selector, proceed as follows:

a. Install a new O-ring onto the piston. Lubricate the O-ring with a suitable rubber grease, then install the return spring into the bore of the piston.

b. Insert the piston partially into the cylinder bore, then position the selector fork and circlip onto the piston (Figure 11). Ensure that the step in the fork is facing the correct way.

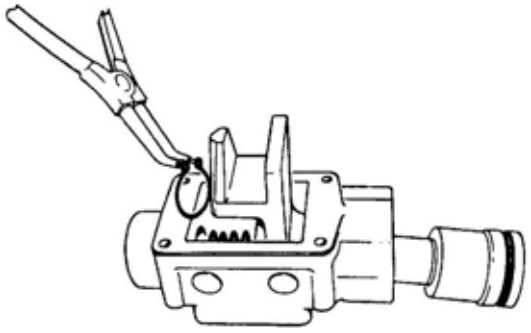


Figure 11 Installing the Circlip

c. Push the piston into the bore while feeding the selector fork and circlip onto the piston. Ensure that the circlip is correctly seated in the groove.

d. Insert a new O-ring in the groove on the air inlet cover then install the cover onto the housing. Fit the retaining bolts and torque to 9 N.m to 13 N.m.

e. Assemble the selector housing and a new gasket onto the PTO housing, aligning the match marks and ensuring that the selector fork is correctly located over the idler gear.

f. Install the four socket-head bolts and torque to 34 N.m to 38 N.m.

Adaptor Housing

20. Disassembly. To disassemble the adaptor housing, proceed as follows:

CAUTION

The adaptor housing is quite brittle and is easily damaged unless handled carefully.

a. Place the adaptor housing in a soft-jawed vice and, using a C-spanner, remove the bearing retaining collar.

NOTE

The collar will be firm on the thread due to the locking indentations.

b. Suitably support the adaptor housing on a press, then press the shaft through the gear until there is sufficient space to remove the gear (Figure 12).

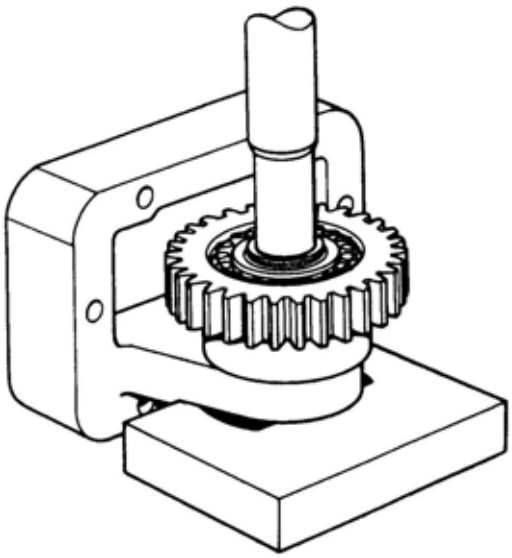


Figure 12 Pressing the Shaft from the Housing

c. Remove the bearing cones and spacers from the assembly.

d. Using a soft drift and hammer, remove the bearing cups from the gear.

e. Remove the snap ring from the gear if damage is evident (Figure 13).

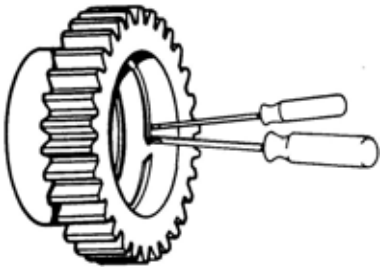


Figure 13 Removing the Snap Ring

21. Cleaning and Inspection. To clean and inspect the adaptor housing, proceed as follows:

a. Clean all parts thoroughly with a suitable cleaning agent and ensure that all gasket residue is removed.

b. Inspect the gear for worn or damaged teeth. Replace as necessary.

c. Check the bearings for wear or damage. Replace as necessary.

d. Check the thickness of the bearing-to-housing spacer, 2.99 mm (0.118 in); the bearing cone spacer, 3.55 mm (0.140 in) and the snap ring, 3.96 mm (0.156 in). Replace if worn or damaged.

NOTE

The snap ring provides the correct bearing cup spacing.

22. Reassembly. To reassemble the adaptor housing, proceed as follows:

a. Install the snap ring (if removed), then press the bearing cups into the gear. Ensure that the bearing cups butt firmly against the snap ring.

b. Position the bearing-to-housing spacer and the inner bearing on the shaft (Figure 14).

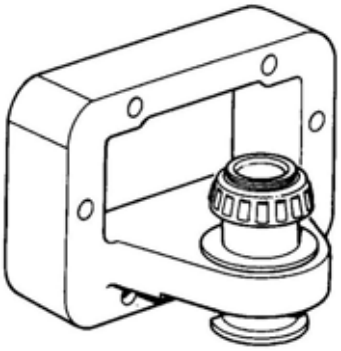


Figure 14 Positioning the Bearing and Spacer

c. Place the adaptor housing and shaft in the press, then position the gear, the spacer and the outer bearing cone on the shaft and press the bearings and gear onto the shaft. Ensure that the flat on the shaft flange is correctly aligned and that the bearings are seated firmly against the spacers (Figure 15).

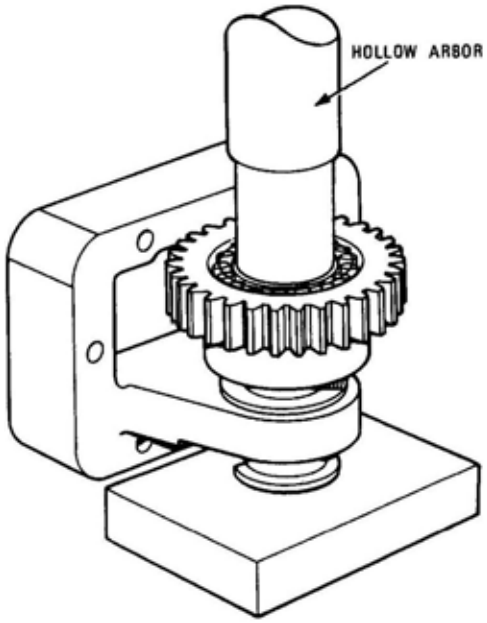


Figure 15 Installing the Shaft, Gear and Bearings

d. Install a new retaining collar and tighten securely. Stake the retaining collar to the shaft, using a staking chisel and hammer.

e. Lubricate the bearings with OEP-220 oil, then check that the gear revolves freely and without undue noise.

23. Determine Gasket Thickness – Adaptor to Transmission. To determine the gasket thickness required between the adaptor plate and the transmission to obtain the correct backlash, proceed as follows:

a. Insert a wooden wedge between the transmission PTO drive gear and the transmission housing (Figure 16).

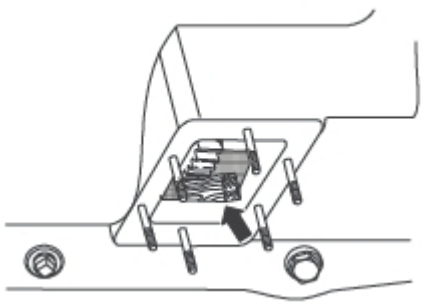


Figure 16 Wedge Location

b. Install new gaskets and the adaptor housing onto the transmission housing and secure in place with the top and bottom nuts only.

c. Install a dial indicator onto the adaptor housing with the dial indicator plunger resting squarely on the adaptor gear (Figure 17).

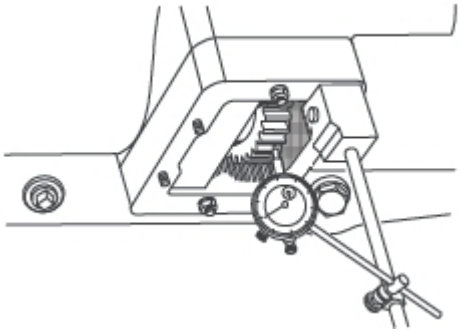


Figure 17 Checking PTO Adaptor to Transmission Backlash

d. Rock the adaptor gear back and forth by hand and check the backlash reading. Add or subtract gaskets between the adaptor and transmission to obtain a backlash figure of 0.250 – 0.375 mm (0.010 – 0.015 in).

e. Remove the nuts from the adaptor and remove the adaptor from the transmission. Retain the gaskets.

f. Remove the wooden wedge from the transmission.

24. Determine Gasket Thickness – Adaptor To PTO. To determine the gasket thickness required between the adaptor plate and the PTO to obtain the correct backlash, proceed as follows:

a. Position new gaskets and the adaptor on the PTO and secure the adaptor to the PTO with two suitably sized bolts and nuts.

b. Install a dial indicator on the adaptor housing with the dial indicator plunger resting squarely on the adaptor gear (Figure 18).

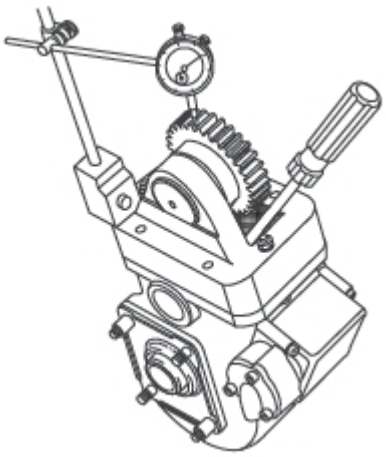


Figure 18 Checking Adaptor to PTO Backlash

c. Slide the idler gear against the spring pressure to mesh the idler gear with the adaptor gear. Hold the gear in this position and lock it to prevent it from turning, then rock the adaptor gear back and forth by hand and check the backlash reading. Add or subtract gaskets between the adaptor and PTO to obtain the correct backlash figure of 0.250 – 0.375 mm (0.010 – 0.015 in).

d. Remove the nuts and bolts and separate the adaptor housing and PTO. Retain the gaskets.

25. Installation (PTO). To install the PTO, proceed as follows:

CAUTION

Both the PTO and adaptor housing are quite brittle and easily damaged unless handled carefully.

a. Position the gaskets (previously determined when setting the adaptor-to-transmission backlash) and the adaptor onto the transmission.

b. Position the gaskets (previously determined when setting the adaptor-to-PTO backlash) onto the adaptor, then install the PTO.

c. Apply Loctite 271 to the studs, then install the spring washers and nuts. Torque the nuts to 34 – 38 N.m.

d. Fit the hydraulic pump and gasket to the PTO. Apply Loctite 271 to the studs, then install the lock washers and nuts. Torque the nuts to 34 – 38 N.m.

e. Remove the plastic plugs from the pump and hoses, fit the hoses and tighten the screw clamp and the connector securely. Reconnect the air line to the selector housing and tighten securely.

f. Start the truck engine and engage the PTO. Check for leaks at the gaskets, the hydraulic hoses and the air hose. Rectify if necessary.

g. Check that the PTO is operating correctly and not making any whining or rattling noise. If the PTO whines or rattles, repeat the backlash adjustment (refer to Paras 23 and 24).

h. Disengage the PTO and shut down the engine.

i. Check the oil level in the transmission. If necessary top up with OEP-220.

j. Check the fluid level in the oil reservoir. If necessary, top up with ISO Grade 68.

k. Replace the hydraulic pump/PTO protective guard.

CRANE ASSEMBLY

WARNING

Before removing hydraulic hoses and components, ensure that the hydraulic fluid is sufficiently cool to avoid burns.

WARNING

Before working on components of the hydraulic system, ensure that no residual pressure remains in the system by operating the relevant control levers.

WARNING

Before commencing removal of hydraulic components, place a warning sign not to operate the crane on or near the vehicle controls.

NOTE

Before commencing the removal procedure of any hydraulic component, clean the component and surrounding area, paying particular attention to pipe connections.

NOTE

After removing pipework from hydraulic components, always plug the pipes and fittings to prevent the ingress of dirt and moisture into the hydraulic system.

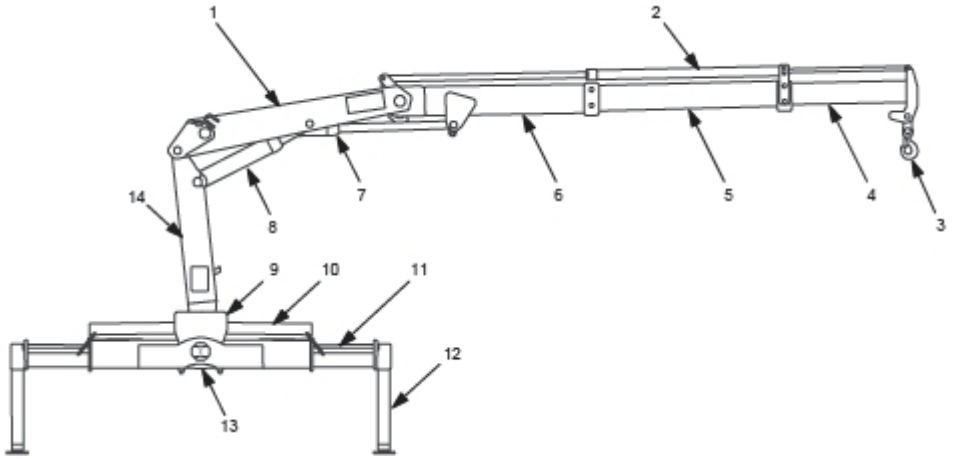
NOTE

After installation, bleeding and testing of hydraulic components, always check the level of fluid in the oil reservoir. If necessary, top up with ISO Grade 68.

26. Removal. To remove the crane assembly from the vehicle, proceed as follows:

a. To facilitate removal, the crane is best positioned in the erect and stowed position. If necessary, use overhead lifting equipment to raise the crane while operating the tilt hydraulic control lever.

b. Prepare a suitable stand that will accommodate the crane when it has been removed from the vehicle.



Item	Description	Item	Description	Item	Description
1	Inner Boom	6	Outer Boom	11	Outrigger Extension Cylinder
2	Boom Extension Cylinder	7	Outer Boom Cylinder	12	Outrigger Leg
3	Load Hook	8	Inner Boom Cylinder	13	Tilt Cylinder (not illustrated)
4	Second Boom Extension	9	Slewing Housing	14	Crane Body
5	First Boom Extension	10	Slewing Cylinder		

Figure 19 Major Crane Components

c. Crack loose the supply hose connection at the main control valve and disconnect the fitting. Use a suitable container to contain any oil spillage.

d. Crack loose the return hose at the ‘T’ piece adjacent to the three point bridge and disconnect the fitting. Use a suitable container to contain any oil spillage.

e. Disconnect the crane’s main wiring loom from the battery and pull the wiring loom back to the crane.

f. Disconnect the work lamp wiring from the park light circuit at the right-hand front side marker lamp. Pull the wiring loom back to the crane.

g. Disconnect the boom height warning lamp wiring from behind the dash and pull the wiring loom back to the crane.

h. Remove the four mounting cap nuts and bolts securing the tilt rocker shaft to the crane mounting ‘I’ beams.

i. Remove the three point bridge mounting frame through bolt nuts under the ‘I’ beam on each side of the crane and free the bolts.

j. Remove the two tilt cylinder frame mounting bolt nuts under the ‘I’ beam on each side of the crane and remove the bolts.

k. Fit the travel latch at the steady post for the inner boom. This will prevent movement in the crane boom system due to hydraulic creep.

l. Attach a suitable wire rope sling to the lifting eyes on the top of the crane body and, using overhead lifting equipment, carefully lift the crane clear of the vehicle. Lower the crane into its safety stand.

27. Inspection. To inspect the crane assembly, proceed as follows:

a. Check the condition of the crane mounting hardware.

b. Replace worn or damaged parts as necessary.

28. Installation. To install the crane assembly, proceed as follows:

a. Using overhead lifting equipment, lift the crane from the safety stand and position the crane over the mounting 'I' beams on the truck.

b. Manoeuvre the crane to align all mounting bolt holes and install bolts (two three point bridge mounting frame through bolts, four tilt rocker shaft cap bolts and four tilt cylinder frame mounting bolts).

c. Fit the four tilt rocker shaft mounting cap nuts and washers.

d. Fit the two three point bridge mounting frame through bolt nuts and washers.

e. Fit the two tilt cylinder mounting frame bolt nuts and washers.

f. Remove the plastic plugs from the supply hose and its fitting in the control valve and reconnect the hose.

g. Remove the plastic plugs from the return hose and its fitting at the 'T' piece and reconnect the hose.

h. Re-route the work lamp wiring back to the park light circuit at the right-hand front side marker lamp and reconnect.

i. Re-route the boom height warning lamp wiring back behind the dash and reconnect.

j. Re-route the crane's main wiring loom back to the battery and reconnect.

k. Remove the travel latch at the steady post for the inner boom.

l. Start the engine, engage the crane PTO and operate the crane and outriggers to bleed the air from the system (see Para 50). Check for leaks and rectify as necessary.

m. Check the level of fluid in the oil reservoir. If necessary, top up with ISO Grade 68.

SECOND BOOM EXTENSION

29. Removal. To remove the second boom extension, proceed as follows (Figure 19, Item 4):

a. Position lifting equipment above the extension and take up the weight of the section with a suitable sling. Ensure that the sling is positioned so as to balance the weight evenly.

b. Remove the split pin and adjusting screw from each slide pad adjuster on the first boom extension. Remove the slide pads.

c. With the boom fully extended, remove the nut and bolt securing the extension cylinder's piston rod pivot pin. Drive the pivot pin out of the mounting.

d. Withdraw the extension and lower to the ground. The extension will need to be tilted as it is withdrawn from the first boom extension to clear the fixed slide pads on its trailing end.

30. Cleaning and Inspection. To clean and inspect the second boom extension, proceed as follows:

a. Clean the extension and load hook thoroughly.

b. Check the condition of the extension, slide pads and load hook. Replace worn or damaged parts as necessary.

31. Installation. To install the second boom extension, proceed as follows:

a. Lift the extension into position, ensuring that the sling is positioned to balance the weight evenly.

b. Engage the hollow section of the first boom extension and push the second extension in until it can support itself. The extension will need to be tilted as it is inserted into the first boom extension to clear the fixed slide pads on its trailing end.

c. Remove the sling and overhead lifting equipment.

d. Push the second boom extension completely into the first boom extension.

e. Install the slide pads and adjusting screws into the first boom extension and adjust the slide pads as detailed in EMEI Vehicle G 713.

f. Align the pivot pin hole in the extension cylinder with that on the boom extension, then insert the pivot pin. Secure using the retaining bolt and nut.

g. Start the engine, engage the PTO and extend and retract the boom extensions to check the operation of the cylinder and to check for leaks. Rectify as necessary.

FIRST BOOM EXTENSION

32. Removal. To remove the first boom extension, proceed as follows (Figure 19, Item 5):

a. Remove the boom extension cylinder as detailed in EMEI Vehicle G 713.

b. Remove the second boom extension as detailed in Para 29.

c. Remove the split pin and adjusting screw from each slide pad adjuster on the outer boom. Remove the slide pads.

d. Position lifting equipment above the first extension and take up the weight of the section with a suitable sling. Ensure that the sling is positioned so as to balance the weight evenly.

e. Withdraw the extension and lower to the ground.

33. Cleaning and Inspection. To clean and inspect the first boom extension, proceed as follows:

a. Clean the boom extension thoroughly.

b. Check the condition of the extension and slide pads. Replace worn or damaged parts as necessary.

c. Check the condition of the boom extension cylinder mounting hardware. Replace worn or damaged parts as necessary.

d. Check the condition of associated hoses and pipework. Repair or replace as necessary.

34. Installation. To install the first boom extension, proceed as follows:

a. Lift the extension into position, ensuring that the sling is positioned to balance the weight evenly.

b. Engage the hollow section of the outer boom and push the first extension in until it can support itself.

c. Remove the sling and overhead lifting equipment.

d. Push the first boom extension completely into the outer boom.

e. .. Install the slide pads and adjusting screws into the outer boom and adjust the slide pads as detailed in EMEI Vehicle G 713.

f. Install the second boom extension as detailed in Para 31.

g. Install the boom extension cylinder as detailed in EMEI Vehicle G 713.

h. Start the engine, engage the PTO and extend and retract the boom extensions to check the operation of the cylinder and to check for leaks. Rectify as necessary.

OUTER BOOM AND EXTENSIONS

35. Removal. To remove the outer boom and extensions, proceed as follows (Figure 19, Items 6, 5 and 4):

a. This operation is best carried out with the crane in the stowed position. If this is not possible, support the crane with chocks to prevent the booms moving due to the loss of fluid (pressure).

b. Position lifting equipment above the outer boom and boom extensions and take up the weight of the section with a suitable sling. Ensure that the sling is positioned so as to balance the weight evenly.

c. Crack loose the boom extension cylinder's two flexible hose connections adjacent to the outer boom cylinder mounting and disconnect the fittings. Use a suitable container to contain the oil spillage. Tag the hoses to ensure correct connection during installation.

d. Cut the necessary cable ties and disconnect the wiring to the work lamp and outer boom tilt indicator.

e. Suitably support the outer boom cylinder, then remove the retaining bolt and pivot pin securing the cylinder to the outer boom.

f. Lift the outer boom cylinder out of the mounting and tie the cylinder out of the way.

g. Remove the two bolts, plate and ring securing the outer boom pivot to the inner boom.

h. Manoeuvre the outer boom and extensions away from the inner boom mount and lower to the ground.

36. Cleaning and Inspection. To clean and inspect the outer boom and extensions, proceed as follows:

a. Clean the outer boom and extensions thoroughly.

b. Check the boom for twist, bend or excessive damage. Check for elongation of any of the mounting points. Repair or replace as necessary.

c. Check the condition of the outer boom pivot pin and the associated bushes mounted in the inner boom. Replace worn or damaged parts as necessary.

d. Check the condition of the slide pad arrangement. Replace worn or damaged parts as necessary.

e. Check the condition of the outer boom cylinder mounting hardware. Replace worn or damaged parts as necessary.

f. Check the condition of the bushes in the piston rod end of the outer boom cylinder. Replace worn or damaged parts as necessary.

g. Check the condition of associated hoses and pipework. Repair or replace as necessary.

37. Installation. To install the outer boom and extensions, proceed as follows:

a. Lift the outer boom complete with extensions into position, ensuring that the sling is positioned to balance the weight evenly.

b. Carefully manoeuvre the pivot pin of the outer boom into the recess in the inner boom, taking care not to damage the bushes and spacer. Secure using the ring, plate and two bolts.

c. Lower the boom onto its rest on the crane body.

d. Lower the outer boom cylinder into its mounting bracket, align the pivot pin holes and secure using the pivot pin and retaining bolt.

e. Reconnect the wiring to the work lamp and outer boom tilt indicator. Suitably secure the wiring with cable ties.

f. Remove the plastic plugs from the hoses and fittings and reconnect the two flexible hose connections to the boom extension cylinder pipework.

g. Start the engine, engage the crane PTO and operate the crane to bleed the air from the system (see Para 50). Check for leaks and rectify as necessary.

INNER BOOM

38. Removal. To remove the inner boom, proceed as follows (Figure 19, Item 1):

a. Remove the outer boom cylinder as detailed in EMEI Vehicle G 713.

b. Remove the outer boom and extensions as detailed in Para 35.

c. Position lifting equipment above the inner boom and take up the weight with a suitable sling. Ensure that the sling is positioned so as to balance the weight evenly.

d. Suitably support the inner boom cylinder then remove the retaining bolt and pivot pin securing the cylinder to the inner boom.

e. Lower the piston rod end of the cylinder out of the mounting and out of the way.

f. Mark the position of the tilt indicator on the inner boom, remove the securing bolt then, move the indicator away from the inner boom.

g. Remove the clamps securing the boom extension cylinder pipework to the top of the inner boom and move the hoses and pipework out of the way.

h. Remove the retaining nut and plate securing the inner boom to crane body pivot shaft and remove the shaft.

i. Lift the inner boom clear of the crane body and lower to the ground.

39. Cleaning and Inspection. To clean and inspect the inner boom, proceed as follows:

a. Clean the inner boom thoroughly.

b. Check the boom for twist, bend or excessive damage. Check for elongation of any of the mounting points. Repair or replace as necessary.

c. Check the condition of the inner boom pivot pin and the associated bushes mounted in the crane body. Replace worn or damaged parts as necessary.

d. Check the condition of the inner boom cylinder mounting hardware. Replace worn or damaged parts as necessary.

e. Check the condition of the bushes in the piston rod end of the inner boom cylinder. Replace worn or damaged parts as necessary.

f. Check the condition of associated hoses and pipework. Repair or replace as necessary.

40. Installation. To install the inner boom, proceed as follows:

a. Lift the inner boom into position, ensuring that the sling is positioned to balance the weight evenly.

b. Carefully manoeuvre the inner boom onto its mounting point on the crane body, align the pivot shaft holes and insert the pivot shaft. Install the retaining plate and nut to secure the pivot pin in position.

c. Raise the inner boom cylinder and position it in its mount, align the pivot pin holes, then insert the pivot pin and secure in position with the retaining bolt.

d. Install the tilt indicator to the inner boom, observing the markings made during removal.

e. Install the outer boom and extensions as detailed in Para 37.

f. Install the outer boom cylinder as detailed in EMEI Vehicle G 713.

g. Start the engine, engage the crane PTO and operate the crane to bleed the air from the system (see Para 50). Check for leaks and rectify as necessary.

CRANE BODY

41. Removal. To remove the crane body, proceed as follows (Figure 19, Item 14):

a. Remove the inner boom, outer boom and boom extensions as detailed in Para 38.

b. Remove the inner boom cylinder as detailed in EMEI Vehicle G 713.

c. Disconnect and remove the hose shelf bracket and move the cluster of hoses clear of the crane body.

d. Remove the four screws securing the SPACE column box to the inside of the crane body and move clear of the crane body.

e. Cut the zip tie and disconnect the electronic safety control system (SPACE) wiring adjacent to the hose shelf. Move the wiring clear of the crane body.

f. Match mark the position of the crane body post in relation to the slew housing.

g. Position lifting equipment above the crane body and take up the weight with a suitable sling.

h. Remove the retaining bolt and plate securing the crane body locating stop in the left-hand side of the slew housing. Remove the locating stop.

i. Carefully lift the crane body free of the slew housing, guiding it vertically to avoid damage to the slewing piston or the upper and lower bushings. Lift the crane body clear of the vehicle and lower to the ground.

j. Match mark the position of the slew rack in relation to the slew housing.

42. Cleaning and Inspection. To clean and inspect the crane body, proceed as follows:

a. Clean the crane body thoroughly.

b. Check the condition of all hydraulic cylinder pins and bushes. Replace as necessary.

c. Check the crane body for twist, bend or damage. Check for elongation of any of the mounting points. Check the condition of the mounting hardware. Repair or replace as necessary.

d. Clean and check the condition of the bearing bushings in the slew housing. Replace as necessary.

e. Clean the base of the crane body thoroughly and check the condition of the bearing journal surfaces.

f. Check the condition of the pinion gear mounted on the base of the crane body. If the gear is worn or damaged, the crane body must be replaced.

g. Check the condition of all associated hoses and pipework. Repair or replace as necessary.

43. Installation. To install the crane body, proceed as follows:

a. If worn or damaged, replace the upper and lower bushings in the slew housing.

b. Replace the O-ring in the upper section of the slew housing.

c. Liberally coat the bearing journal surfaces, bushings, pinion gear and slewing rack with XG-274.

d. Ensure that the match marks on the rack and the slew housing are aligned.

e. Lift the crane body into position above the slew housing and align the match marks on the crane body post and the slew housing. Carefully lower the crane body while guiding the base through the upper and lower bushings, taking care not to damage the bushings.

f. Install the locating stop in the left-hand side of the slew housing and secure in position with the retaining plate and bolt.

g. Install the hose shelf bracket to the side of the crane body ensuring that the hoses are laying correctly.

h. Install the column box to the inside of the crane body.

i. Secure the SPACE wiring adjacent to the hose shelf with a zip tie.

j. Install the inner boom, outer boom and boom extensions as detailed in Para 40.

k. Install the inner boom cylinder as detailed in EMEI Vehicle G 713.

l. Start the engine, engage the crane PTO and operate the crane to bleed the air from the system (see Para 50). Check for leaks and rectify as necessary.

m. Check the level of fluid in the oil reservoir. If necessary, top up with ISO Grade 68.

SLEW MECHANISM – CYLINDERS AND RACK

44. Disassembly. To disassemble the slew mechanism, proceed as follows (Figure 19, Item 10):

a. Slew the crane to the left as far as it will travel. Disengage the PTO and shut down the engine.

b. Crack loose the flexible hose connection on the left-hand slew cylinder and disconnect the fitting. Use a suitable container to contain any oil spillage.

c. Place a suitable receptacle under the left-hand slew cylinder and to catch fluid spills as the cylinder is removed.

d. Remove the left-hand cylinder tube from the slew housing by screwing the tube out of the slew housing.

e. Slew the crane to the right as far as possible by hand.

f. Crack loose the flexible hose connection on the right-hand slew cylinder and disconnect the fitting. Use a suitable container to contain any oil spillage.

g. Place a suitable receptacle under the right-hand slew cylinder and to catch fluid spills as the cylinder is removed.

h. Remove the right-hand cylinder tube from the slew housing by screwing the tube out of the slew housing.

i. Remove the crane body as detailed in Para 41.

j. Withdraw the rack, complete with pistons, from the gearbox housing.

k. Remove the bolt securing the slide pad guide and remove the slide pad and guide.

45. Cleaning and Inspection. To clean and inspect the slew mechanism, proceed as follows:

a. Clean all components thoroughly.

b. Strip the seals from the pistons and discard.

c. Check the condition of the cylinder tubes. Replace worn or damaged parts as necessary.

d. Check the condition of the rack and its pinion gear. Repair or replace worn or damaged parts as necessary.

e. Check the condition of the slide pad and replace as necessary.

f. Clean and check the condition of the bearing bushings in the slew housing. Replace as necessary.

g. Clean the base of the crane body thoroughly and check the condition of the bearing journal surfaces.

46. Reassembly. To reassemble the slew mechanism, proceed as follows:

a. Install the slide pad and its guide and secure in position using the retaining bolt.

b. Renew all piston seals and install the rack, complete with pistons, in the gearbox housing.

c. Liberally coat the piston, seals and internal walls of the right-hand cylinder tube with hydraulic fluid and slide the cylinder tube over the rack. Screw fully home into the slew housing.

d. Slew the crane to the left as far as possible by hand.

e. Liberally coat the piston, seals and internal walls of the left-hand cylinder tube with hydraulic fluid and slide the cylinder tube over the rack. Screw fully home into the slew housing.

f. Remove the plastic plugs from the hoses and fittings and reconnect the two flexible hose connections to the slew cylinders.

g. Install the crane body as detailed in Para 43.

h. Start the engine, engage the crane PTO and operate the crane to bleed the air from the system (see Para 50). Check that the crane operates smoothly and correctly and rectify any leaks as necessary.

i. Check the level of fluid in the oil reservoir. If necessary, top up with ISO Grade 68.

OUTRIGGER EXTENSION

47. Removal. To remove the outrigger extension, proceed as follows:

a. Extend the outrigger extension cylinder to withdraw the extension slightly (approx. 200 mm) from the outrigger beam.

b. Disengage the PTO and shut down the engine.

c. Crack loose the two flexible hose connections at the valve block at the base of the outrigger leg cylinder and disconnect the fittings. Use a suitable container to contain the oil spillage. Tag the hoses to ensure correct connection during installation.

d. Position lifting equipment above the extension and outrigger leg and take up the weight using a suitable sling. Ensure that the sling is positioned so as to balance the weight evenly.

e. Remove the retaining nut on the push rod end of the outrigger extension cylinder and manually slide the extension beam out of the outrigger beam slightly to free the push rod end of the cylinder.

f. Fully withdraw the extension from the outrigger beam and lift it clear of the crane.

48. Cleaning and Inspection. To clean and inspect the outrigger extension, proceed as follows:

a. Clean the outrigger extension thoroughly.

b. Check the condition of the outrigger extension and roller system. Replace worn or damaged parts as necessary.

c. Check the condition of the outrigger extension cylinder mounting hardware. Replace worn or damaged parts as necessary.

d. Check the condition of associated hoses and pipework. Repair or replace as necessary.

49. Installation. To install the outrigger extension, proceed as follows:

a. Lift the outrigger extension into position, ensuring that the sling is positioned to balance the weight evenly.

b. Engage the hollow section of the outrigger beam and push the extension in until it can support itself.

c. Remove the sling and overhead lifting equipment.

d. Push the outrigger extension into the outrigger beam until the push rod end of the outrigger extension cylinder engages fully in the mounting bracket.

e. Secure the push rod end of the outrigger extension cylinder by installing the retaining nut.

f. Remove the plastic plugs from the hoses and fittings and reconnect the two flexible hose connections to the valve block at the base of the outrigger leg cylinder.

g. Start the engine, engage the crane PTO and operate the crane to bleed the air from the system (see Para 50). Check for leaks and rectify as necessary.

h. Check the level of fluid in the oil reservoir. If necessary, top up with ISO Grade 68.

HYDRAULIC SYSTEM

WARNING

Before removing hydraulic hoses and components, ensure that the hydraulic fluid is sufficiently cool to avoid burns.

WARNING

Before working on components of the hydraulic system, ensure that no residual pressure remains in the system by operating the relevant control levers.

WARNING

Before commencing removal of hydraulic components, place a warning sign not to operate the crane on or near the vehicle controls.

NOTE

Before commencing the removal procedure of any hydraulic component, clean the component and surrounding area, paying particular attention to pipe connections.

NOTE

After removing pipework from hydraulic components, always plug the pipes and fittings to prevent the ingress of dirt and moisture into the hydraulic system.

NOTE

After installation, bleeding and testing of hydraulic components, always check the level of fluid in the oil reservoir. If necessary, top up with ISO Grade 68.

BLEEDING AIR FROM THE SYSTEM

50. After repairs to any hydraulic component, the crane's hydraulic system must be bled to evacuate all air. If air is left to accumulate in the system, damage to hydraulic components can occur.

51. Damages that can occur include:

- **a.** cavitation damage to the pump;
- **b.** slow, jerky crane actions; and
- **c.** auto-ignition (dieseling) resulting in burnt and damaged seals.

52. To bleed air from the hydraulic system after repairs, proceed as follows (refer Figure 20):

- **a.** Check the level of fluid in the oil reservoir. If necessary, top up with ISO Grade 68.
- **b.** Start the engine and engage the crane PTO.
- **c.** Before unfolding the crane, operate the hydraulic cylinders against their stops.
- **d.** Operate the crane and run each hydraulic cylinder out to its end position at least twice. Refer to Figure 20 for the recommended sequence.
- **e.** Ensure that both pistons in the boom extension cylinder reach their end positions.
- **f.** Check for leaks and rectify as necessary.
- **g.** When the crane and outriggers have been returned to the transport position, re-check the level of fluid in the oil reservoir. If necessary, top up with ISO Grade 68.

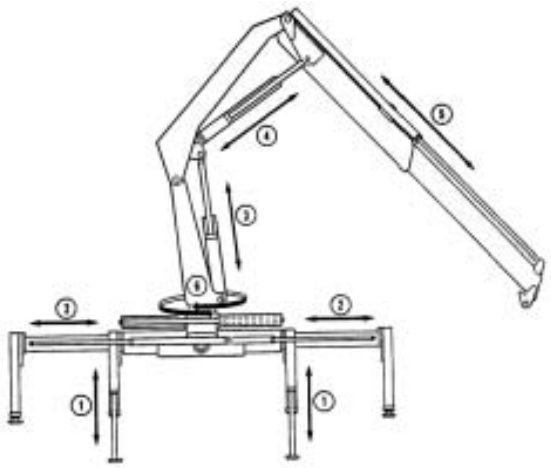


Figure 20 Bleeding Sequence

HYDRAULIC PUMP

53. Removal. To remove the hydraulic pump, refer to EMEI Vehicle G 713.

54. Disassembly. To disassemble the hydraulic pump, proceed as follows:

- **a.** Mount the pump in a vice and match mark the pump adaptor flange to the pump housing, then remove the three adaptor flange nuts and washers and separate the flange from the pump.
- **b.** Match mark the pump housing and rear cover plate then remove the eight bolts securing the rear cover plate to the pump housing.
- **c.** Using a soft faced hammer, tap the drive gear to dislodge the rear cover plate from the locating dowels and remove the rear cover plate.
- **d.** Using a screwdriver, lift and remove the thrust plate.
- **e.** Remove the pump gears and the lower thrust plate.
- **f.** Using suitable circlip pliers, remove the seal retaining circlip.
- **g.** Using a suitably sized socket from the inside of the pump housing, remove the seal and washer.

55. Cleaning and Inspection. To clean and inspect the hydraulic pump, proceed as follows:

a. Remove any gasket residue from mating surfaces of the adaptor plate and pump housing.

b. Check the sealing surfaces of the pump housing and end plate for damage and warpage. Repair or replace damaged components as necessary.

c. Check the condition of the bushes for nicks, burrs, scoring or elongation. Replace as necessary.

d. Check the gear teeth, shafts and spline for excessive wear and damage. Replace as a set if necessary.

e. Check the suction and pressure ports and connectors for signs of fractures or damage. Replace as necessary.

f. Check the splined sleeve of the adaptor plate for wear or damage. Replace as necessary.

56. Reassembly. To reassemble the hydraulic pump, proceed as follows:

a. Replace the O-ring seal in the rear cover plate. Grease the seal to facilitate fitment.

b. Replace the thrust plate balance and backup seals.

c. Lightly lubricate the new drive shaft seal, then insert the seal and washer from the outside until they sit squarely below the circlip recess. Secure the seal and washer with the retaining circlip.

d. Install the front thrust plate with the seal facing down and the suction side of the thrust plate over the drain hole.

e. Install the gears and the rear thrust plate with the suction side of the thrust plate aligned the same as the front thrust plate.

f. Align the rear cover plate to pump housing match marks and install the rear cover plate to the pump housing. The drain holes in the rear cover and pump housing must align.

g. Secure the rear cover plate with the eight retaining bolts.

h. Align the adaptor flange to pump housing match marks and install the adaptor flange to the pump housing. Apply Loctite 271 to the studs, then install the lock washers and nuts. Torque the nuts to 22 – 25 N.m.

57. Pressure Testing. To test the hydraulic pump output, proceed as follows:

a. Mount the pump on a test bench and connect to a 70 000 kPa (10 000 psi) pressure gauge and a 45 L/min (10 gal/min) flow meter.

b. Run the pump at 1 000 rpm and check that the pump produces the rated 36 L/min at 30 000 kPa (4 350 psi).

58. Installation. To install the hydraulic pump, refer to EMEI Vehicle G 713.

HYDRAULIC VALVES

59. The crane's major hydraulic valves are serviced as described in the following paragraphs.

Main Control Valve

60. Removal. To remove the main control valve, proceed as follows:

a. Remove the protective guard from the side of the control valve.

b. Before commencing the removal procedure of the control valve, clean the valve and surrounding area, paying particular attention to the pipe connections.

c. Tag all hydraulic pipework at the control valve to facilitate correct reconnection during re-assembly.

d. Disconnect all hydraulic pipework at the control valve and seal with suitable plugs.

e. Remove the retaining screw from the connector and remove the dump valve cable.

f. Remove the clevis pins securing the control levers and same sequence cross control rods to the control valve spools.

g. Remove the bolts securing the control valve to the mounting bracket and remove the control valve from the crane.

61. Disassembly. To disassemble the main control valve, proceed as follows:

a. Remove the positioners and solenoids from the valve bank by removing the securing Allen head screws.

b. Strip the dump valve, relief and solenoid valves from the valve body and disassemble. Discard all seals and O-rings.

62. **Cleaning and Inspection.** To clean and inspect the main control valve, proceed as follows:

a. Clean all components thoroughly.

b. Inspect all components for wear and corrosion. Replace worn or damaged parts as necessary.

63. **Reassembly.** To reassemble the main control valve, proceed as follows:

a. Reassemble all valves, ensuring that all seals and O-rings are replaced.

b. Refit the positioners and solenoids to the valve bank.

64. **Installation.** To install the main control valve, proceed as follows:

a. Position the control valve onto the mounting bracket and secure in position using the bolts, nuts and washers.

b. Install the clevis pins securing the control levers and same sequence cross control rods to the control valve spools.

c. Replace the dump valve cable and ensure that the connector is firmly secured using its retaining screw.

d. Remove the sealing plugs and reconnect all hydraulic pipework to the control valve. Refer to the tags placed on the pipework during removal for correct connection.

e. Start the engine, engage the crane PTO and operate the crane to bleed the air from the system (see Para 50). Check the operation of all functions of the crane. Check for leaks and rectify as necessary.

f. Check the level of fluid in the oil reservoir. If necessary, top up with ISO Grade 68.

g. Replace the protective guard onto the side of the control valve.

65. **Pressure Testing.** To test the system's maximum and counter pressures, proceed as follows:

a. **Maximum Pressure.** Remove the cap from the measuring nipple fitted to the main control valve and connect a 70 000 kPa (10 000 psi) oil pressure gauge.

b. Start the engine, engage the crane PTO and, while operating the crane, check the pressure reading on the pressure gauge. The reading is to be 27 000 kPa.

c. **Counter Pressure.** Disengage the crane PTO and connect a 3 500 kPa (500 psi) oil pressure gauge to the measuring nipple of the main control valve.

d. With the crane PTO engaged and the engine at operating rpm, allow the crane to sit at rest (with all levers in the neutral position) and check the pressure reading on the pressure gauge. The reading is to be 1 400 kPa.

e. Shut down the engine, disengage the crane PTO, remove the pressure gauge from the measuring nipple and replace the nipple cover.

Outrigger Control Valve

66. The outrigger control valve is located on the left-hand side of the vehicle above the outrigger beam.

67. **Removal.** To remove the outrigger control valve, proceed as follows:

a. Disconnect all hydraulic hoses from the outrigger control valve and seal with suitable plugs. Tag all hoses to facilitate correct reconnection during re-assembly.

b. Dismantle the cable control mechanisms from the control valve spools.

c. Remove the three bolts, nuts and washers securing the control valve and protective guard to the mounting bracket and remove the valve assembly and guard.

68. **Disassembly.** To disassemble the outrigger control valve, proceed as follows:

a. Remove the clevis pins retaining the control levers and remove the levers from the spool valve.

b. Strip the relief and check valves from the valve body and disassemble. Discard all seals and O-rings.

c. Disassemble the spool controls from the operating spools and discard all seals and O-rings.

d. Remove the screws retaining the lever pivot brackets, remove the brackets and their seals. Discard all seals and O-rings.

e. Remove the spools from the valve body.

69. Cleaning and Inspection. To clean and inspect the outrigger control valve, proceed as follows:

a. Clean all components thoroughly.

b. Inspect all components for wear and corrosion. Replace worn or damaged parts as necessary.

70. Reassembly. To reassemble the outrigger control valve, proceed as follows:

a. Reassemble the relief and check valves and install them in the valve body, ensuring that all seals and O-rings are replaced.

b. Install the spools and spool control mechanisms.

c. Refit the lever pivot brackets to the appropriate spools, replacing the scrapers, seals and O-rings.

d. Refit the levers to the appropriate brackets.

71. Installation. To install the outrigger control valve, proceed as follows:

a. Position the control valve and protective guard onto the mounting bracket and secure in position using the three bolts, nuts and washers.

b. Re-install the cable control mechanisms to the appropriate control valve spools.

c. Remove the sealing plugs and reconnect all hydraulic pipework to the control valve. Refer to the tags placed on the pipework during removal for correct connection.

d. Start the engine, engage the crane PTO and operate the outriggers and crane functions to bleed the air from the system (see Para 50). Check for leaks and rectify as necessary.

e. Check the level of fluid in the oil reservoir. If necessary, top up with ISO Grade 68.

Inner and Outer Boom Cylinder Load Holding Valves (LHV)

72. Load holding valves are fitted to the underside of the inner and the top of the outer boom cylinders.

73. Removal. To remove the LHV, proceed as follows:

a. Disconnect all hydraulic pipework at the LHV and seal with suitable plugs. Tag all pipes to facilitate correct reconnection during reassembly.

b. Cut the appropriate cable ties and disconnect the Overload Protection (OLP) wiring to the LHV.

c. Remove the two bolts and nuts securing the LHV to the cylinder bracket. Remove the LHV from the crane.

74. Disassembly. To disassemble the LHV, proceed as follows:

a. Remove the OLP sender from the body of the LHV.

b. Unscrew the straight adaptor from the V1 port and remove the spring and cone from the housing. Discard the O-ring.

c. Unscrew and remove the relief valve housing and its components from the housing. Discard all O-rings.

75. Cleaning and Inspection. To clean and inspect the LHV, proceed as follows:

a. Clean all components thoroughly.

b. Inspect all components for wear and corrosion. Replace worn or damaged parts as necessary.

76. Reassembly. To reassemble the LHV, proceed as follows:

a. Reinstall the relief valve and its components in the housing.

b. Reinstall the spring and cone in the V1 port of the housing, fit a new O-ring to the straight adaptor and reinstall the adaptor in the housing.

c. Reinstall the OLP sender in the body of the LHV in the port marked OLP.

77. Installation. To install the LHV, proceed as follows:

a. Locate the LHV against the cylinder bracket and secure in position using the two bolts and nuts.

b. Remove the sealing plugs and reconnect all hydraulic pipework to the LHV. Refer to the tags placed on the pipework during removal for correct connection.

c. Reconnect the OLP wiring to the LHV and secure using cable ties.

d. Start the engine, engage the crane PTO and operate the crane to bleed the air from the system (see Para 50). Check the operation of all functions of the crane. Check for leaks and rectify as necessary.

e. Check the level of fluid in the oil reservoir. If necessary, top up with ISO Grade 68.

Boom Extension Cylinder Load Holding Valve (LHV)

78. A load holding valve is fitted to the leading end of the boom extension cylinder on the right-hand side.

79. Removal. To remove the LHV, proceed as follows:

a. Disconnect all hydraulic pipework at the LHV and seal with suitable plugs. Tag all pipes to facilitate correct reconnection during reassembly.

b. Remove the two bolts and nuts securing the LHV to the cylinder bracket. Remove the LHV from the crane.

80. Disassembly. To disassemble the LHV, proceed as follows:

a. Remove the lead seals and the protective covers from both valves.

b. Disassemble both valves and discard all seals and O-rings.

81. Cleaning and Inspection. To clean and inspect the LHV, proceed as follows:

a. Clean all components thoroughly.

b. Inspect all components for wear and corrosion. Replace worn or damaged parts as necessary.

82. Reassembly. To reassemble the LHV, proceed as follows:

a. Reassemble both valves replacing all seals and O-rings.

b. Replace the protective covers and lead seals onto both valves.

83. Installation. To install the LHV, proceed as follows:

a. Locate the LHV against the cylinder bracket and secure in position using the two bolts and nuts.

b. Remove the sealing plugs and reconnect all hydraulic pipework to the LHV. Refer to the tags placed on the pipework during removal for correct connection.

c. Start the engine, engage the crane PTO and operate the crane to bleed the air from the system (see Para 50). Check the operation of all functions of the crane. Check for leaks and rectify as necessary.

d. Check the level of fluid in the oil reservoir. If necessary, top up with ISO Grade 68.

HYDRAULIC CYLINDERS

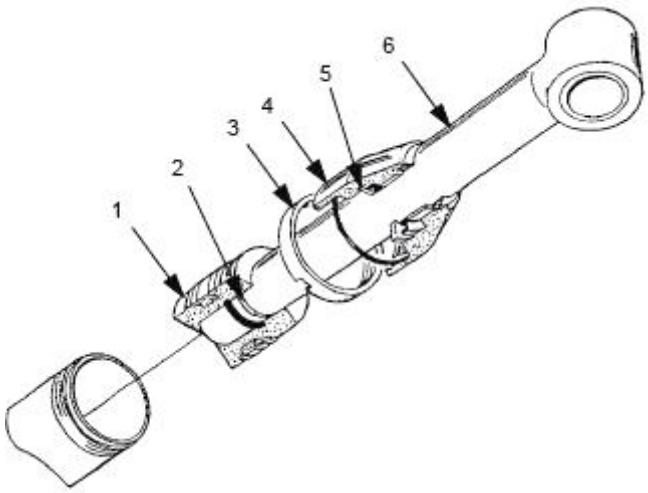
Inner and Outer Boom Cylinders

84. Removal. To remove the inner and outer boom cylinders, refer to EMEI Vehicle G 713.

85. Disassembly. To disassemble the inner and outer boom cylinders, proceed as follows (Figure 21):

a. Mark the position of the locking nut (3) and top nut (4).

b. Undo the locking nut a half turn using a hook spanner or drift. It is easier to loosen if you put pressure on the piston side. Up to 30 MPa is allowed.



Item	Description	Item	Description	Item	Description
1	Piston	3	Locking Nut	5	Locking Ring
2	Locking Wire	4	Top Nut	6	Piston Rod

Figure 21 Boom Cylinder

c. Release the hydraulic pressure and undo the top nut.

d. Withdraw the piston rod (6) with the top nut (4) and piston (1).

e. The piston is held in place using a locking wire (2). This is forced out when the piston is rotated on the piston rod. Locate the locking hole by observing the etched marking on the piston rod (Figure 22). Rotate the piston until the recess in the piston indexes with the mark on the piston rod. Push the hooked part of the locking wire into the locking hole (the hook may have already come loose from the hole). Rotate until the pointed end of the locking wire can be lifted out of the recess using a screwdriver. Continue to rotate until the locking wire is completely free.

f. Drive the piston off the piston rod using a rubber mallet.

g. Remove the top nut (4) from the piston rod (6).

h. Remove the locking ring (5).

i. Remove the seals from the piston and discard.

86. Cleaning and Inspection. To clean and inspect the inner and outer boom cylinders, proceed as follows:

a. Thoroughly clean all components and check for corrosion, pitting, nicks, burrs, scratches and excessive wear. Replace worn or damaged components as necessary.

b. Inspect the condition of the hydraulic pipes for cracking and fatigue. Replace if necessary.

c. Check the condition of the bushes at each end of the cylinder. Replace worn bushes using a hammer and drift.

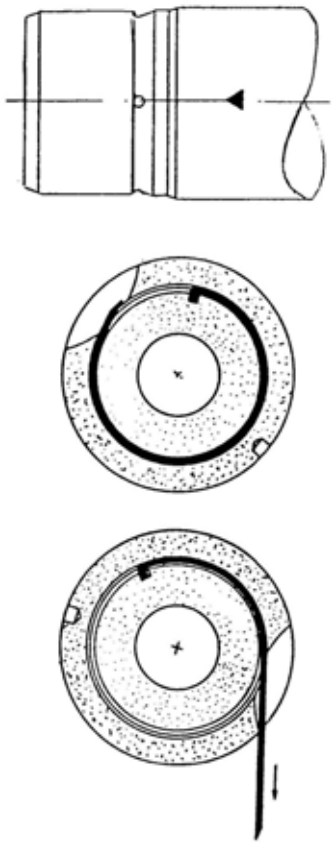


Figure 22 Locking Wire Removal

87. Reassembly. To reassemble the inner and outer boom cylinders, proceed as follows:

a. Replace all piston and top nut seals and rings (the packing set).

b. Install the top nut and locking nut on to the piston rod.

c. Install the piston to the piston rod, ensuring that the locking wire locating hole is visible.

d. Using a new locking wire, locate the hooked end into the locating hole and rotate the piston until the locking wire is fully seated.

e. Fit the stop.

f. Lubricate the piston seals using hydraulic fluid (ISO Grade 68).

g. Reassemble the piston rod and piston into the cylinder tube.

h. Lubricate the threaded section of the cylinder tube with anti-seize grease.

i. Screw the top nut and locking nut fully into position and then back off till the originally marked position is reached. This position is correct for fitting the hydraulic pipe connection.

j. Prestress the top nut by applying 30 MPa hydraulic pressure on the piston side of the cylinder.

k. Securely tighten the locking nut against the top nut back to its original marked position while the hydraulic pressure is still applied.

88. Installation. To install the inner and outer boom cylinders, refer to EMEI Vehicle G 713.

Outrigger Leg Cylinder

89. Removal. To remove the outrigger leg cylinder, refer to EMEI Vehicle G 713.

90. Disassembly. To disassemble the outrigger leg cylinder, proceed as follows (Figure 23):

a. Pressurise the piston rod end of the cylinder to approximately 20 MPa through the hydraulic connection in the top nut (4).

b. Remove the three bolts securing the support plate extension to the support plate (1).

c. Warm up the support plate (1) to 400 °C to 500 °C to release the Loctite bond.

d. After approximately 15 minutes, unscrew the plate one half turn using a drift.

e. Release the pressure on the piston rod end of the cylinder.

f. Clean the sealant from the locking wire slot in the outrigger leg cylinder (10).

g. Turn the top nut (4) anticlockwise (as seen from the lower end of the outrigger leg), so that the locking wire (7) is pushed out through the slot in the outrigger cylinder.

h. Remove the outrigger piston/rod assembly (8) with the top nut, from the cylinder.

i. Unscrew the support plate (1) and remove the top nut.

j. Remove and discard all the seals (2), (3), (5), (6) and (9).

91. Cleaning and Inspection. To clean and inspect the outrigger leg cylinder, proceed as follows:

a. Thoroughly clean all components and check surfaces for corrosion, pitting, nicks, burrs, scratches and excessive wear. Replace worn or damaged components as necessary.

b. Inspect the condition of the hydraulic pipes for cracking and fatigue. Replace if necessary.

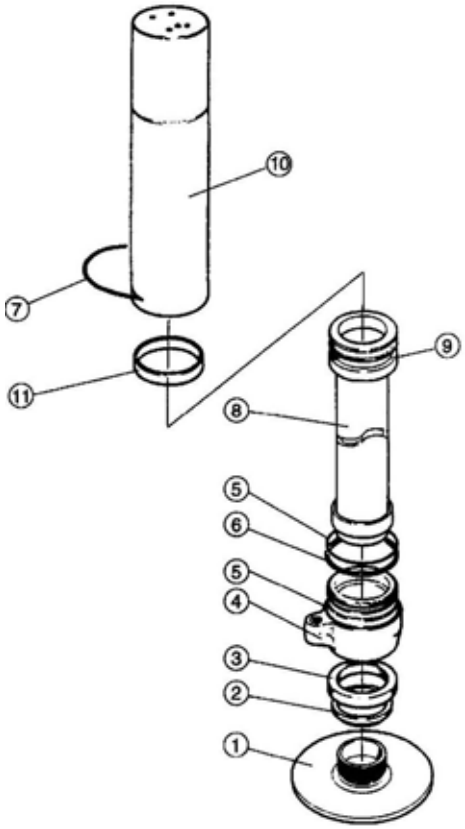


Figure 23 Outrigger Leg Cylinder

92. Reassembly. To reassemble the outrigger leg cylinder, proceed as follows (Figure 23):

a. Lubricate all the new seals with hydraulic oil (ISO Grade 68).

b. Lubricate the inside surfaces of the top nut (4) with molybdenum sulphide grease.

c. Assemble the parts in reverse order to dismantling, noting the following:

(1) Fit the top nut (4) with a new locking wire. Turn the top nut through 345° to seat the lock wire.

(2) Seal the slot in the outrigger leg cylinder (10) with silicone sealant.

(3) Clean the support plate (1) thread with a steel brush and lock it to the outrigger piston/rod assembly (8) with Loctite 275.

93. Installation. To install the outrigger leg cylinder, refer to EMEI Vehicle G 713.

HYDRAULIC HOSES AND PIPES

Replacement

94. Hydraulic hoses, pipes, couplings and associated components are to be replaced using standard workshop procedures. Refer to Repair Parts Scale 02164 for the correct replacement hose, pipe or component part. After replacement, operate the hydraulics to ensure that the components are correctly connected and are free of leaks.

Hydraulic Circuit Diagram

95. Figure 24 illustrates the hydraulic system in a simplified form indicating the various control valves associated with each circuit.

CONTROL SYSTEM

WARNING

Before removing hydraulic hoses and components, ensure that the hydraulic fluid is sufficiently cool to avoid burns.

WARNING

Before commencing removal of hydraulic components, place a warning sign not to operate the crane on or near the vehicle controls.

CAUTION

After any maintenance work is carried out on hydraulic components of the pressure reduction filter circuit, the lines must be flushed as described at PARA 107.

NOTE

Before commencing the removal procedure of any hydraulic component, clean the component and surrounding area, paying particular attention to pipe connections.

NOTE

After removing pipework from hydraulic components, always plug the pipes and fittings to prevent the ingress of dirt and moisture into the hydraulic system.

NOTE

After installation and testing of hydraulic components, always check the level of fluid in the oil reservoir. If necessary, top up with ISO Grade 68.

COMBIDRIVE REMOTE COMPONENTS

96. The CombiDrive is an electronic-hydraulic system for remote control of the main control valve in the crane. Its digital electronic system contains a number of microprocessors that receive signals from the operator’s controller and converts them to commands to the operating hydraulic system that governs the crane valve spools.

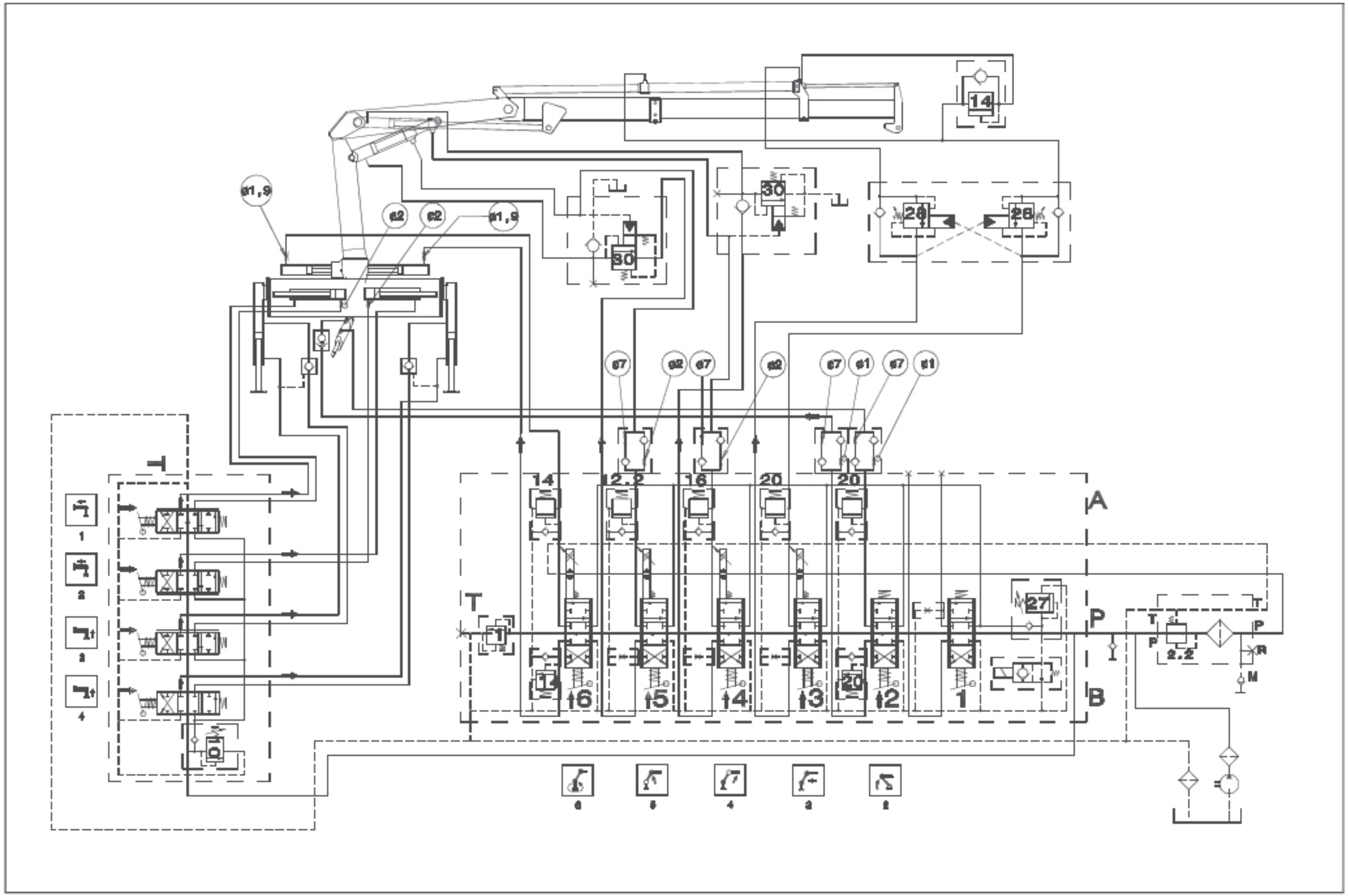


Figure 24 Hydraulic Circuit Diagram

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97. The microprocessor in the controller transmits a 'protocol' 45 times per second to the Digital Amplifiers (DA modules). The signals in the microprocessor in each DA module are converted into a proportional current to the solenoids. This current to the solenoids will cause a corresponding movement of the spool valve to operate the appropriate crane function. A special safety check is performed each time the stop button on the controller is pulled out and also continuously during operation.

98. The CombiDrive remote control system consists of the following components (Figure 25):

a. Controller;

b. DA Modules;

c. Positioners;

d. Dump Valve; and

e. Pressure Reduction Filter.

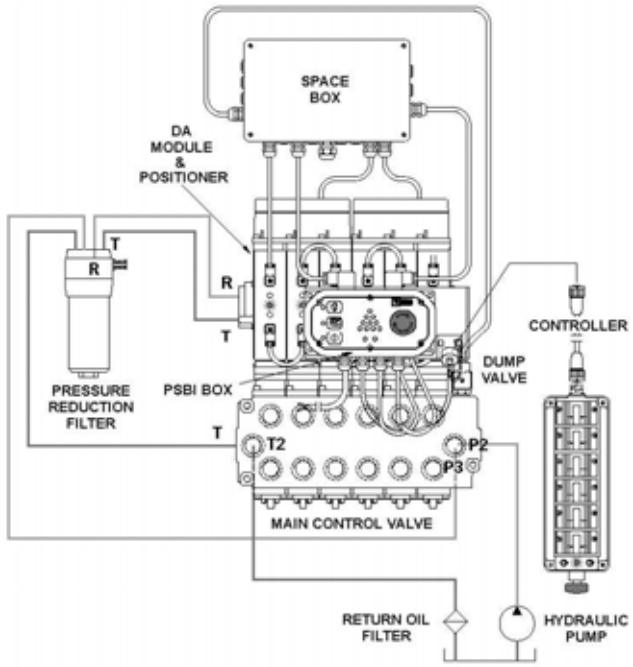


Figure 25 CombiDrive Remote Control System

Controller

99. The controller is used to allow remote control over the operations of the crane. A 15-metre cable is supplied to connect the controller to the crane control system. The connection is made on the left-hand side of the vehicle adjacent to the PSBI power box. The controller is equipped to control the slewing, inner boom, outer boom, boom extension and outrigger functions of the crane. It is fitted with an emergency stop button, six proportional control operating levers, a three position crane speed toggle switch, an indicator light, a spring-loaded toggle switch (for additional functions) and two push buttons (not used).

100. The controller can be serviced by replacement of the following items:

a. control lever units;

b. toggle switches;

c. contact for the control cable;

d. protective frame; and

e. chassis with stop button and electronics.

NOTE

The stop button is not replaceable.

DA Modules

101. The DA modules contain microprocessors and amplifiers which control the positioners' solenoids. The positioners are located directly above each spool valve unit and the DA modules are attached.

102. Each DA module can be serviced by replacement of the following items:

a. cables; and

b. connectors.

Positioners

103. The positioners are servo valves governing the control valve functions and thereby the crane functions.

104. **Upper Solenoid.** To replace the upper solenoids and seals, proceed as follows:

a. Clean the main control valve and surrounding area, paying particular attention to pipe connections.

b. Loosen the DA module by removing the two retaining screws.

c. Remove the four bolts that retain the solenoid and pull up the solenoid housing.

d. Fit and lubricate a new O-ring with ISO Grade 68, then replace the solenoid housing. Ensure that no dirt penetrates into the housing or spool valve.

Pressure Reduction Filter

105. The function of the pressure reduction filter is to supply the positioners with filtered oil at a working pressure of approximately 22 bar. The filter is attached to the slew cylinder on the left-hand side of the vehicle.

106. To check and adjust the pressure reduction filter's output, proceed as follows (Figure 26):

a. Remove the cap from the measuring nipple (3) and connect a 3 500 kPa oil pressure gauge.

b. Start the engine, engage the crane PTO and operate the crane using the CombiDrive remote controller and check the reduced pressure reading on the pressure gauge. The reading is to be 2 200 kPa.

c. If the pressure setting requires adjustment, remove the cover from the relief valve (2) and adjust the valve to achieve the required pressure.

d. Replace the reduction valve cover, shut down the engine, disengage the crane PTO, remove the pressure gauge from the measuring nipple and replace the nipple cover.

e. Before running oil through the pressure reduction system, flush the system as described at Para 107.

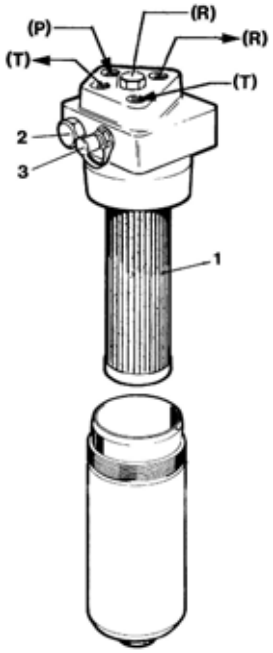


Figure 26 Pressure Reduction Filter

107. Flushing Lines. Before running oil through the pressure reduction system after performing maintenance tasks on the system (excluding replacement of the filter element), flush the circuit as follows:

a. Disconnect both hoses from their connections at the valve positioners at the main control valve.

b. Using a suitable male/male adapter, connect the two hoses together.

c. ..Start the engine, engage the crane PTO and allow oil to circulate through the filter for approximately 30 seconds.

d. Disengage the crane PTO and stop the engine.

e. Disconnect the hoses from the adapter and re-install to the correct ports on the valve positioners.

CAUTION

Never operate the crane without the filter cartridge.

CAUTION

After any maintenance work is carried out on hydraulic components of the pressure reduction filter circuit, the lines must be flushed as described at Para 107. This does not apply to filter element changes.

NOTE

There is no bypass valve in the filter. Consequently, if the filter is blocked, the remote control will cease to function.

108. The filter element is to be replaced in accordance with instructions contained in EMEI Vehicle G 713.

SPACE SYSTEM COMPONENTS

109. The SPACE system components are serviced as described in the following paragraphs.

SPACE Box

110. This box is an aluminium case with several cable inlets. (Figure 27). It is fitted to the right-hand slew cylinder tube. All the signals from sensors and the remote control are received by the SPACE box.

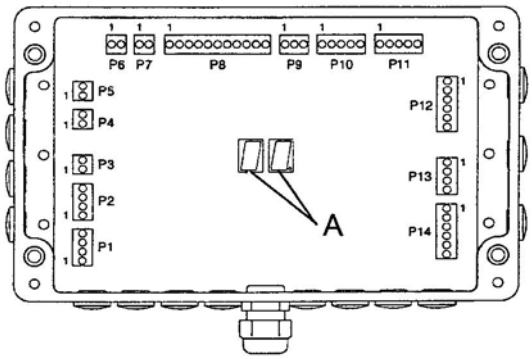


Figure 27 Space Box Connection Plinths

111. There are two digital indicators (A) in the box, which display a number (error code) if a error occurs in the system. They also indicate the number of errors. To interpret these numbers, there is an error code list detailed at Table 42. If there are no errors, the number 0 flashes.

NOTE

When ordering a replacement SPACE box, specify the crane model and serial number details and the replacement SPACE box will be supplied correctly configured. In the event that configuration is required, refer to the procedure detailed at Para 112.

112. Removal and Installation. To remove a faulty SPACE box and install a replacement, proceed as follows:

a. Remove the old SPACE box from its support.

b. Remove and connect all cables plinth by plinth from the old box to the replacement box, paying particular attention to cable numbers and their positions.

c. Plug all unused cable entry points and seal with a suitable silicone sealant.

d. Start the SPACE system by pressing the start button on the PSBI box.

e. Check that there are no errors displayed on the error digital display.

f. Locate and record the following data:

(1) program serial number;

(2) old system type;

(3) new system type; and

(4) date of change.

g. Contact HIAB and request a password to affect the change. The HIAB representative will request the above information and will issue a password which will only be valid for that change on that date.

113. Configure New System Type

a. Connect the diagnostic terminal (laptop computer) to the SPACE box via the interface cable and start the configuration application.

b. On the main menu, select the system access level.

c. Select PARS (F3).

d. Select TYPE (F5).

e. Enter the new system type and press ENTER.

f. Enter the password and press ENTER.

g. The new system type will be displayed.

114. Configure Crane Type

a. Contact HIAB and request a temporary password for Access Level 2.

b. On the main menu, select INIT (F2).

c. Select TYPE (F1).

d. Select the crane model from the list using the arrow keys and press ENTER.

e. The new model will be displayed, press ENTER.

f. A confirmation message will be displayed asking if you are sure. If you are sure, press the Y key (Yes) and press ENTER.

g. A confirmation message will be displayed asking if you want to start from defaults. This means that the program will assign the correct values to all parameters for the selected crane model. Press the Y key (Yes) and press ENTER.

h. A message will be displayed asking for the crane serial number. Type the serial number (available on the crane slewing housing, e.g. 0901013) and press ENTER.

115. Connection Plinths. The connection plinths for the SPACE box are described in Table 3 (Figure 27).

Table 3 Space Box Connection Plinths

Plinth	Connection	Plinth	Connection
P1	**Communication with Terminal**	**P12**	**From MUX Boxes (1-3) cont.**
P1.1	Ground	P12.3	Clock pulse
P1.2	24 volt	P12.4	Signal from MUX box 1 (0 or 24 volt)
P1.3	Data to terminal	P12.5	Signal from MUX box 2 (2 or 24 volt)
P1.4	Data from terminal	P12.6	Signal from MUX box 3 (0 or 24 volt)
P2	**To Digital Amplifier**	**P7**	**Tank Temperature**
P2.1	Ground	P7.1	24 volt
P2.2	24 volt DA Modules	P7.2	Signal from tank temperature sensor
P2.3	Data -	**P8**	**From Sensors at Arm System**
P2.4	Data +	P8.1	Ground
P3	**To Dump Valve**	P8.2	24 volt
P3.1	Ground	P8.3	Signal from pressure sensor, inner boom (4-20 mA)
P3.2	24 volt to dump valve	P8.4	Signal from pressure sensor, outer boom (4-20 mA
P4	**Supply to Relay Box**	P8.5	Signal from tilt indicator, outer boom (10 mA or 19 mA)
P4.1	Ground	P8.6	Signal from angle sensor or tilt indicator, inner boom (4-20 mA/10 or 19 mA)
P4.2	24 volt to relay box	P8.7	Signal from pressure sensor, jib, piston rod side (4-20 mA)
P5	**Data to Relay Box**	P8.8	Signal from pressure sensor, jib, piston side (4-20 mA)
P5.1	Data -	P8.9	Signal from tilt indicator, jib (10 mA or 19 mA)
P5.2	Data +	P8.10	Signal from winch indicators (4-20 mA, in steps)
P6	**Slewing Angle Sensor**	P8.11	Signal from personnel basket switch (between 4 and 20 mA)
P6.1	24 volt	**P9**	**From Spool Sensor No. 7**
P6.2	Signal from slewing angle sensor	P9.1	Ground
P10	**From Spool Sensor No. 4-6**	P9.2	24 volt
P10.1	Ground	P9.3	Spool sensor signal (1,5-4,5 volt)
P10.2	24 volt	**P13**	**From PSBI Box (Left Side)**
P10.3	Signal from spool sensor (1,5-4,5 volt)	P13.1	Ground
P10.4	Signal from spool sensor (1,5-4,5 volt)	P13.2	24 volt (MAN/REM)
P10.5	Signal from spool sensor (1,5-4,5 volt)	P13.3	Data -
P11	**From Spool Sensor No. 1-3**	P13.4	Data +
P11.1	Ground	**P14**	**From PSBI Box (Right Side)**
P11.2	24 volt	P14.1	Ground
P11.3	Signal from spool sensor (1,5-4,5 volt)	P14.2	24 volt (dump valve)
P11.4	Signal from spool sensor (1,5-4,5 volt)	P14.3	Signal from release button (0 and 24 volt)
P11.5	Signal from spool sensor (1,5-4,5 volt)	P14.4	Main voltage (24 volt)
P12	**From MUX Boxes (1-3)**	P14.5	Protocol to PSBI
P12.1	Ground	P14.6	Ground
P12.2	24 volt		

PSBI Box

116. A PSBI box is fitted at the main operator station. It contains a selector for remote and manual control. The main power supply is connected to the Main Power Connection Box (MPCB) and distributed to appropriate components in the system. The box is fitted with various buttons and lamps, which are used to operate the crane.

117. Connection Plinths. The connection plinths for the PSBI box are as described in Table 4, (Figure 28).

Table 4 PSBI Box Connection Plinths

Plinth	Connection	Plinth	Connection
P1	**To MPCB Box (90% Lamp)**	**P4**	**To External Dump Valve**
P1.1	Ground	P4.1	Relay contact
P1.2	24 volt	P4.2	Relay contact
P2	**To/from CombiDrive Hand Controller**	**Cover**	
P2.1	24 volt	**P1**	**Signal From Pressure Switch**
P2.2	Data	P1.1	24 volt
P2.3	Ground (connection only to HBC)	P1.2	Signal
P3	**Supply Voltage (from Battery Via Fuse)**	**P2**	**To/from Lamp Kit**
P3.1	Ground	P2.1	24 volt from lamp kit
P3.2	24 volt	P2.2	Signal to lamp kit

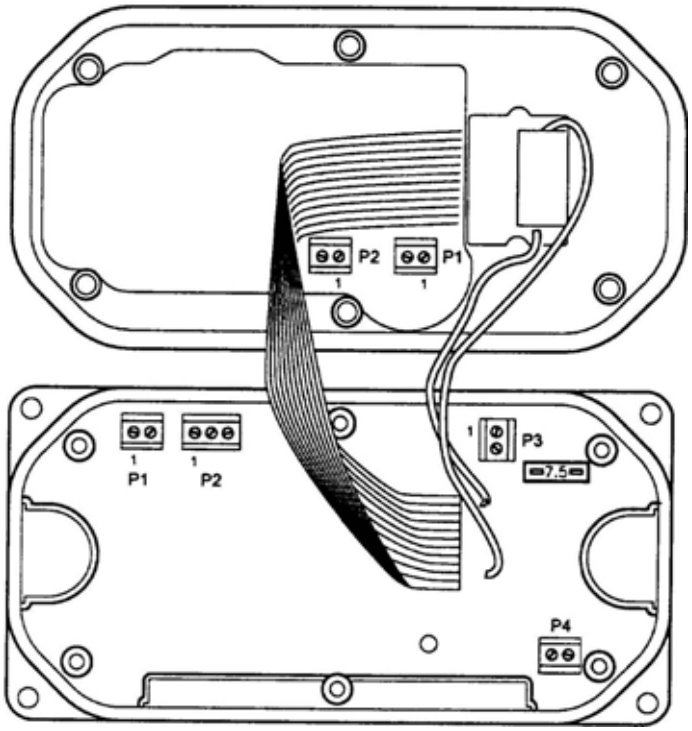


Figure 28 PSBI Box Connection Plinths

MPCB Box

118. A MPCB box is mounted below the PSBI box and is used to distribute 24 V power to different boxes and components within the system. The PSBI box, and consequently the SPACE system, receives power from the MPCB box. There are two separate circuits each protected by a 15 A fuse. The SPACE system is connected to one of the circuits while the oil cooler and other high current draw components are connected to the other circuit.

119. Connection Plinths. The connection plinths for the MPCB box (Figure 29) are described in Table 5.

Table 5 MPCB Box Connection Plinths

Plinth	Connection
P1	**Vehicle Power Supply**
P1.1	Ground
P1.2	24 volt
P2-P5, P8-P11	**Connection Plinths**
PX.1	Ground
PX.2	24 volt
P6	**90% Lamp (Signal out to Lamp)**
P6.1	Ground
P6.2	24 volt
P7	**90% Lamp (Signal In from PSBI Box)**
P7.1	Ground
P7.2	24 volt

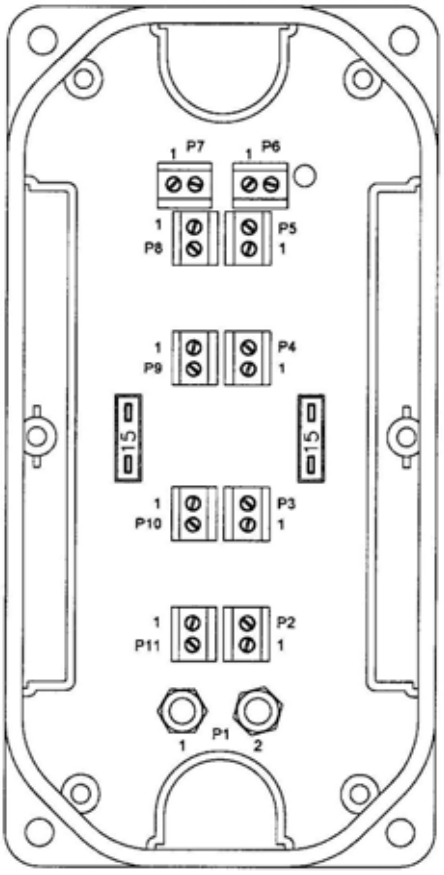


Figure 29 MPCB Box Connection Plinths

Column Box

120. This connection box is fitted to the crane column. All the signals from the pressure sensors and indicators on the boom system are collected in the box. The column box is connected to the SPACE box using an 11-conductor cable.

121. The plugs A (Figure 30) are only to be removed if a jib or winch is fitted.

122. Connection Plinths. The connection plinths for the column box are as described in Table 6 (refer to Figure 30).

Table 6 Column Box Connection Plinths

Plinth	Connection	Plinth	Connection
P1	**To SPACE Box**	**P4**	**From Tilt Indicator, Outer Boom**
P1.1	Ground	P4.1	24 volt
P1.2	24 volt	P4.2	Signal (10 or 19 mA)
P1.3	Signal from pressure sensor inner boom (4-20 mA)	**P5**	**From Angle Sensor/Tilt Indicator, Inner Boom**
P1.4	Signal from pressure sensor, outer boom (4-20 mA)	P5.1	24 volt
P1.5	Signal from tilt indicator, outer boom (10 mA or 19 mA)	P5.2	Signal (4-20 mA/10 or 19 mA)
P1.6	Signal from angle sensor or tilt indicator, inner boom (4-20 mA/10 or 19 mA)	**P6**	**From Jib**
P1.7	Signal from pressure sensor, jib, piston rod side (4-20 mA)	P6.1	24 volt
P1.8	Signal from pressure sensor, jib, piston side (4-20 mA)	P6.2	Signal from pressure sensor, jib, piston rod side (4-20 mA)
P1.9	Signal from tilt indicator, jib, (10 mA or 19 mA)	P6.3	Signal from pressure sensor, jib, piston rod side (4-20 mA)
P1.10	Signal from winch indicators (4-20 mA, in steps)	P6.4	Signal from tilt indicator, jib, (10 mA or 19 mA)
P1.11	Signal from personnel basket indicator (between 4 and 20 mA)	**P7**	**From Winch**
P2	**From Pressure Sensor, Inner Boom**	P7.1	Ground
P2.1	24 volt	P7.2	24 volt
P2.2	Signal (4-20 mA)	P7.3	Signal from winch indicators (4-20 mA, in steps)
P3	**From Pressure Sensor, Outer Boom**	**P8**	**From Personnel Basket**
P3.1	24 volt	P8.1	24 volt
P3.2	Signal (4-20 mA)	P8.2	Signal from personnel basket 4-20 mA

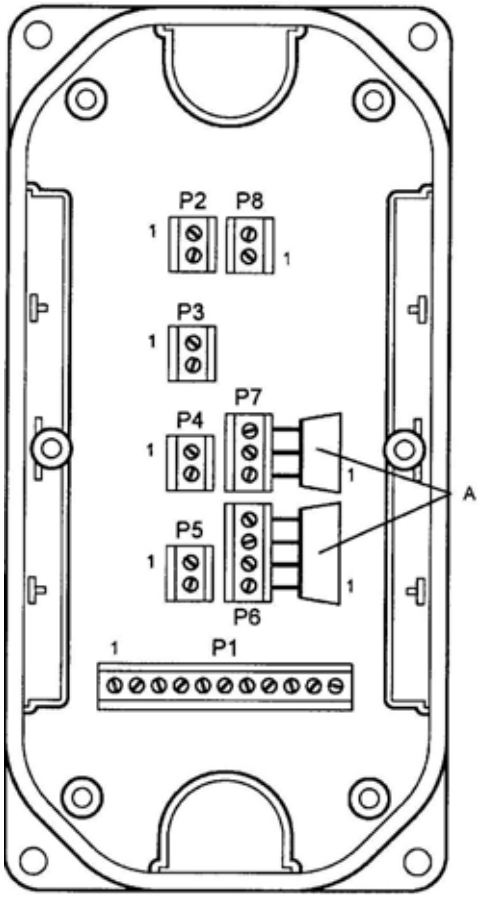


Figure 30 Column Box Connection Plinths

SPACE Cable Connections

123. Figure 31 illustrates the connection between SPACE components and can be useful during fault finding of the crane's control system.

DIAGNOSTIC TERMINAL

124. In the SPACE box microprocessor, there is a monitoring program for the different SPACE functions. The computer terminal is equipped with its own program to serve as a link between the service staff and SPACE during:

- **a.** parameter checking;
- **b.** parameter setting;
- **c.** variable checking; and
- **d.** troubleshooting.

125. To carry out the above tasks, the computer terminal must have the appropriate terminal software loaded and be connected to the SPACE box using the cable supplied in the Interface Kit (p/n 3650766).

Working with the Terminal

126. There are two different access levels to the SPACE system. Access 1 is the normal level. Access 2 is the higher level for HIAB system specialists. One of these levels are needed to adjust settings, etc.

127. All authorised service personnel have a personal ID code and password (the personal ID code and password governs the access level). It is possible to enter the system and check a limited number of settings without a password. To do this, press ENTER when you are asked for the ID code.

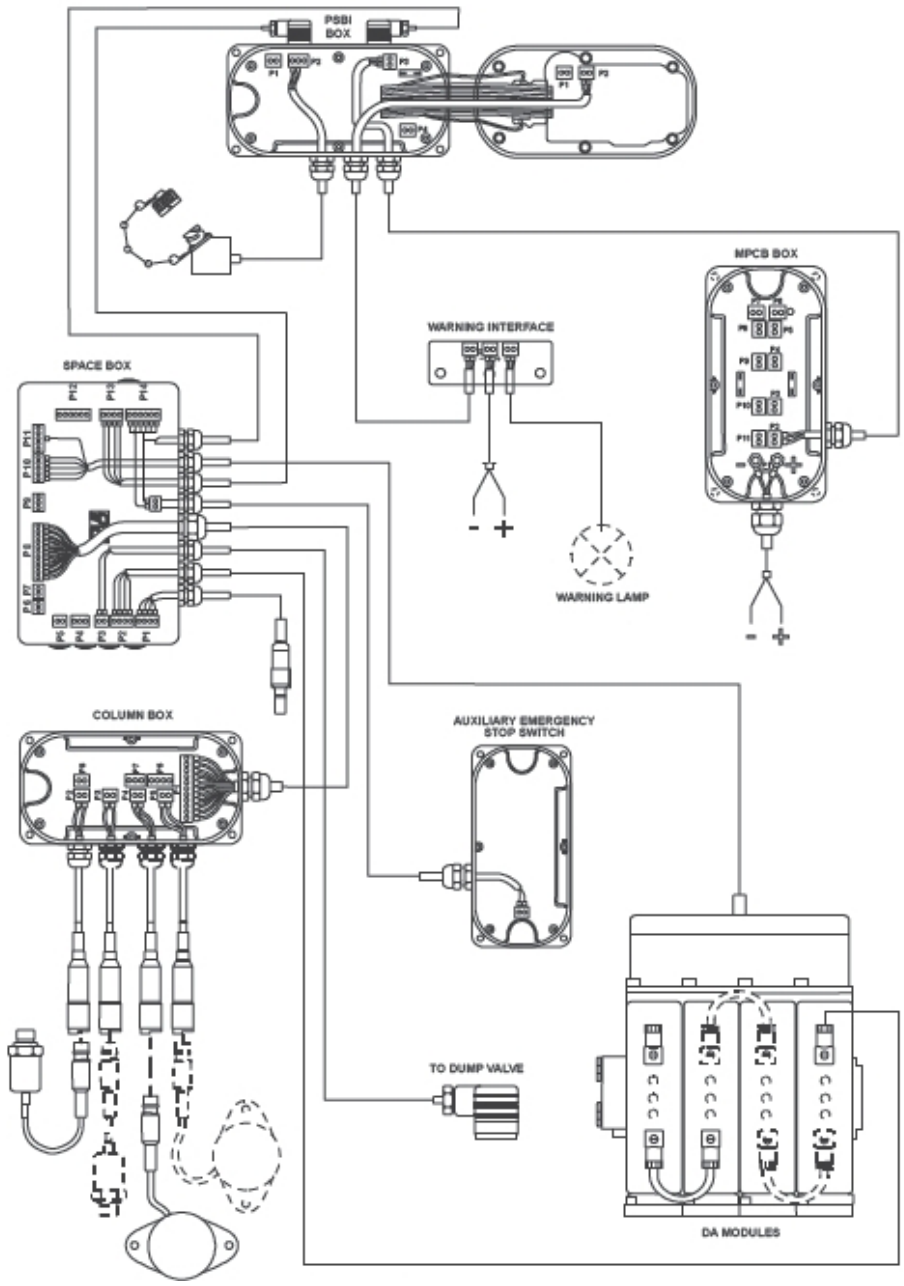


Figure 31 Space Connection Diagram

Starting the Terminal Program

128. To start the program, proceed as follows:

- **a.** The terminal must be switched off.
- **b.** Switch off the ON/OFF button on the power supply box (PSBI).
- **c.** Connect the terminal to the SPACE box using the interface cable.
- **d.** Switch on the system at the PSBI box.
- **e.** Switch the terminal on and start the SPACE program. The display will now show the HIAB logo and 'Terminal software for HIAB SPACE system version x.xx' and the version date.
- **f.** Press ENTER.
- **g.** Type your ID code and press ENTER.
- **h.** Type your password and press ENTER. The main menu will be displayed. This is the starting point for using the terminal software.

Quitting the Terminal Program

129. To quit the program, proceed as follows:

a. From the main menu, press F10 (EXIT). The question 'Quit SPACE (Y/N)' will be displayed.

b. Type Y, then press ENTER. The program start point will be displayed.

c. Switch off the terminal.

Main Menu

130. Table 7 describes the items displayed on the main menu.

Table 7 Main Menu

Key	Function	Description
F1		---
F2	**INIT**	(Initialise) Set new values for:
	TYPE	new crane type
	LEVS	calibrate the levers (when the lever position sensors have been dismantled)
	RELS	in use only when special applications are used
	MISC	in use when initialising SPACE
F3	**PARS**	Parameters are values that can be set. Refer to Table 17. The parameters are divided into classes. Select the parameter class to be changed, e.g. OLP. The menu states min., max., and set value. - state new value - If the parameters are n/a (on and off function) only the set value is displayed. - state new value - In some parameter classes, several values can be set. See the example at Para 134, sub-menu 3.
F4	**VARS**	Variables are values which the sensors and indicators sense momentarily. These values can be read off during operations. See Table 29.
F5		---
F6	**ERRS**	Errors, displays faults past and present.
F7	**FILE**	Temporary storage of parameters.
F8		---
F9	**COUNT**	Counter. Shows some recorded data/counters – diary.
F10	**EXIT**	Finish, saving.

NOTE

When you press F10 (exit) to finish, you return to the previous level in the menu (a level closer to the main menu each time you press the key). You can press ESC if you do something wrong; however, this must be done prior to pressing F10 (exit and save).

TERMINAL PROGRAM USE

131. The following paragraphs describe the use of the various functions of the terminal program:

132. INIT (Type) = New Crane Type. Table 8 lists the use of the INIT (type) function.

Table 8 Init (Type) = New Crane Type

Menu Item	Description	Action
Main Menu:	Here you select the function: **F2-F10** *(F2=INIT, F3=PARS, F4=VARS, F6=ERRS, F7=FILE, F9=COUNT and F10=EXIT)* Example: Presetting parameters.	Select **INIT** by pressing **F2**.
Sub menu 1:	This function sets the values (parameters) specific for a certain crane type.	Select **TYPE** by pressing **F1**.
Sub menu 2:	Select crane type (using the arrow keys).	Press **ENTER**.
Sub menu 3:	Choose the number of value functions being used (using the arrow keys).	Press **ENTER**.
Sub menu 4:	The system shows your selection and asks if you want to continue.	If so, answer **Y** and press **ENTER**.
Sub menu 5:		If you want all parameters to be set from defaults answer **Y**. Press **ENTER** If you answer **N** only the parameters specific for the selected crane will be set (for example, 330-6F).
Sub menu 6:		Key in the crane serial number. Press **ENTER**.

133. INIT (Levs) – Calibrating Spool Sensors. Table 9 lists the use of the INIT (Levs) function.

Table 9 INIT (Levs) – Calibrating Spool Sensors

Menu Item	Description	Action
Main menu:	Here you select the function: **F2-F10** *(F2=INIT, F3=PARS, F4=VARS, F6=ERRS, F7=FILE, F9=COUNT and F10=EXIT)* Example: Presetting parameters.	Select **INIT** by pressing **F2**.
Sub menu 1 – Initiate (set) parameters for LEVS:		Select **LEVS** by pressing **F3** to calibrate spool sensors.
Sub menu 2 – LEVS		If you do not want to calibrate, select **ABORT** by pressing **F1**. When the levers are to be set, press **ENTER**. A new menu will appear. Read off and carry out the lever movements shown in the Sub menu 3.
Sub menu 3 – Calibrating lever sensors:	Example: setting the slew lever.	a. Move the slew lever and press ENTER. b. Release the slew lever and press ENTER. c. Move the slew lever for max. speed counterclockwise and press ENTER. d. Release the slew lever and press ENTER. The slew lever is now calibrated.

Table 9 INIT (Levs) – Calibrating Spool Sensors (continued)

Menu Item	Description	Action
Other levers:		Follow the same procedure used for the slew lever using the following order: (Instructions for each function are shown on the screen in English. Follow these, if you make a mistake press **ABORT** and start again with slewing). Inner movement first down then up Outer movement ‘ down ‘ up Extension ‘ out ‘ in Jib (lift) ‘ down (in) ‘ up (out) Jib extension ‘ out ‘ in Winch ‘ out ‘ in Tool 5th function Tool 6th function

134. PARS = Check and Change Parameters. Table 10 lists the use of the PARS check and change parameters function.

Table 10 PARS = Check and Change Parameters

Menu Item	Description	Action
Main Menu:	Here you select the function: **F2-F10** *(F2=INIT, F3=PARS, F4=VARS, F6=ERRS, F7=FILE, F9=COUNT and F10=EXIT)* Example: Check or set parameters that your access level permits (Access 2).	Select **PARS** by pressing **F3**.
Sub menu 1 – Parameter-class:	In the new menu, you extend your selection.	Mark **Remote Control** using the arrow keys and then press **ENTER**.
Sub menu 2 – Class: Remote Control	Continue to check or change.	Mark **oil_need_n.** using the arrow keys and then press **ENTER**.
Sub menu 3 – Parameter: Oil_need_n:		You can set new values for the flow which the spool can provide in the negative direction, **(oil_need_n)**.
This is the last menu in the hierarchy.		Press **EXIT** and you will return to the main menu. You must always go back to the main menu when you have changed a parameter setting. This is because the change shall be confirmed.

135. Vars = Check Variables. Table 11 lists the use of the VARS check variables function.

Table 11 Vars = Check Variables

Menu Item	Description	Action
Main Menu:	Here you select the function: **F2-F10** *(F2=INIT, F3=PARS, F4=VARS, F6=ERRS, F7=FILE, F9=COUNT and F10=EXIT)* Example: Check variables.	Select **VARS** by pressing **F4**.
Sub menu 1 – Display variables:	This display is called the SUMMARY display. Here you can read off several variables simultaneously. **NOTE! Slow function.**	In order to see a particular variable and/or a fast-changing one: Select **DETAILED** by pressing **F4**.
Sub menu 2 – Variable-class:	Example: Choose to check LOS.	Mark **LOS** using the arrow keys and then press **ENTER**. If you select **SUMMARY** by pressing **F4,** you will return to the SUMMARY display.
Sub menu 3 – Class: LOS:	Example: Choose to check the LOS level.	Mark **los_level** using the arrow keys and then press **ENTER**.
Sub menu 4 – Class: LOS:	You can see the **los_level** variable here.	
This is the last menu in the hierarchy.		Press **EXIT** and you will return to the main menu.

136. Vars = Summary. Figure 32 details the VARS summary screen.

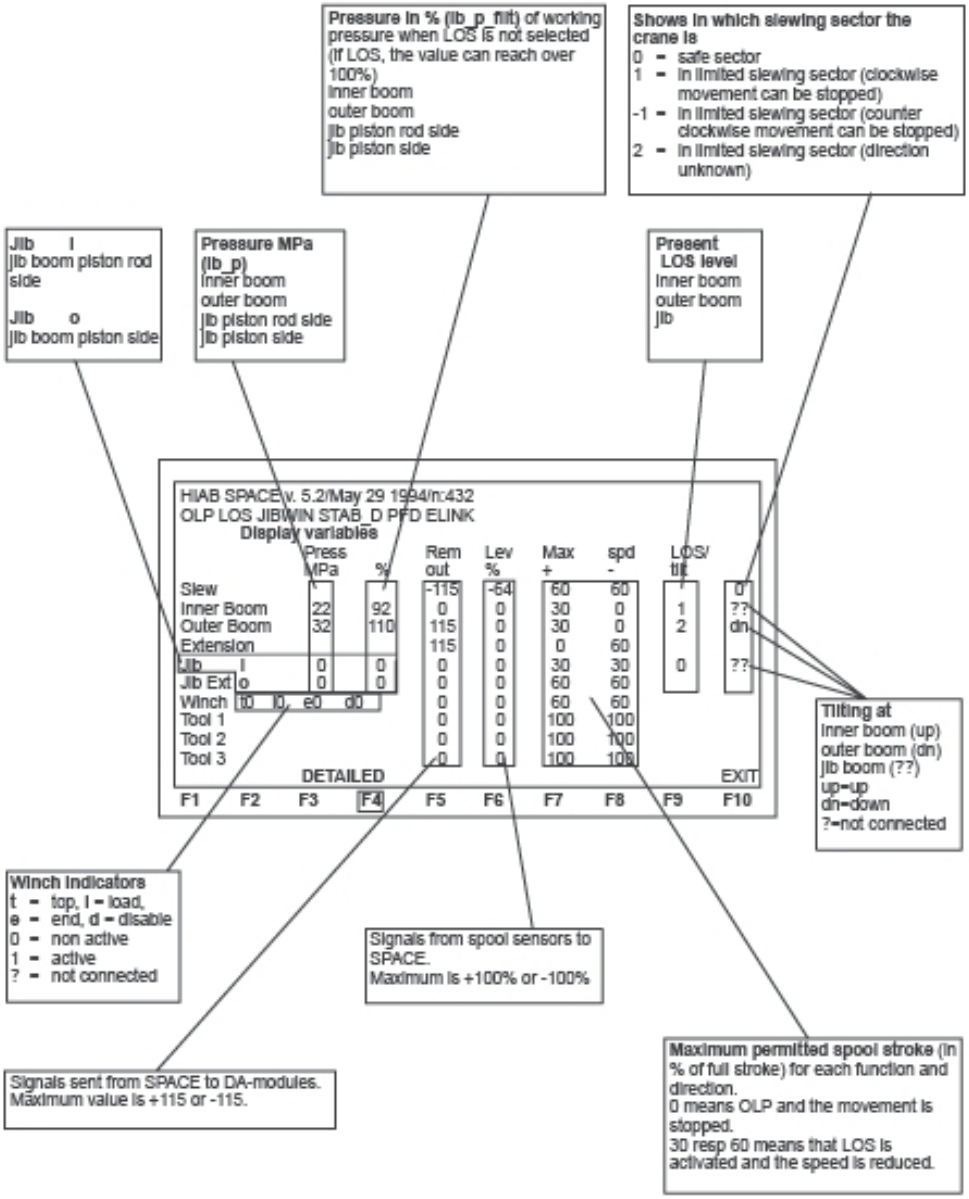


Figure 32 Vars = Summary

137. VARS = Check Analog Inputs. Table 12 lists the use of the VARS check analog inputs function.

Table 12 VARS = Check Analog Inputs

Menu Items	Description	Action
Main Menu:	Here you select the function: **F2-F10** *(F2=INIT, F3=PARS, F4=VARS, F6=ERRS, F7=FILE, F9=COUNT and F10=EXIT)* Example: Check variables.	Select **VARS** by pressing **F4**.
Sub menu 1 – Display variables:	You read-off the variables here.	To see the variable class, select **DETAILED** by pressing **F4**.
Sub menu – Variable-class:	Example: Check analog inputs.	Mark Analog inputs using the arrow keys and then press **ENTER**. If you select **SUMMARY** by pressing **F4,** you will return to the sub-menu 1.
Sub menu 3 – Analog inputs:	You will find an explanation of this menu in sub-menu 4 - Analog inputs and Analog inputs: Explaining the menu	
Sub menu 4 – Analog inputs:	Raw data from the analog inputs are given here. The minimum value 0 is equivalent to 0 volts or 0 mA. The maximum value 255 is equivalent to +5 volts or 22.7 mA. The display shows three rows with eight values per row. The upper row A, the intermediate row B and the lower row C. The values are designated according to the row, followed by a number which indicates where the value is positioned in the row. The first value (left) is value No. 1 and the last (right) is value No. 8. Example: Analog input B2 is the tilt indicator outer boom.	

Analog inputs: Explaining the menu

K=channel P=plinths in SPACE box

A1 K0 P12.2 sensor feed	A2 K1 P9.3 spool sensor 7	A3 K2 P10.3 spool sensor 4	A4 K3 P10.4 spool sensor 5	A5 K4 P10.5 spool sensor 6	A6 K5 P11.3 spool sensor 1	A7 K6 P11.4 spool sensor 2	A8 K7 P11.5 spool sensor 3
B1 K8 P8.4 pressure sensor(ob)	B2 K9 P8.5 tilt indicator(ob)	B3 K10 P8.6 angle sensor(ib)	B4 K11 P8.7 pressure piston rod jib	B5 K12 08.8 pressure piston jib	B6 K13 P8.9 tilt indicator jib	B7 K14 P8.10 winch	B8 K15 P8.11 personnel basket
C1 K16 P14.3 emergency stop/automatic dumping	C2 K17 P14.2 dump voltage	C3 K18 P3.2 dump out	C4 K19 P13.2 man/remote switch	C5 K20 P8.2 box (loader body) voltage	C6 K21 P6.2 slewing angle sensor	C7 K22 P7.2 temp. sensor	C8 K23 P8.3 pressure sensor (ib)

Table 12 VARS = Check Analog Inputs (Continued)

Analog inputs: Explaining the menu							
K=channel P=plinths in SPACE box							
Maximum permitted values are:							
240	240	240	240	240	240	240	240
240	240	240	240	240	240	219	240
255	240	240	240	240	240	240	240
If any of these values are exceeded the equivalent input is regarded as short circuited to 24 volt.							
Minimum permitted values are:							
16	16	16	16	16	16	16	16
16	16	16	16	16	16	16	16
0	0	16	0	16	0	0	16
If any of these values are exceeded the equivalent input is regarded as being broken or short circuited to 0 volt.							

138. ERRS = Check Type and Number of Errors. Table 13 lists the ERRS check type and number function.

Table 13 ERRS = Check Type and Number of Errors

Menu Item	Description	Action
Main Menu:	Here you select the function: **F2-F10** *(F2=INIT, F3=PARS, F4=VARS, F6=ERRS, F7=FILE, F9=COUNT and F10=EXIT)* Example: Check error message and number of errors.	Select **ERRS** by pressing **F6**.
Sub menu 1 – Display errors:	If there are no errors, the text 'No errors' is displayed. Example: Shows one error: E11. E11 = the program detects one or two connected jib sensors, but not all three.	Most errors are automatically removed when the cause of the error has been rectified. To see on screen whether these errors have been removed, press **REFR**. To see the number of errors there has been, select **COUNT** by pressing **F5**.
Sub menu 2 – Display error counters:	Each error has two counters, which display how many times the error has occurred. The digits in the first column error cannot be reset to 0. The other column can be reset after the error has been rectified. Press **RESET**.	To update the screen, press **REFR**. When <more> is visible on the lower section of the screen this means that you can display more error reports using the arrow keys.

139. FILE = Save Parameters as Files. Table 14 lists the FILE save parameters as files function.

Table 14 FILE = Save Parameters As Files

Menu Item	Description	Action
Main Menu:	Here you select the function: **F2-F10** (F2=INIT, F3=PARS, F4=VARS, F6=ERRS, F7=FILE, F9=COUNT and F10=EXIT)	Select **FILE** by pressing **F7**.
Sub menu 1 – File functions:	Here you can save parameters as files on the SPACE-card, if you, for example, change the SPACE box on the loader. This can be useful if you have a customised loader on which you have set several parameters that only apply to this particular customer. By saving the parameters from the old box to the card and then loading them into the new, you can save a great deal of time and avoid the need to set all the parameters again.	Press **F3** or **F5**. Enter a name for the file, e.g. the loader type and serial number (maximum eight characters).
F3 SAVE:	With this function, you can save parameters in coded form and download them in a SPACE box.	
F5 SAVE TXT	With this function, you can save parameters as files you can read on your computer. You can also print out on paper.	
F1 LOAD	Download a file that has been saved.	Press **F3** in the SPACE box.

140. Count = Recorded Counters/Timers. Table 15 lists the COUNT recorded counters/timers functions.

Table 15 Count = Recorded Counters/Timers

Menu Item	Description	Action
Main Menu:	Here you select the function: **F2-F10** *(F2=INIT, F3=PARS, F4=VARS, F6=ERRS, F7=FILE, F9=COUNT and F10=EXIT)*	Select **COUNT** by pressing **F9**.
Sub menu 1 – Show timers and counters:	With this function, you can inspect the stored counters of the diary timers and counters since the first start-up. When <more> is visible on the lower section of the screen this means that there is more information to see using the arrow keys.	Select DIARY by pressing **F1**.
Sub menu 2 – Show diary for month (1-12):	With this function, you can inspect the contents of the diary timers and counters for each month. The example shows month 1 = January.	You can select any month to inspect with the arrow keys. Select **ERROR** by pressing **F1**.
Sub menu 3 – Show diary for month 1:	Here the errors for the chosen month (1) are displayed, i.e. the number of times each error has occurred.	Press **REFR** to update the screen. Finish with the **EXIT** function.

Diary:

The following data is recorded at monthly intervals and stored for the past 12-month period. Month 1 - January, month 2 – February, etc.

These data and counter readings are also stored for the entire life of the system.

Counter:

ib_OLP_ctr	indicates how many times inner boom has reached OLP
ob_OLP_ctr	indicates how many times outer boom has reached OLP
jb_OLP_ctr	indicates how many times jib has reached OLP
Wi_OLP_ctr	indicates how many times winch has been overloaded (winch torque)
olp_rel_ctr	indicates how many times emergency override has been used
error_ctr	indicates how many system errors there have been

Time counter:

use_time	indicates how long (hours:minutes) the dump valve has been active
man_time	indicates how long (hours:minutes) the loader has been operated manually
LOS_set_time	indicates how long (hours:minutes) the crane has been operated with LOS selected
LOS_act_time	indicates how long (hours:minutes) the crane has been operated with LOS active (low speed)
stab_time	indicates how long (hours:minutes) the crane has been operated in limited slewing sector
pfd_time	indicates how long (hours:minutes) the PFD function has been active (reduced lever travel)
elink_time	indicates how long (hours:minutes) the electronic link has been active (large angles + high load)
tot_time	indicates how long (hours:minutes) the power has been on
inp_time	indicates how long (hours:minutes) the digital input defined by parameter time_chan has been active

PARAMETERS

141. The following paragraphs detail the functions and channels in SPACE and provide a listing of the available parameters and their descriptions.

Functions in SPACE

142. In SPACE the crane functions are numbered as shown in Table 16.

Table 16 Functions In SPACE

Number	Function	Positive Direction
0	Slewing	Clockwise
1	Inner boom	Down
2	Outer boom	Down
3	Extension	Out
4	Jib	In
5	Jib extension	Out
6	Winch	Out
7	Tool 1	-
8	Tool 2	-
9	Tool 3	-

NOTE

The crane functions in SPACE must not be confused with the numbering of the levers on the valve block. The levers are numbered, from the left, 1 to 6. For example, slewing has the function 0, but is operated with the lever 1.

Channels in SPACE

143. The remote control channels are numbered, from the left on the remote control unit, 0 to 5. By operating the shift-button, a further six channels are available, numbered from the left 6 to 11.

Function Dependant Parameters and Variables

144. Certain parameters and variables are function-dependent. These are followed by the designation **'[FUNCS]'**, e.g. **rem_chan[FUNCS]** = remote control channels.

145. For example, a crane is equipped with winch and bucket with rotator. On the remote control, the functions are required to be connected to the following channels:

- **a.** slewing (channel 0);
- **b.** inner boom (channel 1);
- **c.** outer boom (channel 2);
- **d.** extension (channel 3);
- **e.** rotator (tool 1, channel 4);
- **f.** bucket (tool 2, channel 5); and
- **g.** winch (channel 11).

146. This means that the winch is to be operated with the lever at the far right when the shift-button is operated.

147. The parameter **rem_chan[FUNCS]** is as follows: 0, 1, 2, 3, -1, -1, 11, 4, 5, -1.

148. The first parameter value concerns the function 0, the next value concerns function 1 and so on. The value describes what channel operates the function.

149. Since functions 4, 5 and 9 (jib, jib extension and tool 3 according, Table 16) are not used, these are designated -1.

Channel Dependent Parameters and Variables

150. Channel dependent parameters and variables are followed by the designation **'[REMS]'**, e.g. **oil_need_n[REMS]** = oil need negative. The parameter values or the variable concerns the remote control channels.

151. For example (the same crane as above example) **oil_need_n[REMS]** = 60, 70, 60, 50, 30, 30, 0, 0, 0, 0, 0, 40.

152. The first parameter value designates the oil need for the function that is connected to the remote control: 0 requires 60 litres/minute when it is operated in the negative direction, channel 1 requires 70 litres/minute, channel 2 requires 60 litres/minute etc. No function is connected to the channels 6 to 10, i.e. no oil supply is required.

Parameter List

153. Table 17 lists all available parameters by class and provides a description of each:

NOTE

In every parameter class you will find a dotted line. Below this line, infrequent parameters are listed.

Table 17 List of Parameters

S = display level system

Class	Access	Display	Parameter Name	Description of Parameters
OLP	1	1	olp_lim	The OLP-limit can be temporarily increased to max. 150%. Returns to 100% at power off/on. Useful for certifications.
	1	1	olp_prewarm	Pressure level in % of the OLP-limits, at which the 90%- and pre-warning lamps will switch on (for inner-outer and jib boom.
LOS	1	1	los_release_mode	If the parameter is 1, the LOS is automatically deactivated. If the parameter is 0, the levers must first come in neutral position.
	2	S	los_hst	The pressure hysteresis [%] when switching between different LOS-levels.
	2	S	jib-los-hst	The pressure hysteresis [%] when switching between different LOS-levels.
	2	S	ob_los_hst	The pressure hysteresis [%] when switching between different LOS-levels.
	2	S	los_lim[2]	Two bytes that set the different pressure LOS-levels.
	2	S	ob_los_lim[2]	Two bytes that set the different pressure LOS-levels.
	2	S	los_olp_spd_p[FUNCS]	Max speed in positive directions when the inner or outer boom pressures exceeds the OLP-limit.
	2	S	los_olp_spd_n[FUNCS]	Max speed in negative directions when the inner or outer boom pressures exceeds the OLP-limit.
	2	S	los_spd_p_(2)[FUNCS]	Max speed in positive directions when the inner boom pressure reaches the corresponding ***los_lim*-limit**.
	2	S	ob_los_spd_p(2)[FUNCS]	Max speed in positive directions when the outer boom pressure reaches the corresponding ***los_lim*-limit**.
	2	S	jib_los_spd_p(2)[FUNCS]	Max speed in positive directions when the jib pressure reaches the corresponding ***los_lim*-limit**.
	2	S	los_spd_n(2)[FUNCS]	Max speed in negative directions when the inner boom pressure reaches the corresponding ***los_lim*-limit**.
	2	S	ob_los_spd_n(2)[FUNCS]	Max speed in negative directions when the outer boom pressure reaches the corresponding ***los_lim*-limit**.
	2	S	jib_los_spd_n(2)[FUNCS]	Max speed in negative directions when the jib pressure reaches the corresponding ***los_lim*-limit**.
	2	S	unload_der	If one of the pressure derivates is more negative than this parameter while the corresponding LOS is active, the LOS will not be released until all remote levers has been centred.

Table 17 List of Parameters (Continued)

S = display level system

Class	Access	Display	Parameter Name	Description of Parameters
Remote Control	2	S	lev_rem_add	How much the signal from the lever-sensors may exceed the remote control signal when the remote control is in use.
	1	2	oil_need_n[REMS]	The max flow the spool can give in negative direction (L/min).
	1	2	oil_need_p[REMS]	The max flow the spool can give in positive direction (L/min).
	1	2	no_pfd_chan[2]	One or two channels for which the spool stroke must not be decreased by the PFD function.
	1	1	pump_flow	The capacity of the hydraulic pump at normal operating rpm (L/min).
	2	2	rem_chan[FUNCS]	Tells the remote control channel for each function.
	1	1	rem_dir[FUNCS]	0 if normal lever directions, 1 if reversed lever directions.
	1	1	rem_gain[REMS]	Tells the system if a lower gain is selected on a digital amplifier.
	2	S	lev_rem_time	When comparing lever-sensor signals to the remote control signals, the control signals *rem_out* are delayed **lev_rem_time** sample intervals.
	2	S	func_k[FUNCS]	An amplification coefficient.
	2	S	rem_k[REMS]	An amplification coefficient with which the received remote control data is multiplied before it is transmitted to the valves.
	2	S	rem_k_micro[REMS]	An extra amplification coefficient with which the received remote control data is multiplied before it is transmitted to the valves when a person basket is connect to the crane.
	2	S	rem_a_ramp[FUNCS]	The ramp when the max allowed remote control speed is increasing.
	2	S	rem_r_ramp[FUNCS]	The ramp when the max allowed remote control speed is decreasing.
	2	S	rem_out_db	The width of the deadband in the remote data communication.
	2	S	rem_vbatt_min	The minimum remote control unit battery voltage in mV.
Levers/Spools	2	S	lev_db_n	The deadband of the valve in the negative direction.
	2	S	lev_db_p	The deadband of the valve in the positive direction.
	2	2	func_dir[FUNCS]	0 if normal lever directions, 1 if reversed. **NOTE** Requires also hydraulic changes
	2	2	lev_ad_chan[FUNCS]	Tells to which channel each function's spool sensor is connected.
	1	2	lev_warn1	Warning level (% of allowed speed) when driving manually with LOS active the level warning lamp will blink.
	1	2	lev_warn2	Warning level (% of allowed speed) when driving manually with LOS active the level warning lamp will shine constantly.
	2	S	lev_n_range[FUNCS]	How much the analog input value differs from lev_offs when the valve is fully open in the negative direction.
	2	S	lev_p_range[FUNCS]	How much the analog input value differs from lev_offs when the valve is fully open in the positive direction.
	2	S	lev_offs[FUNCS]	The analog input value when the lever is centred.
	2	S	lev_zero_range	How much the lever-transducer-inputs may vary from the centred position for the control to accept the lever as centred.

Table 17 List of Parameters (Continued)

S = display level system

Class	Access	Display	Parameter Name	Description of Parameters
Pressures	1	2	ib_p_lim_corr	Adjustment of working pressure (%).
	2	2	stop_tool_1_load	Tells at what pressure in % of the OLP limit the function 'outrigger legs up' is stopped (tool 1 is stopped in positive direction).
	2	2	stop_tool_2_load	Tells at what pressure in % of the OLP limit the function 'outrigger legs up' is stopped (tool 2 is stopped in positive direction).
	1	1	counter_press	The counter pressure of the hydraulic system (bar).
	2	S	der_zero_lev	The minimum speed the functions must be moving.
	2	S	der_zero_time	The time in which the pressure values may be constant when the corresponding function is moving over a min speed.
	2	S	frict_comp	A compensation for friction in the cylinders.
	2	S	ib_p_chan	The analog input channel (0..23) the pressure sensor is connected to.
	2	S	ob_p_chan	The analog input channel (0..23) the pressure sensor is connected to.
	2	S	ji_p_chan	The analog input channel (0..23) the pressure sensor is connected to.
	2	S	jo_p_chan	The analog input channel (0..23) the pressure sensor is connected to.
	2	2	ib_p_lim	The working pressure, inner boom (olp_limit, bar).
	2	2	ob_p_lim	The working pressure, outer boom (olp_limit, bar).
	2	2	ji_p_lim	The working pressure, jib boom (olp_limit) in/down (bar).
	2	2	jo_p_lim	The working pressure, jib boom (olp_limit) out/up (bar).
	2	S	j_ratio	The cylinder area ratio for the jib cylinder.
Digital Inputs	2	2	lo_load_inp_load	Max. allowed working pressure in % of OLP limit when manual extension is used.
	2	S	micro_load	How much the inner boom capacity (OLP-level) will be reduced when the micro-mode is selected.
	2	2	micro_off_chan	Tells at personnel basket to which channel the key switch position 'OFF' (24 volt) is connected.
	2	2	micro_on_chan	Tells at personnel basket to which channel the key switch position 'ON' (24 volt) is connected.
	1	1	win_pos	Where on the crane the winch is mounted (1, 2, 3, 4, 5, 6).
	2	2	lo_load_inp_chan	Which channel the switch for manual extensions is connected.
	2	S	plc_tilt_chan	An extra tilt indicator for PLC use.
	2	2	stab_d_n_chan[3]	Which channel the negative slewing sector indicator is connected (normally 53).
	2	2	stab_d_p_chan[3]	Which channel the positive slewing sector indicator is connected (normally 52).
	2	S	filt_err_chan	The filter error input.
	2	2	ib_t45_chan	Which channel the inner boom tilt indicator is connected (-1 means disconnected).
	2	S	j_tilt_chan	Which channel the jib tilt angle indicator is connected (normally 13).
	2	S	tilt_chan	Which channel the tilt angle indicator is connected (normally 9).
	1	1	time_chan	Which channel one's own decided time counting is connected.
	2	S	win_chan	Which channel the winch-box is connected (normally 14).
	2	S	micro_sel_chan	The analog input to which the micro-mode box is connected.

Table 17 List of Parameters (Continued)

S = display level system				
Class	**Access**	**Display**	**Parameter Name**	**Description of Parameters**
Angle	2	S	ib_ang_chan	The analog input the sensor is connected to.
	2	2	ib_anb_0	The analog input B3 values for horizontal inner boom.
	2	2	ib_ang_80	The analog input B3 value for 80° inner boom angle (above horizontal).
	1	2	ib_ang_warn_h	The inner boom angle at which the warning lamp for high inner boom will light.
	1	2	ib_ang_warn_l	The inner boom angle at which the warning lamp for low inner boom will light.
	2	S	slew_chan	The analog input the sensor is connected to.
	2	2	slew_max	The analog input C6 value for clockwise end position.
	2	2	slew_min	The analog input C6 value, anticlockwise end position.
	2	2	slew_range	Max slewing angle for the crane.
	2	2	slew_zero	The value from analog input when the crane is pointing to the rear of the truck.
Stability	1	1	stab_olp[3]	Maximum working pressure (OLP-limit) in % of normal when boom is inside restricted sector.
	2	2	stab_sect_type[3]	Tells the type of the three different stability sectors.
	2	S	stop_legs_load	The inner boom pressure level at which the CombiDrive channels for support legs up are disabled.
	2	2	stop_legs_p[REMS]	Remote controlled function is stopped in positive direction when the parameter for corresponding remote control channel is 1 and the load is above **stop_legs_load**.
	2	2	stop_legs_n[REMS]	Remote controlled function is stopped in negative direction when the parameter for corresponding remote control channel is 1 and the load is above **stop_legs_load**
	2	2	supp_legs_down[6]	3 bytes that tell to which MUX terminal the outrigger leg indicators are connected. A 1-bit means that the corresponding input has to be 1 if it shall be possible to drive the crane at a load above **supp_leg_load**.
	?	?	supp_legs_hout[6]	The 3 first bytes that tells to which digital multiplexer-inputs the left-side support legs halfway out-indicators are connected. The three last bytes are the same for the right-side support legs.
	2	2	supp_legs_out[6]	3 bytes that tells to which MUX terminal the outriggers indicators are connected. A 1-bit means that the corresponding input has to be 1 if it shall be possible to drive the crane at a load above **supp_leg load**.
	2	2	supp_legs_load[3]	The inner boom OLP limit is limited to one of these values when operating the crane without fully extracting and setting the support legs.
	2	S	supp_legs_time	Tells how many seconds the crane still can be operated normally even if one or more of the support legs down inputs are deactivated.
	2	2	sir_on_chan	To which channel the pre-set slewing sector switch ON is connected.
	2	2	sir_set_chan	To which channel the pre-set slewing sector switch SET is connected.
	2	2	stab_a_beg[3]	Limit for slewing sector (analog sensor).
	2	2	stab_a_end[3]	Limit for slewing sector (analog sensor).
	2	2	stab_a_slope[3]	Capacity changes for slewing sector.

Table 17 List of Parameters (Continued)

S = display level system				
Class	**Access**	**Display**	**Parameter name**	**Description of parameters**
Manual Extensions	2	2	mext_i_offs	The load cell analog input value with zero load.
	2	2	mext_i_range	Tells how much the load cell analog input value increases from **mext_i_offs** with max load (**mext_load_range**).
	2	2	mext_load_chan	Tells to which channel the load sensor is connected.
	2	2	mext_load_limit[5]	Tells maximum allowed load for each extension.
	2	2	mext_load_range	The load range [kg] for the manual extension load cell.
	2	2	mext_sel_chan	Tells to which channel the six-position key is connected.
	2	S	mext_stop_p[FUNCS]	Indicates how the function is to be affected by a manual extension overload at different crane positions.
	2	S	mext_stop_n[FUNCS]	Indicates how the function is to be affected by a manual extension overload at different crane positions.
	2	2	weight_factor	How much the load weight increases when the inner boom pressure increases with 10 bar.
	2	2	weight_offset	The inner boom pressure with zero load.
	2	2	weight_r_chan	The input channel the ‘Real Load Weight’ switch is connected to.
	2	2	weight_t_chan	The input channel the ‘Set Weight Tare’ switch is connected to.
Various	2	2	always_time_dump	When this parameter is 1, the automatic dumping can not be switched off with the OLP override switch. When zero, it is possible.
	2	2	crane_ser_no	A string containing the serial number of the crane.
	2	2	crane_type	Crane type.
	1	2	lubr_interval	Time interval in minutes between each lubrication.
	1	2	lubr_pulse_len	Time (50 ms periods) that the lubrication lasts.
	2	S	no_use_time	The time (50 ms/period, 60 = 3 sec) in which the dump valve will remain active after all levers has been centred.
	2	2	no_apo	Disables the Automatic Power Off-function in the PSBI box.
	2	S	oil_temp_chan	The number of the analog input for the oil temperature sensor.
	2	S	oil_temp_max	The oil temperature at which the E70 error is given.
	2	S	oil_temp_warn	The oil temperature at which the relay output starts to blink.
	2	S	oil_temp_0	The analog input value corresponding to 0 °C oil temperature.
	2	S	oil_temp_80	The analog input value corresponding to 80 °C oil temperature.
	2	S	psbi_dump	Dump output from the PSBI box.
	-	1	seriel_no	The serial number of the OLP-program.
	2	2	run	A system running flag that is automatically set after an error-free power-on.

OLP

154. Table 18 lists the parameter settings for the OLP function.

Table 18 OLP Parameter Settings

Name	Description
olp_lim	access:1 limits:50..150 default:100 The default OLP limit pressure (in % of the working pressure **??_p_lim**) for the three different OLP-systems (Inner Boom, Outer Boom, Jib). The final OLP limit pressure will vary depending on LOS, errors, cabin area and so on. **NOTE** This parameter will always default to 100% when the power is switched on.
olp_lim_bu	access:2 limits:100..120 default:110 The pressure level (in % of the current OLP-limits, ***ib_olp_lim*** and ***ob_olp_lim*****)** at which the backup OLP-logic is activated. (Taken away from ver 5.91).
olp_prewarn	access:1 limits:0..100 default:90 Inner, outer and jib boom pressure level (in % of the OLP-limits, that is the ***ib_olp_lim***-, ***ob_olp_lim***- and ***jib_olp_lim***-variables) at which the 90%- and pre-warning-lamps will switch on.

LOS

155. Table 19 lists the parameter settings for the LOS function.

Table 19 LOS Parameter Settings

Name	Description
los_release_mode	access:1 limits:0..1 default:1 A non-zero value in this parameter means that the LOS will be automatically deactivated when the pressure drops below the LOS-pressures. If the parameter is zero, the LOS is not deactivated before the user releases all the levers.
los_hst	access:2 limits:0..5 default:0
jib_los_hst	access:2 limits:0..5 default:0
ob_los_hst	access:2 limits:0..5 default:0 The pressure hysteresis (5) when switching between different LOS-levels.
ob_los_lim[2]	access:2 limits:0..128 default:90, 100
jib_los_lim[2]	access:2 limits:0..128 default:90, 100 Two bytes that set the different pressure LOS-levels (%of **ib_olp_lim**, **ob_olp_lim** and **jib_olp_lim**). los_lim[0] < los_lim[1].
los_olp_spd_p[FUNCS]	access:2 limits:0..100 defaults:100, 30, 30, 100, 30, 100, 60, 100, 100, 100 Max speed in positive directions [%] when the inner or outer boom pressures **(ib_olp_lim** or **ob_olp_lim**) or a LOS-only crane when the LOS is de-selected.
los_spd_p[2][FUNCS]	access:2 limits:0..100
ob_los_spd_p[2][FUNCS]	access:2 limits:0..100
jib_los_spd_p[2][FUNCS	access:2 limits:0..100 defaults: [0] = 100, 60, 60, 100, 60, 100, 100, 100, 100, 100, [1] = 60, 30, 30, 60, 30, 60, 60, 100, 100, 100, 100, Max speed in positive directions [%] when the inner boom, outer boom or jib pressure reaches the corresponding **los_lim**-limit. If two or more of the LOS-systems are active at the same time, the lowest of the max speeds is used. **Los_spd_p[0]** < **lost_spd_p[1]**.

Table 19 LOS Parameter Settings (Continued)

Name	Description
los_spd_p[2][FUNCS]	access:2 limits:0..100
ob_los_spd_p[2][FUNCS]	access:2 limits:0..100
jib_los_spd_p[2][FUNCS]	access:2 limits:0..100
	defaults: [0] = 100, 60, 60, 100, 60, 100, 100, 100, 100, 100,
	[1] = 60, 30, 30, 60, 30, 60, 60, 100, 100, 100, 100,
	Max speed in negative directions [%] when the inner boom, outer boom or jib pressure reaches the corresponding los_lim-limit. If two or more of the LOS-systems are active at the same time, the lowest of the max speeds is used.
Unload_der	access:2 limits:-100..0 default:-10
	If one of the pressure derivates (**ib_p_der**, **ob_p_der**, **ji_p_der**, **jo_p_der**) is more negative than this parameter while the corresponding LOS is active, the LOS will not be released until all remote levers has been centred.

Remote Control

156. Table 20 lists the parameter settings for the Remote Control function.

Table 20 Remote Control Parameter Settings

Name	Description
lev_rem_add	access:2 limits:0..48 default:25
	How much [%-units] the signal from the lever-sensors (variable *lever*) may exceed the remote control signal (variable ***rem_out***) when the remote control is in use. If *lever.**rem_out + lev_rem_add*** the oil is dumped.
oil_need_n[REMS]	access:1 limits:0..100 default:0
oil_need_p[REMS]	access:1 limits:0..100 default:0
	The amount of pump-flow (L/min) each remote channel needs for full speed (***rem_in_chan***=100% and gain = 100%) in the negative resp. Positive direction. When the automatic dumping is used, the dump valve will be activated only for functions with ***oil_need_?***>0.
No_pfd_chan[2]	access:1 limits:-1..11 default:-1, -1
	The number of the two remote channels that will be excluded from the pump flow distribution (in priority order). By setting the second value to -1, only one channel is excluded and by setting the first value to -1, no channel is excluded.
Pump_flow	access:1 limits:0..150 default:120
	The capacity of the hydraulic pump at normal operating rpm. When the sum of the calculated oil-needs exceeds this value, all the speeds on the crane are reduced (only when remote-control in use).
Rem_chan[FUNCS]	access:2 limits:-1..11 default:0, 1, 2, 3, 4, 5, 4, 4, 5, -1
	Remote control channel 0.11 for each function. -1 if a function is not remote controlled.
Rem_dir[FUNCS]	access:2 limits:0..1 defaults:0, 0, 0, 0, 0, 0, 0, 0, 0, 0
	A '1' in this parameter will invert the remote data for the corresponding function (thus making the remote lever direction opposite to the manual lever direction).
Rem_gain[REMS]	access:1 limits:20..100 default:-100
	Used to tell the system if a lower gain is selected on a digital amplifier (the amplifier gains can be reduced to 87, 73, 60, 47 and 33% by strappings on the amplifier).
lev_rem_time	access:2 limits:0..16 default:1
	When comparing lever-sensor signals to the remote control signals (see ***lev_rem_add*** above), the remote control signals ***rem_out*** are delayed ***lev_rem_time*** sample intervals (to compensate for delays in remote control transmission, valve movement, analog input sampling/filtering, etc.)

Table 20 Remote Control Parameter Settings (Continued)

Name	Description
rem_k[REMS]	access:2 limits:0..200 default:200 An amplification coefficient 0..200 %, with which the received remote control data is multiplied before it is transmitted to the valves.
func_k[FUNCS]	access:2 limits:0..200 default:100 An amplification coefficient 0..200 %, with which the received remote control data is multiplied before it is transmitted to the valves (new from ver. 5.9).
rem_k_micro[REMS]	access:2 limits:0..100 default:30 An extra amplification coefficient 0..100 %, with which the received remote control data is multiplied before it is transmitted to the valves when a personnel basket is connected to the crane (the max. allowed speeds are also set to these values).
rem_a_ramp[FUNCS] **rem_r_ramp[FUNCS]**	access:2 limits:1..100 defaults:4, 4, 4, 4, 4, 4, 4, 20, 20, 20 access:2 limits:1..100 defaults:20, 20, 20, 20, 20, 20, 100, 20, 20, 20 The ramp (%-units / sample interval) when the max allowed remote control speed is increasing (as when deactivating LOS, if ***los_release_mode*** is on). The slowest ramp you can get is 20 %/sec (1 %/sample). A parameter value of 100 means no ramp (100 %/sample).
Rem_out_db	access:2 limits:0..64 default:10 The width of the deadband in the remote data communication. This parameter is used as the point where the remote scaling factors (gain, PFD, micro-mode and so on) start to work and when calculating the amount of oil needed for each function. The parameter must be set so that it corresponds to settings in the digital amplifiers.
Rem_vbatt_min	access:2 limits:0..10000 default:6900 The minimum remote control unit battery voltage in mV (the voltage is supervised only when remote selected and a radio unit is used). When the voltage (***rem_vbatt*** variable) goes below this level, the error 'E77: Remote battery is empty' is given and the ***mask_rem_b_low*** output is activated.

Levers

157. Table 21 lists the parameter settings for the Levers function.

Table 21 Levers Parameter Settings

Name	Description
lev_db_n	access:2 limits:0..50 default:33 The dead band [%] of the valve in the negative direction, that is, how much the lever has to be moved, before it is opened.
lev_db_p	access:2 limits:0..50 default:33 The dead band [%] of the valve in the positive direction, that is, how much the lever has to be moved, before it is opened.
func_dir[FUNCS]	access:2 limits:0..1 defaults:0, 0, 0, 0, 0, 0, 0, 0, 0, 0 0 if the function has normal lever directions (positive direction = lever up). 1 for functions with reversed lever directions (positive direction = lever down).
lev_ad_chan[FUNCS]	access:2 limits:-1..23 defaults:-1, 5, 6, 7, -1, -1, -1, -1, -1, -1 ADC-channel (0..23) for each function's lever position sensor. -1 if the function does not have a sensor.
lev_warn1 **lev_warn2**	access:1 limits:0..100 default:70 access:1 limits:0..100 default:85 Warning levels (% of allowed speed) when driving manually with LOS active. when *lever./**lev_warn1* los_out_? /* 100 the level warning lamp will blink and when *lever>**lev_warn2* los_out_?* / 100 the level warning lamp will shine constantly.

Table 21 Levers Parameter Settings (Continued)

Name	Description
lev_n_range[FUNCS]	access:2 limits:-120..120 default:102 How much the analog input value differs from ***lev_offs[]*** when the valve is fully open in the negative direction.
lev_p_range[FUNCS]	access:2 limits:-120..120 default:-102 How much the analog input value differs from ***lev_offs[]*** when the valve is fully open in the positive direction.
lev_offs[FUNCS]	access:2 limits:0..255 default:128 The analog input value when the lever is centred.
lev_zero_range	access:2 limits:0..50 default:25 How much (in % of full stroke) the lever-transducer-inputs may vary from the centred position for the control to accept the lever as centred (used to supervise that the levers are not moved manually when the remote control is connected).

Pressure

158. Table 22 lists the parameter settings for the Pressure function.

Table 22 Pressure Parameter Settings

Name	Description
ib_p_lim_corr	access:1 limits:-50..+8 default:0 A person with access-level 1 can with this parameter adjust the ib_p_lim-value.
stop_tool_1_load	access:2 limits:0..255 default:200 When the inner boom pressure (***ib_p_filt***) is higher than this level, the positive direction of TOOL_1 is stopped. Intended to be used on cranes with the support legs on the TOOL_1-function.
stop_tool_2_load	access:2 limits:0..255 default:200 When the inner boom pressure (***ib_p_filt***) is higher than this level, the positive direction of TOOL_2 is stopped. Intended to be used on cranes with the support legs on the TOOL_2-function.
counter_press	access:2 limits:0..20 default:0 The counter-pressure of the hydraulic system [bar]. This value is subtracted from the pressure values to compensate for the counter pressure in the hydraulics.
der_zer_lev	access:2 limits:1.111 default:50 The minimum speed the functions must be moving (%, read from *lever[]*) before the pressure sensor supervision is activated (the pressure must not be constant for a longer time than ***der_zero_time***). The supervision can be disconnected by setting this parameter to 111 (because the max value for *lever[]* is 110). This function is not used for the outer boom pressure sensor.
der_zero_time	access:2 limits:2..240 default:30 The time (seconds) in which the pressure values may be constant when the corresponding function is moving over a min speed (***der_zero_lev***). If the pressure value is constant longer, the sensor is considered faulty. This function is not in use for the outer boom.
frict_comp	access:2 limits:-12..12 default:-2 A compensation for friction in the cylinders (inner boom, outer boom and jib boom). This value is subtracted from the filtrated relative pressure values (***??_p_filt***) when the cylinder is moving in positive direction (positive compensation) or negative direction (negative compensation).
iv_p_chan **ob_p_chan** **ji_p_chan** **jo_p_chan**	access:2 limits:-1..27 default:23 access:2 limits:-1..27 default:8 access:2 limits:-1..27 default:11 access:2 limits:-1..27 default:12 The analog input channel (0..27) the pressure sensor is connected to. -1 if the function do not have a sensor.

Table 22 Pressure Parameter Settings (Continued)

Name	Description		
iv_p_lim	access:2	limits:10..400	default:265
ob_p_lim	access:2	limits:10..400	default:265
ji_p_lim	access:2	limits:10..400	default:215
jo_p_lim	access:2	limits:10..400	default:215
	The working (100%-) pressure [bar] for each function.		
j_ratio	access:2	limits:50..200	default:145
	The cylinder area ratio for the jib cylinder **j_ratio** = 100 * job-out-area / jib-in-area Used when compensating for the counter pressure in the jib-cylinder.		

Digital Inputs

159. The following general on/off-signals can be connected to the system, either to the analog inputs or the multiplexed digital inputs (the winch signals are connected to the winch-box, which in turn has to be connected to an analog input):

a. the tilt angle indicator for the outer boom (***tilt***);

b. the jib tilt angle indicator for the outer boom (***j_tilt***);

c. the tilt angle indicator for the inner boom (***ib_t45***);

d. the torque limiting indicator of the winch (***wload***);

e. the end limit indicator (3 coils left) for the winch (***wend***);

f. the top limit indicator for the winch (***wtop***);

g. the disable limit indicator (wire completely in) (***wdis***);

h. the negative stability sector-switch (***stab_d_n***);

i. the positive stability sector-switch (***stab_d_p***);

j. the micro selector switch (***micro_sel_chan***);

k. the timer-input (***time_chan***);

l. a signal indicating that the crane is parked (***parked_chan***);

m. a signal used to stop user selected functions (***stop_inp_chan***); and

n. a signal used to lower the cranes to capacity (***lo_load_inp_chan***).

160. Table 23 lists the parameter settings for the Digital Inputs function.

Table 23 Digital Inputs Parameter Settings

Name	Description
lo_load_inp_load	access:2 limits:0..100 default:50 The level (in %) by which the inner boom OLP-limit (***ib_olp_lim***) is reduced when ***lo_load_inp*** is active.
micro_load	access:2 limits:20..100 default:60 How much the inner boom capacity (OLP-level) must be reduced when the micro-mode is selected.
micro_off_chan **micro_on_chan**	access:2 limits:-1..62 default:44 access:2 limits:-1..62 default:45 The digital inputs to which the micro-mode on/off-switch is connected. One (and only one) of these inputs has to be active all the time, otherwise an error (E61: Micro ON/OFF-switch error) is given.
win_pos	access:2 limits:1..6 default:1 Tells the system where on the crane the winch is mounted: 1 column 3 outer boom 5 jib boom 2 inner boom 4 extension 6 jib extension
lo_load_inp_chan	access:2 limits:-1..62 default:-1
pic_tilt_chan	access:2 limits:-1..62 default:-1
stab_d_n_chan[3]	access:2 limits:-1..62 default:53, -1,-1
stab_d_p_chan[3]	access:2 limits:-1..62 default:52, -1,-1
filt_err_chan	access:2 limits:-1..62 default:-1
ib_t45_chan	access:1 limits:-1..62 default:-1
j_tilt_chan	access:2 limits:-1..62 default:13
tilt_chan	access:2 limits:-1..62 default:9
time_chan	access:1 limits:-1..62 default:-1
win_chan	access:2 limits:-1..62 default:14 names the input the signal is connected to: -1 the signal do not exist. 0..23 the signal is connected to one of the analog inputs. 24..27 the signal uses one of the ***plc_anin[0..3]***-variables. 28..25 the signal is connected to multiplexer 1 (***bit ??? _chan - 28***) 36..43 the signal is connected to multiplexer 2 (***bit ??? _chan - 36***) 44..51 the signal is connected to multiplexer 3 (***bit ??? _chan - 44***) 52 the signal is connected to the MUX1- input in the SPACE-box 53 the signal is connected to the MUX2- input in the SPACE-box 54 the signal is connected to the MUX3- input in the SPACE-box 55..62 the signal uses on of the ***pic_digin***-bits (***bit ??? _chan - 55***)
micro_sel_chan	access:2 limits:-1..27 default:15 The analog input to which the micro-mode box is connected. The box contains a three-position selector-switch that is connected to the current-inputs so that the following current signals are obtained (the basic 4 mA current for the box is included): NORMAL -> 14 mA, MICRO -> 18 mA and MICRO_REL -. 10 mA. current values more than ± 1 mA from these values will cause error 'E19: Micro-mode selector error' to be given.
wdis_bp_time	access:1 limits:0..240 default:20 The bypass-time (seconds for the winch-disabled signal (bypassed with the OLP-release-switch) (Taken away from ver 5.91).

Angle

161. The following angle sensors can be connected to the system:

a. Slewing angle sensor for slewing angle dependent OLP (**stab_a**) and manual slewing restriction (**slew_???**).

b. Inner boom angle sensor for inner boom angle dependent OLP (electronic link) (**ib_ang_???**, **elink_???**).

162. Table 24 lists the parameter settings for the Angle function.

Table 24 Angle Parameter Settings

Name	Description		
ib_ang_chan	access:2	limits:-1..27	default:-1
	The analog input (0..27) the sensor is connected to. -1 if no sensor present.		
ib_ang_0	access:2	limits:0..255	default:200
	The analog input value for horizontal inner boom (angle - 0)		
ib_ang_80	access:2	limits:0..255	default:92
	The analog input value for 80 degrees inner boom angle (above horizontal).		
in_ang_warn_h	access:1	limits:-20..90	default:20
	The inner boom angle (degrees) at which the warning lamp for high inner boom will light.		
in_ang_warn_l	access:1	limits:-20..90	default:0
	The inner boom angle (degrees) at which the warning lamp for low inner boom will light.		
slew_chan	access:2	limits:-1..27	default:21
	The analog input (0..27) the sensor is connected to. -1 if no sensor present.		
slew_max	access:2	limits:0..255	default:224
	The analog input value for max angle.		
slew_min	access:2	limits:0..255	default:32
	The analog input value for min angle.		
slew-range	access:2	limits:-1080..1080	default:400
	The range of the sensor, that is, the angle (degrees) between ***???_min*** and ***???_max***.		
slew_zero	access:2	limits:0..255	default:128
	The analog input value for the angle 0 degrees. For the inner boom angle this parameter must be set so that the angle is 0 when the boom is horizontal and for the slewing so that the angle is 0 when the crane is in the direction of the truck (pointing to the rear of the truck).		

Stability

163. Table 25 lists the parameter settings for the Stability function.

Table 25 Stability Parameter Settings

Name	Description		
stab_olp[3]	access:1	limits:0..100	default:60, 60, 60
	The level (in %) to which the inner boom OLP-pressure limit shall reduce when the slewing is inside the restriction sector (either with analog slewing angle sensor, ***stab_a***, or slewing sector sensors, ***stab_d***).		
stab_sect_type[3]	access:2	limits:0..4	default:0, 0, 0
	When this parameter is set to 1, the normal stability sector logic is disabled and the slewing damping system is enabled instead.		
stop_legs_load	access:2	limits:0..100	default:40
	The inner boom pressure level (***%, ib_p_filt***) at which the CombiDrive channels for support legs are disabled.		
stop_legs_p[REMS] **stop_legs_N[REMS]**	access:2 access:2	limits:0..1 limits:0..1	defaults: all 0 defaults: all 0
	The positive (***stop_legs_p***) and/or negative ***stop_legs_n***) CombiDrive directions will be stopped for the channels with these parameters set to 1 when the inner boom load (***ib_p_filt***) is higher than ***stop_legs_load***.		
supp_legs_down[6]	access:2	limits:0..255	default:0, 0, 0, 0, 0, 0
	3 bytes that tells to which digital multiplexer-inputs the support legs down-indicators are connected. A 1-bit in one of the bytes means that the corresponding multiplexer input also has to be on for the crane to be operated.		
supp_legs_hout[6]	access:2	limits:0..255	default:0, 0, 0, 0, 0, 0
	3 bytes that tells to which digital multiplexer-inputs the support legs out-indicators are connected. A 1-bit in one of the bytes means that the corresponding multiplexer input also has to be on for the crane to be operated.		
supp_legs_out[6]	access:2	limits:0..255	default:0, 0, 0, 0, 0, 0
	3 bytes that tells to which digital multiplexer-inputs the support legs out-indicators are connected. A 1-bit in one of the bytes means that the corresponding multiplexer input also has to be on for the crane to be operated.		
supp_legs_load[3]	access:2	limits:0..100	default:25, 50, 75
	The inner boom pressure limit when operating the crane without setting the support legs (and after ***supp_legs_time*** seconds if one or more of the support leg inputs are deactivated).		
supp_legs_time	access:2	limits:0..60	default:5
	How many seconds the crane still can be operated normally even if one or more of the support leg inputs are deactivated.		
sir_on_chan	access:2	limits:-1..62	default:30
	To which input the slewing restriction on-switch is connected.		
sir_set_chan	access:2	limits:-1..62	default:31
	To which input the slewing set-switch is connected.		
stab_a_beg[3] **stab_a_end[3]**	access:2 access:2	limits:-180..180 limits:-180..180	default:90, 0, 0 default:90, 0, 0
	The slewing angle (degrees from straight back, independent of turn) at which the different restricted sectors start and end. If beg = end for a sector, that sector is not in use. If end > beg, the sector starts at the beg-angle and continues (possibly through zero if end and beg has different signs but never over the 180 line) to the end-angle. If beg> end, the sector is always over the 180-line (straight forward over the cabin).		
stab_a_slope[3]	access:2	limits:1..100	default:2, 2, 2
	How steeply the inner boom OLP-limit will reduce when the slewing is entering an analog slewing sector [% per].		

Table 25 Stability Parameter Settings (Continued)

Name	Description		
stab_olp_bu	access:2	limits:100..120	default:110
	The inner boom pressure level (in % of ***stab_olp***) at which the cabin sector OLP-logic is replaced by the normal OLP-logic. (Taken away from ver. 5.91).		
stab_olp_logic	access:2	limits:0..1	default:0
	Which OLP-logic is to be used in the stability area: '0 -> normal OLP-logic, '1' -> cabin area logic (only one function after pre-warning, reversing of last function possible after OLP). (Taken away from ver. 5.91).		

Manual Extensions

164. Table 26 lists the parameter settings for the Manual Extensions function.

Table 26 Manual Extensions Parameter Settings

Name	Description		
mext_i_offs	access:2	limits:0..255	default:44
	The load cell analog input value with zero load (corresponding to a 4 mA sensor signal).		
mext_i_range	access:2	limits:32..224	default:180
	How much the load cell analog input value increases from ***mext_i_offs*** with max load (***mext_load_range***). At max load the analog input value must be ***mext_i_offs + mext_i_range*** (4 mA + 16 mA - 20 mA).		
mext_load_chan	access:2	limits:-1..27	default:-1
	The number of the analog input from the manual extension load cell (-1 means that no sensor is connected).		
mext_load_limit[5]	access:2	limits:n/a	default:2500, 2000, 1500, 1000, 500
	The max allowable load [kg] for 1, 2, 3, 4 or 5 manual extensions. Which of the five limits that is actually used, is selected with the selector switch.		
mext_load_range	access:2	limits:n/a	default:4000
	The load range [kg] for the manual extension load cell (the load that corresponds to 20 mA output).		
mext_sel_chan	access:2	limits:-1..60	default:-1
	The number of the first (of three) digital inputs from the 6-position manual extension selector switch (-1 means that no switch connected).		
mext_stop-p[FUNCS]	access:2	limits:n/a	defaults: see table in the SPACE - description
mext_stop-n[FUNCS]	access:2	limits:n/a	
	Two bytes per function (negative and positive direction) that indicates how the function is to be affected by a manual extension overload at different crane positions (see ***crane_pos***-variable under Various):		
	bit 0 (dec 1)	stop neg/pos direction if crane in position 0	
	bit 1 (dec 2)	stop neg/pos direction if crane in position 1	
	bit 2 (dec 4)	stop neg/pos direction if crane in position 2	
	bit 3 (dec 8)	stop neg/pos direction if crane in position 3	
	bit 4 (dec 16)	stop neg/pos direction if crane in position 4	
	bit 5 (dec 32)	stop neg/pos direction if crane in position 5	
	bit 6 (dec 64)	stop neg/pos direction if crane in position 6	
	bit 7 (dec 128)	stop neg/pos direction if crane in position 7	
	For example, if both bytes for a function are zero, the corresponding function is completely independent of the manual extensions. If one of the ***mext_stop_p***-byte is 255 (all bits on), the positive direction for that function is stopped, independent of the crane position.		
weight_factor	access:2	limits:0..3000	default:200
	How much the load weight increases when the inner boom pressure increases with 10 bar.		

Table 26 Manual Extensions Parameter Settings (Continued)

Name	Description		
weight_offset	access:2	limits:0..400	default:80
	The inner boom pressure [bar] with zero load (empty crane).		
weight_r_chan	access:2	limits:-1..62	default:-1
	The input channel the 'Read Load Weight' switch is connected to.		
weight_t_chan	access:2	limits:-1..62	default:-1
	The input channel the 'Set Weight Tare' switch is connected to.		

Various

165. Table 27 lists the parameter settings for various functions.

Table 27 Various Parameter Settings

Name	Description		
always_time_dump	access:2	limits:0..1	default:0
	When this parameter is 1, the automatic dumping can not be switched off with the OLP-release switch.		
crane_ser_no	access:2	limits:n/a	default:'Default'
	A string (max 19 characters) containing the serial number of the crane (asked by the terminal at initialisation).		
crane_type	access:2	limits:n/a	default:'Default'
	A string (max 19 characters) containing a description of the parameters. Automatically set to the crane-type by the terminal at initialisation.		
lubr_interval	access:1	limits:1..65535	default:60
	The lubrication interval in minutes (the lubrication timer only runs when the dump-valve is activated.		
lub_pulse_len	access:1	limits:1..65535	default:10
	The lubrication pulse length in sample intervals (50 ms).		
no_apo	access:2	limits:0..1	default:0
	This parameter (when set to 1) disables the Automatic Power Off-function of the PSBI box (only when remote selected, APO is also disabled when micro-mode is selected).		
no_use_time	access:2	limits:20..65535	default:60
	The time (50 ms/ period, 60 = 3 sec.) in which the dump-valve will remain active after all levers have been centred. This automatic dumping function can be disabled by setting no_use_time = 65535.		
oil_temp_chan	access:2	limits:-1..27	default:-1
	The number of the analog input for the oil temperature sensor (-1 means that no sensor connected).		
oil_temp_max	access:2	limits:n/a	default:80
	The oil temperature (°C) at which the 'E70: Hydr Oil Hot' error is given and the relay output (mask_oil_hot) is constantly on.		
oil_temp_warn	access:2	limits:n/a	default:70
	The oil temperature (°C) at which the relay output (mask_oil_hot) starts to blink.		
oil_temp_0	access:2	limits:44..224	default:44
	The analog input value corresponding to 0°C oil temperature.		
oil_temp_80	access:2	limits:44..224	default:224
	The analog input value corresponding to 80°C oil temperature.		
psbi_dump	access:2	limits:0..1	default:1
	When psbi_dump is set to 1, a dump-output error in the SPACE-box will cause the PSBI-box to switch off it's dump-output.		
serial_no	no access	system limits: n/a	default: n/a
	The serial number of the OLP-program downloaded to the system.		

Table 28 Various Parameter Settings (Continued)

Name	Description
system_type	access:2 limits:n/a default:n/a This parameter can be changed with the terminal to activate or deactivate different options but it will always reset to the default-value at power-on.
run	access:2 limits:n/a default:n/a A system running flag that is automatically set aft an error-free power-on. If the parameters are uninitialised, have a checksum-error or are outside the permitted range, this flag will remain reset. When the flag is reset, the dump-valve cannot be activated and the system-on-output will remain off.

VARIABLES

Variable list

166. Table 29 contains a list of variables by class and provides a description of each:

Table 29 List of Variables

S = display level system

Class	Display	Variable Name	Description of Variables
OLP	2	ib_olp_lim	The present OLP-limit.
	2	ib_prewarn_lim	The present pre-warning limit.
	2	jib_olp_lim	The present OLP-limit.
	2	jib_prewarn_lim	The present pre-warning limit.
	2	ob_olp_lim	The present OLP-limit.
	2	ob_prewarn_lim	The present pre-warning limit.
	S S	olp_out_n[FUNCS] olp_out_p[FUNCS]	A non-zero value in these bytes indicates that the OLP of some function has stopped the neg/pos direction for the corresponding functions.
	S	ib_ep_ctr	A non-zero value shows that the corresponding function was driving up when its OLP was activated.
	S	ob_ep_ctr	A non-zero value shows that the corresponding function was driving up when its OLP was activated.
	S	jo-ep_ctr	A non-zero value shows that the corresponding function was driving up when its OLP was activated.
	S	ji_ep-ctr	A non-zero value shows that the corresponding function was driving up when its OLP was activated.
	S 1	olp_rel_ctr olp_rel_w_ctr	Shoes the number of sample intervals that remains of the OLP release mode.
LOS	1	los_level	Shows the current LOS levels: 0 = no reduced crane speed 1 = reduced crane speed 1 2 = reduced crane speed 2.
	1	ob_los_level	Shows the current LOS levels for outer boom.
	1	jib_los_level	Shows the current LOS levels for jib.
	2 2	los_out_n[FUNCS] los_out_p[FUNCS]	shows the actual max allowed speed [%] in the negative and positive directions for the different functions. These speeds are dependent of the error and OLP-status.

Table 28 List of Variables (Continued)

S = display level system

Class	Display	Variable Name	Description of Variables
Remote Control	2	oil_need	Shows the amount of pump flow currently required (L/min).
	S	pump_lim[REMS]	The data from the remote control is multiplied by this variable before it is sent to the valves.
	2	rem_in[FUNCS]	The received remote control data for each function.
	S	rem_max_n[REMS]	The transmitted max negative and positive speed data for each remote control

		rem_max_p_[REMS]	channel.
	2	rem_out[FUNCS]	The actual transmitted (to DA-modules) remote control data for each function (mean value).
	1	rem_vbatt	The remote control unit battery voltage in mV.
	2	global_gain	Remote control gain received from the lever on the remote control unit.
	S	rem_in_chan[REMS]	The received remote control data for each remote control channel.
	S	rem_in_ctrl	The received remote control control byte.
	S	rem_in_onoff	The received remote control on/off.
	S	rem_out_chan[REMS]	The actual transmitted remote control data for each control channel.
	S	rem_out_ctrl	The transmitted remote control control byte.
Levers	2	lever[FUNCS]	Shows the lever position (%).
Pressures	1	ib_p	Current pressure in bar, inner boom cylinder.
	1	ob_p	Current pressure in bar, outer boom cylinder.
	1	ji_p	Current pressure in bar, jib cylinder (piston rod side).
	1	jo_p	Current pressure in bar, jib cylinder (piston side).
	S	ib_p_r	The momentary relative pressure [%].
	S	ob_p_r	The momentary relative pressure [%].
	S	ji_p_r	The momentary relative pressure [%].
	S	jo_p_r	The momentary relative pressure [%].
	S	ib-p-avg	The average relative pressure [%].
	S	ob-p-avg	The average relative pressure [%].
	S	ji-p-avg	The average relative pressure [%].
	S	jo-p-avg	The average relative pressure [%].
	S	ib_p_der	The average of the min and max derivatives over a long time.
	S	ob_p_der	The average of the min and max derivatives over a long time.
	S	ji_p_der	The average of the min and max derivatives over a long time.
	S	jo_p_der	The average of the min and max derivatives over a long time.
	1	ib_p_filt	The filtrated relative pressure [%].
	1	ob_p_filt	The filtrated relative pressure [%].
	1	ji_p_filt	The filtrated relative pressure [%].
	1	jo_p_filt	The filtrated relative pressure [%].

Table 28 List of Variables (Continued)

S = display level system

Class	Display	Variable Name	Description of Variables
Digital Inputs	2	digin	The state of the multiplexed inputs.
	2	muxin[3]	The state of the three multiplexed input bytes min value 0,0,0 means no inputs closed (0 V) max value 255,255,255 means all inputs closed (24 V).
	2	micro-on	Shows actual state for personnel basket systems.
	1	ib_t45	0, 1, -1 tilt inner boom 0 = less than 45°.
	1	j-tilt	0, 1, -1, tilt jib.
	1	lo-load-imp	The actual state of the signal (0=off, 1=on, -1=not connected).
	1	plc_tilt	The actual state of the signal (0=off, 1=on, -1=not connected).
	1	time_inp	Switch position of one's own decided time counter.
	1	wload	0, 1, -1 indicator winch 1 = high torque.
	1	wend	0, 1, -1 ' ' 1 = three coils left.
	1	wtop	0, 1, -1 ' ' 1 = hook at top.

	1	wdis	0, 1, -1 ‘ ‘ 1 = wire total wound in.
	1	filt_err_inp	The actual state of the signal (0=off, 1=on, -1=not connected).
Angles	1	ib_ang	Inner boom angle (degrees).
	S	slew	Slewing angle (degrees).
	S	sir_max	Max slewing angle (degrees).
	S	sir_min	Min slewing angle (degrees).
Stability	1	stab_d_n[3]	The current status of the slewing sector indicators 1=active (near metal).
	1	stab_d_p[3]	The current status of the slewing sector indicators 1=active (near metal).
	1	stab_sect	The present slewing sector.
	1	stab_sects[3]	This parameter tells the type of the three different slewing sectors.
Manual Extensions	2	mext_load	The actual load (kg).
	2	mext_sel	Shows the number of selected extensions, plus 1.
	2	weight	The previous load weight.
	2	weight_tare	An extra dead weight on the crane.
Various	2	crane_pos	A variable that indicates the current crane position (0-7).
	2	lubr_time	Shows the time (minutes) remaining until next lubrication.
	2	max_out_n[FUNCS]	The maximum permitted speed (%) for each function (neg. direction).
	2	max_out_p[FUNCS}	The maximum permitted speed (%) for each function (pos. direction).
	1	oil_temp	Hydraulic oil temperature.
	1	oil_temp_high	The highest temperature since the last power on.
	S	idle_time	A counter that is incremented always when the CUP is idling.
	S	ill_int_type	When one of the processor exception interrupts occur, a corresponding bit will be set.
Analog Inputs	2	anin	Shows the raw data from every analog input, value 0-255.

OLP

167. Table 30 lists the OLP variables.

Table 30 OLP Variables

Name	Description
ib_olp_lim	The present OLP-activating pressure for the inner boom, outer boom and jib (in **ob_olp_lim** % of the working pressure **??_p_lim**). These values are normally 100, but **jib_olp_lim** changes according to LOS-status, electronic link angle, stability conditions and so on.
jb_prewarn_lim **ob_prewarn_lim** **jib_prewarn_lim**	The present pre-warning pressure limits for the inner, outer and jib booms (in % of the working pressures **??_p_lim**). This value is calculated as **olp_prewarn *??_olp_lim /** .
olp_out_n[FUNCS]	A non zero value in these bytes indicates that the OLP of one function (inner boom, outer boom, winch, jib or slewing sector) has stopped the negative direction for the corresponding functions.
olp_out_p[FUNCS]	A non zero value in these bytes indicates that the OLP of one function (inner boom, out boom, winch, jib or slewing sector) has stopped the positive direction for the corresponding functions.
ib_ep_ctr **ob_ep_ctr** **jo_ep_ctr** **ji_ep_ctr**	A non zero value in any of these variables shows that the corresponding function was driving up when its OLP was activated (that is, the cylinder has reached its end position or a heavy load was lifted from the ground). The value of the variables is the number of sample intervals you still can drive the function in the opposite direction (see **end_pos_spd**).
olp_rel_ctr	Shows the number of sample intervals that remain the OLP release mode.
olp_rel_w_ctr	Shows the number of seconds that remain until the OLP release mode can be activated again.

LOS

168. Table 31 lists the LOS variables.

Table 31 LOS Variables

Name	Description
los_level **ob_los_level** **jib_los_level**	Shows the actual LOS-levels. 0 means the LOS is not activated, 1 that the pressure is over **los_lim[0]**, etc.
los_out_n[FUNCS] **los_out_P[FUNCS]**	Shows the actual max allowed speed [%] in the negative and positive directions for the different functions. These speeds are dependent of (in addition to **los_level, ob_los level** and **jib_los_level**) the error-status (some errors give reduced crane speed) and OLP-status (OLP will give zero speed).

Remote Control

169. Table 32 lists the Remote Control variables.

Table 32 Remote Control Variables

Name	Description
oil_need	The sum of the momentary needed pump-flows [L/min] for the different functions.
pump_lim[REMS]	These variables [1/255-parts] are 255 as long as **oil_need** is smaller than **pump_flow**, but when **oil_need** starts to grow, **pump_lim** will get smaller so that the product of *oil_need* pump_lim[i] / 255* - **pump_flow**. The data from the remote control is multiplied by this variable before it is sent to the valves.
rem_in[FUNCS]	The received remote control data for each function.
rem_max_n[REMS] **rem_max_p[REMS]**	The transmitted max negative and positive speed data for each remote control channel.
rem_out[FUNCS]	An average of four delayed (see **lev_rem_time**) transmitted remote control data (after all restrictions and re-scalings). This value is compared to *lever[FUNCS]* when supervising that the value is not manoeuvred manually when remote mode selected.
rem_vbatt	The remote control unit battery voltage in mV. Showed only in remote mode when using a radio unit, 0 otherwise.
global_gain	This is the remote control gain [% of max speed] received from the microswitch on the remote control unit. The gain of each remote control channel will follow this global gain always when resp. lever is centred.
rem_in_chan[REMS]	The received remote control data for each remote control channel.
rem_in_ctrl	The received remote control control byte (byte 3, contains LOS Shift and Error info).
rem_in_onoff	The received remote control on/off-byte.
rem_out_chan[REMS]	The actual transmitted remote control data for each control channel.
rem_out_ctrl	The transmitted remote control control byte (byte 3, contains LOS, Shift and Error info).

Levers

170. Table 33 lists the Levers variables.

Table 33 Levers Variables

Name	Description
lever[FUNCS]	Shows the lever position [%]. Must correspond to the amount of oil that flows through the valve (must also correspond to the remote control data when the valve is remote controlled.

Pressure

171. Table 34 lists the Pressure variables.

Table 34 Pressure Variables

Name	Description
ib_p **ob_p** **ji_p** **jo_p**	The actual momentary pressure in bars (**counter_press** is already subtracted).
ib_p_r **ob_p_r** **ji_p_r** **jo_p_r**	The momentary (unfiltrated) relative (to **??_p_lim**) pressure [%].
ib_p_avg **ob_p_avg** **ji_p_avg** **jo_p_avg**	The average relative pressure [%] (average over a time given by **avg_len** relative to **??_p_lim**).
ib_p_der **ob_p_der** **ji_p_der** **jo_p_der**	The average of the min and max derivatives over a **der_max_len** long time.
ib_p_filt **ob_p_filt** **ji_p_filt** **jo_p_filt**	The filtrated relative pressure [%] (***??_p_avg + ??_p_der***).

Digital Inputs

172. Table 35 lists the Digital Inputs variables.

Table 35 Digital Inputs Variables

Name	Description
digin	The state of the three multiplexer inputs.
muxin[3]	The state of the three multiplexed input bytes (-1 means an communication error, e.g. no multiplexer connected).
micro_on	The actual state of the micro_mode: 0 OFF The crane is stopped 1 NORMAL The crane is in normal mode 2 MICRO The crane is in micro-mode (speed reduced) 3 MICRO-REL The crane is in micro-mode and the OLP is disconnected for a certain time (timing as for OLP-release, see the olp_rel-parameters).
ib_t45 **j_tilt** **lo_load_iinp** **plc_tilt** **time_inp** **wload** **wend** **wtop** **wdis** **filt_err_inp**	The actual state of the signal (0 = off, 1 = on, -1 = not connected). (wdis is activated when the inputs for both **wend** and **wtop** are activated at the same time).

Angles

173. Table 36 lists the Angles variables.

Table 36 Angles Variables

Name	Description
ib_ang	The actual inner boom angle (degrees).
slew	The actual slewing angle (degrees).
sir_max	The max slewing angle set by the operator.
sir_min	The min slewing angle set by the operator.

Stability

174. Table 37 lists the Stability variables.

Table 37 Stability Variables

Name	Description
stab_d_n[3] **stab_d_p[3]**	The current status of the slewing sector indicators (negative and positive, for three different sectors).
stab_sects[3]	The status of the slewing sectors (analog or digital). A zero means that the crane is out of the restricted sector. +1 means that the crane has entered the restricted sector from the positive side and -1 that the sector is entered from the negative side. 2 means that the entering direction is unknown (indicator error if digital sectors).
stab_sect	The combined (worst case) status of all the slewing sectors (analog or digital). A zero means that the crane is not in any sector. +1 means that the crane has entered a restricted sector from the positive side and -1 that the sector is entered from the negative side. 2 means that the entering direction is unknown (indicator error if digital sectors) or that two conflicting sectors are active.

Manual Extensions

175. Table 38 lists the Manual Extensions variables.

Table 38 Manual Extensions Variables

Name	Description
mext_load	The actual load [kg] measured from the manual extension load sensor.
mext_sel	Indicates the position of the manual extension selector switch. The value of the variable is the number of selected extensions plus 1 (see table in the SPACE - description).
weight	The previous load weight [kg] (calculated from the inner boom pressure when the 'Read Load Weight' switch is pressed).
weight_tare	An extra dead weight on the crane (read and set when the 'Set Weight Tare' switch is pressed). Subtracted from the weight variable.

Various

176. Table 39 lists the various variables.

Table 39 Various Variables

Name	Description
crane_pos	A variable that indicates the actual crane position (detected by tilt, j-tilt and if jo_p > ji_p).
	crane_pos 0 = outer boom down, jib in and down. crane_pos 1 = outer boom down, jib out and down. crane_pos 2 = outer boom down, jib in and up. crane_pos 3 = outer boom down, jib out and up (illegal, conv. to 1). crane_pos 4 = outer boom up, jib in and down. crane_pos 5 = outer boom up, jib out and down. crane_pos 6 = outer boom up, jib in and up (illegal, conv. to 4). crane_pos 7 = outer boom up, jib out and up. If the crane has no jib, only positions 0 and 4 are in use.
lubr_time	The time (in minutes) left to the next lubrication.
max_out_n[FUNCS] **max_out_p[FUNCS]**	The actual maximum permitted speed [%] for each function in both directions (negative resp positive). These values reflects the status of the LOS and the different OLPs, and they are ramped up and down as they change.
oil_temp	The actual hydraulic oil temperature.
oil_temp_high	The highest oil temperature measured since the last power on (defaults to 100 °C at power on).
idle_time	A counter that is incremented always when the CUP of the SPACE-board is idling, gives a measure of how much capacity the CPU has left.
il_int_type	When one of the processor exception interrupts (see below) occur, error 1 will be issue and the corresponding bit in this variable will be set. This variable is reset only at power up, so it will remember all the exception types that have occurred since then. The bits in ill_int_type are: bit 0 Unknown interrupt (dec 1) bit 1 Divide by zero (dec 2) bit 2 Unused opcode (dec 4) bit 3 Escape-opcode (dec 8) The ‘Divide by zero’-exception is probably caused by faulty parameter-values and possibly no so fatal (if you know what you are doing), but the rest is caused by fatal hardware or software errors and must never occur.

Analog Inputs

177. Table 40 lists the Analog Inputs variables.

Table 40 Analog Inputs Variables

Name	Description
anin	These variables contain the raw data from the analog inputs. A value of 0 corresponds to a input voltage of 0 v or a current of 0 mA. The max. value is 255 and corresponds to a input voltage of +5V or a current of 22.7 mA.

CONNECTION AND INITIATION OF SPACE

178. The following paragraphs list the tasks that must be performed after a major overhaul of the crane and/or its electronic safety control system. The section covers the connection of the SPACE system to the vehicle, the appropriate settings to be performed using the terminal program and the functional tests to be carried out prior to delivery.

Connection

179. When mounting the crane onto the vehicle, the following connections must be made:

a. connect the system to a 24 V power supply;

b. connect the high boom warning lamp relay unit to the ignition; and

c. ensure that the crane's SPACE system is connected as shown at Figure 31.

180. 24 V Power Supply. Connect the 24 V power supply to the P1 terminals of the MPCB box from the vehicle battery as detailed at Para 119. Ensure that a 40 A fuse is fitted in the wiring, close to the battery.

181. Warning Lamp Relay Unit. To connect the warning lamp relay unit, proceed as follows:

a. Connect the P1 on the PSBI cover to the warning lamp relay unit P1 as illustrated in Figure 33.

b. Connect the lamp relay unit P2 to the fan switch supply at the dash.

c. Connect the lamp relay unit P3 to the warning lamp on the dashboard.

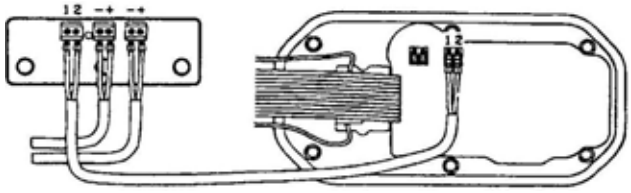


Figure 33 Lamp Relay Unit Connection

Initiation of the System

182. The following information is to be programmed in the SPACE system prior to delivery.

a. pump flow;

b. counter pressure; and

c. adjustment of high boom warning.

183. Pump Flow. Connect a flow meter in the main supply line from the hydraulic pump and note the pump flow rate while the vehicle engine is set at 1 000 rpm.

184. Counter Pressure. The counter pressure is recorded by connecting a low pressure gauge to the measuring quick disconnect on the main control valve. All levers must be in the neutral position and the stop button pushed in during counter pressure measurement. If the counter pressure measurement is higher than 1 400 kPa, check the hydraulic installation for restrictions in the return line.

185. Programming the SPACE System. To program the SPACE system using the terminal program, proceed as follows:

a. Start the terminal program and proceed to the main menu.

b. On the main menu, select INIT by pressing F2.

c. On sub-menu 1, select MISC by pressing F7.

d. State the pump flow value recorded above by stating the litre quantity numerically. Press ENTER.

e. Counter Pressure. Enter the value recorded above and press ENTER.

186. Adjustment of High Boom Warning. To adjust the high boom warning position, proceed as follows:

a. Move the inner boom to the position where the high boom warning light is to be activated.

b. Start the terminal program and proceed to the main menu.

c. On the main menu, select VARS by pressing F4.

d. On the summary menu, observe whether the signal from the tilting indicator is ‘up’ or ‘dn’ (down). Adjust the tilt indicator on the inner boom to the position where the signal shifts between up/dn. Refer Figure 34.

e. Return to the main menu by pressing F10 three times.

NOTE

An alternate method of setting the high boom warning is to position the inner boom, then release the tilt indicator locking bolt and move the indicator slowly up/down until a ‘click’ is heard as it shifts between registering ‘up’ and ‘down’. Lock the indicator in this position.

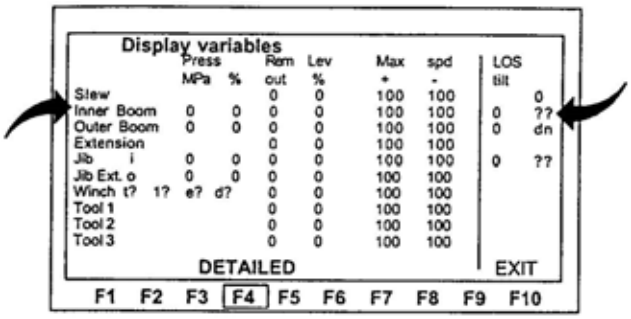


Figure 34 Summary Menu

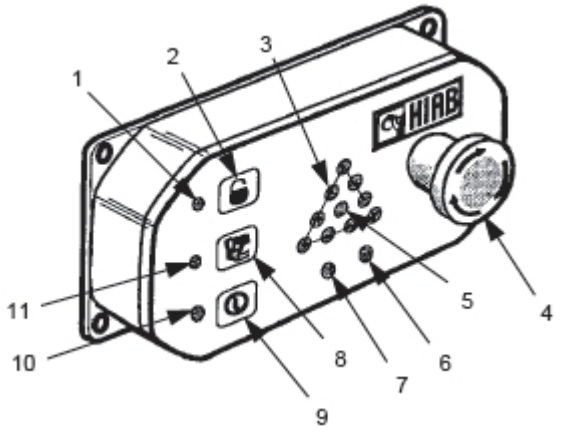
TEST PROCEDURES

FUNCTIONAL TEST

187. To carry out functional tests on the crane, proceed as follows:

Starting the SPACE System

188. To start the SPACE system, proceed as follows (refer Figure 35):



Item	Description	Item	Description	Item	Description
1	Release Lamp	5	Fault Lamp	9	On/Off Button
2	Release Button	6	Oil 2 Lamp	10	On Lamp
3	Warning Triangle Lamps	7	Oil 1 Lamp	11	Remote Lamp
4	Stop Button	8	Remote/Manual Button		

Figure 35 PSBI Box Buttons And Lamps

a. Push in the stop button (4) on the PSBI box.

b. Start the engine, engage the crane PTO and set the hand throttle to run the engine at 1 000 rpm.

c. Hang the controller around your neck or over your shoulder. The stop button is to be on the right.

d. Connect the cable from the remote controller to the socket located adjacent to the PSBI power box.

e. A red lamp (5), located in the centre of the warning triangle lamps (3), will blink. This indicates that 'height boom warning' is installed.

f. Start the control system by pressing the On/Off button (9) on the PSBI power box. An indicator light (10), adjacent to the button, will be lit.

g. The red lamp (5) will blink faster (3 Hz) indicating that a fault is found in the system.

h. Press the Manual/Remote button (8). The green indicator light (11), adjacent to the button, will blink.

i. Pull out the stop button (4) on the PSBI box.

j. Pull out the stop button on the controller. The indicator light (11) that was blinking on the PSBI power box will illuminate, lamp (7) will illuminate and, the indicator light on the remote controller will begin to blink. The crane is now ready for operation in the remote mode using the levers located on the controller.

Crane Operation

189. To check the SPACE system during crane operation, proceed as follows (refer Figure 35):

a. When a crane function is operated and the function is 'allowed' by the SPACE system, lamp (6) lights up indicating that the dump valve in the main control valve is activated.

b. When 90% of lifting capacity is reached, the triangle (3) blinks. Crane operation is still possible. When 100% of lifting capacity is reached, operation is stopped. The triangle (3) shows a steady light. Only movements decreasing the load moment are possible.

Temporary Release of OLP

190. To release the OLP system temporarily, proceed as follows (refer Figure 35):

a. In certain conditions, the crane boom can be locked in by the OLP and no movements are possible. A temporary release of the OLP is required to recover from the OLP situation.

b. Push button (2) on the PSBI box. The triangle (3) will flash in a circulating pattern.

c. Operate the appropriate functions to recover from the overload situation. A 4 to 5 second release period is allowed.

d. After the initial 4 to 5 second release period, there is a time delay of 2 minutes until a second release period is allowed. For further release periods, the time delay will be doubled each time, e.g. 4 mins, 8 mins, 16 mins and so on.

NOTE

If the SPACE system detects an OLP situation as a result of either the inner or outer boom cylinders bottoming out, the system will automatically engage the OLP release function.

Testing the Stop Function

191. To test the Stop function, proceed as follows:

a. Lift the rated load at maximum outreach (see the load plate).

b. Operate the inner boom downwards and, while doing so, push the stop button at the controller. The inner boom must stop. If not, the load holding valve must be adjusted.

Switching Off the SPACE System

192. To switch off the SPACE system, proceed as follows (refer Figure 35):

a. Switch the system off by pressing the On/Off button (9) on the PSBI power box.

b. If the crane is not folded and the position of the inner boom is too high, the triangle (3) will blink for five minutes (high boom warning).

TROUBLESHOOTING

TROUBLESHOOTING ORGANISATION

193. To determine in which of the crane systems the fault lies, perform the following checks.

NOTE

All troubleshooting is to be carried out with SPACE active.

Using the Diagnostic Terminal

194. To check error codes using the diagnostic terminal, proceed as follows:

a. Connect the computer terminal to the SPACE box.

b. Start the terminal program as described at Para 128.

c. On the main menu, select ERRS by pressing F6.

d. Any error codes stored in SPACE will be displayed.

e. Perform troubleshooting according to the displayed error code (refer Table 42).

f. If there are no errors displayed, carry out a hydraulic system check (refer Para 196).

g. When all errors have been eliminated, carry out the final check (refer Para 200).

195. Most of the errors are reset automatically when the faulty condition disappears, but a few errors require to be reset manually. A manual reset can be done with the terminal (ERRORS/CLEAR) or by switching the SPACE power off and on.

Hydraulic System Check

196. To check for faults in the hydraulic system, proceed as follows:

a. Try to operate the crane by using the levers on the valve unit.

b. If the crane works without faults, carry out intermittent error checks (refer Para 198).

c. If the crane has any defects, check the crane hydraulic system in accordance with Table 44.

CombiDrive Check

197. To check for faults using the CombiDrive remote controller, proceed as follows:

a. Connect the remote controller and operate the crane functions.

b. If the crane works without faults, carry out intermittent error checks (refer Para 198).

c. If the crane has any defects, check the CombiDrive remote control system in accordance with Table 43.

Intermittent Error Check

198. To check for intermittent faults, proceed as follows:

a. Operate all crane functions to end position. At the same time, check that the red indicator light on the PSBI box illuminates.

b. If the indicator light illuminates, read the error code either from the diagnostic terminal or the SPACE box’s digital indicator and perform troubleshooting according to the displayed error code (refer Table 42).

c. If the indicator light fails to illuminate, carry out the steps detailed below at Para 199.

Continued Steps

199. To check for additional faults in the system, proceed as follows:

a. Connect the computer terminal to the SPACE box.

b. Start the terminal program as described at Para 128.

c. On the main menu, select ERRS by pressing F6.

d. Select COUNT by pressing F5 and reset error codes by selecting RESET by pressing F1.

e. After resetting the error codes in SPACE, return the crane to service.

f. If the equipment is returned as faulty, check for error codes in SPACE as detailed in Para 194.

g. If no error code is stored in SPACE, select ERRS on the file menu by pressing F6.

h. Select COUNT by pressing F5 and read the counters which error codes have been stored since last service. If the counter shows values over 0, it indicates that SPACE has recorded an error earlier, but the error is now inactive (intermittent error). Perform troubleshooting according to error codes for intermittent errors like bad contact, contact resistivity, oxidation, damaged wiring etc.

Final Check of Crane

200. After repair, the crane shall be tested before it is returned to service. Proceed as follows:

a. Connect the computer terminal to the SPACE box.

b. Start the terminal program as described at Para 128.

c. On the main menu, select ERRS by pressing F6.

d. Select COUNT by pressing F5.

e. Reset error codes by selecting RESET by pressing F1.

f. Test all crane functions to end position.

g. Update the computer terminal by selecting REFR with F3.

h. Press F10 (EXIT) until you return to the main menu.

i. Quit the terminal program as described at Para 129.

Reading Out Errors from SPACE Box

201. To diagnose errors using the SPACE box, proceed as follows:

a. Unscrew the cover of the SPACE box.

b. Read the number of errors and the error codes from the two digit digital indicator, e.g. when the digital display flashes the number 2 and then 23, it means that there are two faults and the first error code is 23.

NOTE

The ‘number of errors’ indication displays a dot after the digit.

c. Identify and rectify the fault by using the error code list (refer Table 42).

d. Repeat the above process until zero errors are displayed on the digital indicator. The fault lamp in the centre of the warning triangle on the PSBI box will no longer be lit.

NOTE

Always use the terminal to check type and number of errors.

GENERAL CHECK OF LEADS AND CONNECTIONS

Visual Inspection of Cables

202. Whenever a connector is disconnected for measurement or inspection, the connections must be checked visually. Perform checks as follows:

a. Look for oxidation that may cause poor contact in connections.

b. Check that pins and terminals are undamaged and that they are properly inserted into the connector.

c. Make sure that the cables to the connection terminals are securely fastened. Make sure that the terminal screws are tight.

Checking for Open-Circuits

203. An open-circuit in a cable is indicated by a loss of one or more functions. Chafed or broken cables or connections that have come loose are common causes of faults in electrical systems. Perform checks as follows:

a. Disconnect connectors at both ends of the cable.

b. Connect an ohmmeter between the ends of the cable. The ohmmeter must read approximately 0 ohm if there is no open-circuit in the cable.

Checking for Short-Circuit to Ground

204. A short-circuit between a live cable and ground is often indicated by the loss of a function or a fuse blowing when a current is passed through the cable. Perform checks as follows:

a. Disconnect connections in the circuit to ensure that they do not affect readings.

b. Use ohmmeter to measure resistance between lead and ground. The ohmmeter must read infinite resistance if no components are connected.

c. In particular check pins and terminals for the relevant fault, according to Para 202.

Checking for Short-Circuit to Supply Voltage

205. A short-circuit between a cable and voltage is often indicated by the loss of a function or a fuse blowing when voltage is passed through the cable. Perform checks as follows:

a. Use a voltmeter to take readings at various points of the circuit while operating switches and sensors. Voltmeter readings will depend on the circuit and status of switches and sensors. Use the wiring diagram to determine the correct voltage in the circuit.

b. Use an ohmmeter between suspect cables to detect short-circuits between them. The ohmmeter must read infinite resistance between leads not connected to each other in the circuit.

c. In particular check pins and terminals for the relevant fault, according to Para 202.

Contact Resistance and Oxidation

206. The resistance in contacts, cables and terminals must be 0 ohm. However, a certain degree of resistance will be present due to oxidation of the connections.

207. If this resistance becomes too great, the result will be a malfunction. The magnitude of resistance before it causes a malfunction depends on circuit load. In addition to the above checks, check cables visually, according to Para 202.

Cleaning Male and Female Terminals

208. To clean terminals, proceed as follows:

a. Switch off SPACE.

b. Use compressed air to clean the disconnected connector.

c. Apply rust solvent spray to the connectors.

d. Blow clean with compressed air.

Greasing Connectors

209. Press grease (type Statoil SG32W Grease way or another ‘white oil’ with a non-organic additive for thickening) into female socket terminals directly from the tube. Check that all the terminal cavities are filled.

NOTE

Do not fill the protective cover with grease.

GENERAL REPAIRS

Cables – Contacts

210. The cables in the system have various numbers of conductors. All conductors in HIAB cables will be marked with numbers and colours as detailed in Table 41.

Table 41 Cable Colour Chart

Conductor Number	Colour
1	brown
2	red
3	orange
4	yellow
5	green
6	blue
7	lilac
8	grey
9	white
10	pink
11	transparent

Main Power

211. All cranes with electronic equipment will be delivered with one 5 m long cable to be connected to the 24 V power at the truck. This cable will be marked with plus (+) and minus (-) signs as well.

212. The conductor number 1, which will be brown and marked with a minus sign (-), must be connected to 0 V.

213. The conductor number 2, which will be red and marked with a plus sign (+), must be connected to 24 V.

214. Conductors that are connected to the SPACE box or any other box are to have crimp terminals. These are fitted using crimping pliers as described at Para 214.

215. The conductors are connected to the screw terminals in the boxes. All conductors from the same cable are connected to the same screw terminal. The numbered conductor is connected to the corresponding screw terminal number, e.g. conductor 1 is connected to pole No. 1, etc.

Disconnecting Contacts

216. The contact is protected by a clamp. When disconnecting cables remove the clamp, take hold of the cables (not the parts of the contact) and pull apart (applies to all connections). Refer to Figure 36.

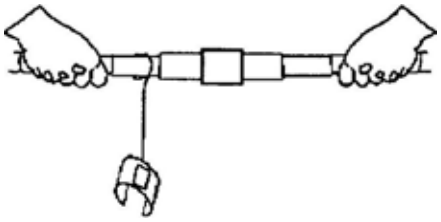


Figure 36 Disconnecting Contacts

Power Supply Box Contacts

217. There are two kinds of 4 pole and 6 pole angled connectors (refer to Figure 37). Note the different coding to prevent faulty connection. These contacts cannot be replaced. Order a new cable.

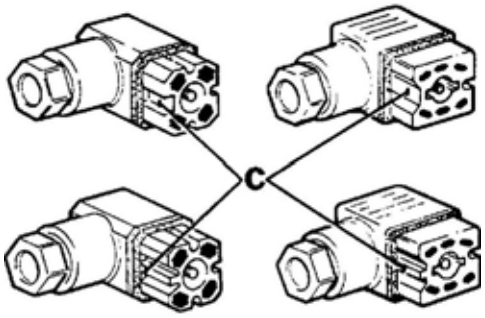


Figure 37 4 Pole and 6 Pole Angled Connectors

Changing a Contact

218. To change a contact, proceed as follows (refer Figure 38):

- **a.** Cut the cable straight.
- **b.** Slide on the clamp (1) and a dust ferrule (2) on the cable.
- **c.** Split the cable sheath 30 mm.
- **d.** Strip the cable ends 5 mm. Be careful not to damage the conductor units.
- **e.** Fit the pin and sleeve using the crimping pliers (3). The cables and contactors are number marked (1-11). Make sure the pin and sleeve are fitted to the right conductor (compare the number marking cable-contact). Brown conductor = no 1, red conductor = no 2.

  NOTE

  Two-conductor cable is not number marked.

- **f.** Insert the pin and sleeve in respective holes. Use the special tool (4) and press the pin/sleeve until their end positions are reached in the contact.
- **g.** Slide the dust ferrule over the contact.

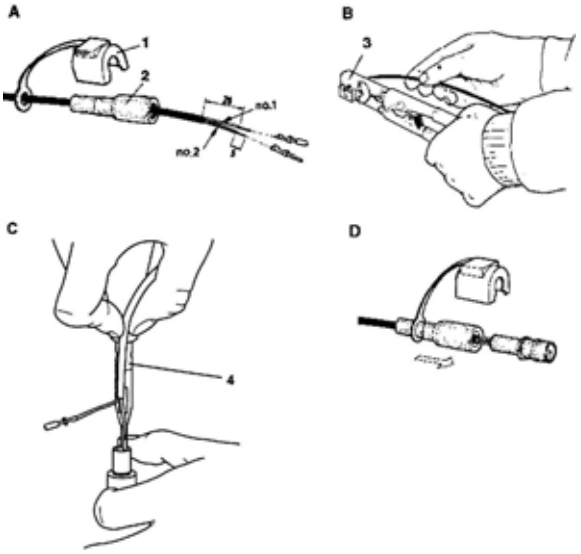


Figure 38 Changing a Contact

SPACE SYSTEM FAULT FINDING

Self Diagnosis

219. The SPACE system has the feature of self diagnosis. It is possible to detect one or more faults as they occur. When a fault occurs, the red indicator in the centre of the warning triangle on the PSBI box will blink three times per second (3 Hz). An error code will be generated and can be read from the digital display in the SPACE box or by using the diagnostic terminal. The advantage of using the diagnostic terminal during fault finding is that several error codes can be read at the same time.

220. The SPACE fault monitoring system does not identify faults with the CombiDrive system nor will it indicate general faults such as hydraulic faults. When breakdowns occur, service personnel must remain observant and continually examine these conditions as well as monitoring the SPACE fault detection system. Refer Table 43 and Table 44 for CombiDrive and hydraulic system fault finding.

NOTE

The fault code E3 'No Dump Voltage' will always be displayed when any of the stop buttons are pressed in. The red indicator in the centre of the warning triangle on the PSBI box will also blink.

SPACE Box

221. To diagnose errors using the SPACE box, proceed as follows:

a. Unscrew the cover of the SPACE box.

b. Read the number of errors and the error codes from the two digit digital indicator, e.g. when the digital display flashes the number 2. and then 23, it means that there are two faults and the first error code is 23.

NOTE

The 'number of errors' indication displays a dot after the digit.

c. Identify and rectify the fault by using the error code list (refer Table 42).

d. Repeat the above process until zero errors are displayed on the digital indicator. The fault lamp in the centre of the warning triangle on the PSBI box will no longer be lit.

Diagnostic Terminal

222. To diagnose errors using the diagnostic terminal, proceed as follows:

a. Connect the computer terminal to the SPACE box.

b. Start the terminal program as described at Para 128.

c. On the main menu, select ERRS to show the Display Errors sub-menu. This sub-menu will list any errors that have been detected.

d. Identify and rectify the fault (refer to the error code list at Table 42.

e. After diagnosing and fixing the fault, select REFR by pressing the F3 key. This will update the sub-menu and the fault will no longer be listed.

f. Repeat the above procedure until all faults have been rectified. The sub-menu will display 'no errors' and the fault lamp in the centre of the warning triangle on the PSBI box will no longer be lit.

g. Press F10 (EXIT) until you return to the main menu.

h. Quit the terminal program as described at Para 129.

SPACE Error Codes

223. Table 42 lists the error codes to be used in conjunction with the digital display in the SPACE box and/or the diagnostic terminal to identify and remedy faults in the crane's SPACE system.

Table 42 Space Error Code List

Code	Condition	Symptom	Probable Cause	Remedial Action
E0: Supply voltage to SPACE box too low	If the SPACE box records a supply voltage below 16.5 V	Fault blink	a. Vehicle battery voltage too low b. Contact resistance in connections or fuse holders	a. **Supply voltage check** Measure voltage from vehicle at + connection in MPCB box. If too low, check supply from battery to MPCB box. If no fault is found, continue at (b) below. b. **Visual check of connections** Check the following connections for contact resistance and oxidation: MPCB box: + & - connections, fuse holders PSBI box: connection P3, fuse holders, external contact piece (right) SPACE box: connection P14.1
E1, E6, E7, E9, E18, E62, E63, E64: Internal error	A system error in SPACE microprocessor or program	Fault blink		**SPACE restart** Turn off SPACE and start again. Run test. If fault appears again, exchange SPACE box as described at Para 112.
E2: Voltage feed to sensors too low	If the SPACE box records voltage to sensors (connection P8 excluded) being below value of parameter **min_volt_in**, fault code E2 is set (VARS, Analog inputs, line 3, value 5)	Crane stops Fault blink	a. Voltage cable to a sensor shorted to ground b. Vehicle battery voltage too low	a. **Checking supply voltage** Measure voltage from vehicle at MPCB connection +. Must be approx 24 V, engine off. If too low, check voltage supply from vehicle to MPCB box. If voltage is OK, continue at c. b. **Visual inspection of connections** Check voltage supply from vehicle to MPCB box. Check supply connections for contact resistance and oxidisation: MPCB box: Connection + and -, fuse holders. PSBI box: Connection P3, fuse holders, external-contact piece (right). SPACE box: Connection P14.4. c. **Visual inspection of cables and components** Check visually cables to all sensors except those on boom system. Make sure that the sensors are OK. If no fault is found, continue at d. d. **Checking voltage cables to sensors** Disengage voltage cables from connections in the SPACE box. Check voltage cables for shorts to ground. SPACE box: Connection P6.1, P7.1, P9.2, P10.2, P11.2, P12.2.

Table 42 Space Error Code List (Continued)

Code	Condition	Symptom	Probable Cause	Remedial Action
E3: Dump valve, signal missing	If the SPACE box receives no dump valve signal from the PSBI box, fault code E3 is set.	Crane stops Fault blink	a. Stop button pushed in b. No contact with remote control c. Contact resistance in connections d. Signal cable between PSBI and SPACE ruptured e. Signal cable to dump valve shorted to ground	a. **Check controls and battery** Make sure that stop buttons are not pushed in. Make sure that battery in remote control unit is charged If no fault is found, continue at b. b. **Remote control** After turning remote control off on the PSBI box, is manual operation possible? Yes: continue remote control fault search according to Table 43. No: continue at c. c. **Visual inspection of cables and connections** Check cables PSBI - SPACE and SPACE - dump valve visually. Check connections for oxidisation and contact resistance: SPACE box: Connections P3, P14 PSBI box: External contact piece (right) If no fault is found, continue at d. d. **Cable check** Check cables PSBI - SPACE and SPACE - dump valve for rupture and short circuit to ground. SPACE box: Connection P3, P14 PSBI box: External contact piece (right).
E4: Signal fault in reception from remote control	If signal from remote control to SPACE box contains too much faulty information, fault code E4 is set.	Crane stops Fault blink	a. Radio transmission b. External disturbance	**Remote control** Carry out remote control trouble shooting according to Table 43.
E5: SPACE box, parameter error	If the SPACE box detects incorrect parameter values at start, fault code E5 is set.	Crane stops Fault blink	a. Incorrect parameter values have been programmed b. Voltage was turned off during setting of parameters c. Parameters have not been initialised, e.g. new SPACE box	a. **Restart SPACE** Turn off SPACE. Start again. If fault remains, continue at b. b. **Incorrect parameter** Read error message on terminal, at top of main menu. Which fault type is indicated? 'Checksum': continue at c. 'Uninitialized' or 'out of range': change SPACE box. c. **Parameter change** Checksum faults may appear if voltage to SPACE is broken during setting of a parameter and is rectified as follows: Make a 'dummy'-change of the incorrect parameter, i.e. chant it to same value as before. Go to main menu. Make sure that value of the parameter which was being changed when voltage break occurred is correct.

Table 42 Space Error Code List (Continued)

Code	Condition	Symptom	Probable Cause	Remedial Action
E10: Fault in dump valve circuit	If the SPACE box records dump valve to be active when it should not be or detects dump valve unconnected, fault code E10 is set.	Crane stops Fault blink	a. Break in ground cable and/or voltage cable b. Contact resistance in connections c. Dump valve relay is jammed	a. **Locating fault** Pull out the PSBI emergency stop button. Measure voltage in SPACE box connection P3.2. If voltage is approx 0 V, continue at 2. If voltage is approx 24 V, continue at 4. b. **Visual inspection of cables** Check cables from SPACE box to dump valve visually. Make sure that cables are properly fixed in the SPACE box. SPACE box: Connection P3. Check connections and contact pieces for oxidisation and contact resistance. If no fault is found, continue at c. c. **Checking cables** Check dump valve cables for breaks. d. **Dump valve relay** If relay is jammed: The SPACE box must be changed otherwise the fault will most likely return.
E11: Jib sensor not connected	If the SPACE box records one but not all jib-sensors to be connected, fault code E11 is set.	Low crane speed Fault blink	a. Contact resistance in connections b. Break in voltage or signal cable c. Signal cable shorted to ground d. Defective sensor	a. **Crane equipment** Is the crane used with jib? Yes: Continue at c. No: Continue at b. b. **Plugs** Make sure that cable plugs for jib connection are properly fixed. If fault remains, continue at c. c. **Locating fault circuit** Check other fault codes (E36, E37, E38) in order to pinpoint faulty circuit. Continue at d. d. **Visual inspection of cables and components** If jib unconnected, check cables up to plug as follows: Check visually cables and contact pieces between sensor and SPACE box. Make sure that cables to sensor/indicator in faulty circuit are properly connected. Jib box: Connections P1, P2, P3, P4. Cable reel box: Connections P1, P2. Column box: Connection P1.7-9, P6. Check connections and contact pieces for oxidisation and contact resistance. If no fault is found, continue at e. e. **Checking sensor cables** Cables between sensor/indicator of faulty circuit and SPACE box: check for breaks. Signal cable between sensor/indicator of faulty circuit and SPACE box: check for short circuit to ground. If not fault is found, try a new sensor/indicator.
E12: Both jib and winch simultaneously connected	If the SPACE box records both jib sensor and winch box to be connected although system has been initialised for jib or winch (JIBWIN), fault code E12 is set.	Low crane speed Low capacity Fault blink	a. Plug fault at jib/winch connection b. Incorrect system type entered	a. **Checking plugs at jib or winch connection** Remove plug in jib alt winch connection for the function not used at the moment. Measure resistance between pins, must be approx 10kΩ. b. **Initialising** If the fault code is set during initialising, incorrect system type has been entered. Initialise system anew, enter correct system type according to section Terminal.

Table 42 Space Error Code List (Continued)

Code	Condition	Symptom	Probable Cause	Remedial Action
E13: Winch, indicator fault	If the SPACE box receives signals implying that indicator WTOP (hook at top position) as well as indicator WEND (three turns left) are active, fault code E13 is set. (This is an impossible combination).	Low crane speed Low capacity Fault blink	a. Defective indicator b. Contact resistance c. Break in power or signal code	a. **Visual inspection of indicators** Check indicators for damage or seizure. Make sure that indicators are correctly fitted/adjusted according to Repairs. If no fault is found, continue at 2. b. **Locating defective indicator circuit** Read off terminal values VARS, Digital inputs, WTOP and WEND. WTOP shall be 1 when hook at top, otherwise 0. WEND shall be 1 when less than three turns are left, otherwise 0. Find out which circuit is causing the fault. Continue fault search in faulty circuit according to 3. c. **Indicator check** Measure resistance in faulty circuit indicator. The resistance for WTOP shall be infinite when hook at top. The resistance for WEND shall be infinite when less than three turns left. If no fault is found, continue at d. d. **Visual inspection of contact pieces and cables to indicator** Check contact pieces for oxidisation and contact resistance. Check cables for visual damage. If no fault is found, continue at e.
E14: Slewing sector, faulty signal	If signals from the two slewing sensors to SPACE stop at the same time, the system will not know the direction from which the crane swings into the sector. Fault code E14 is set.	Low crane speed Low capacity Fault blink	a. Sector plate defective b. Cable break	a. **Checking sector plate** Find out if sector plate under the crane is defective or loose. If no fault is found continue at b. b. **Check cables visually** Check the sensor cables visually.
E15: Pressure sensor inner boom, faulty signal	Fault code E15 is set when the following applies: After 30 seconds of inner boom cylinder operation at a minimum speed of 50%, signal from the pressure sensor of this cylinder remains unchanged.	Low crane speed Fault blink	Defective sensor	**Change of component** Try a new pressure sensor.
E16: Pressure sensor piston side jib, faulty signal	Fault code E16 is set when the following applies: After 30 seconds of jib cylinder operation at a minimum speed of 50%, signal from the pressure sensor at the piston side of this cylinder remains unchanged.	Low crane speed Fault blink	Defective sensor	**Change of component** Try a new pressure sensor.

Table 42 Space Error Code List (continued)

Code	Condition	Symptom	Probable Cause	Remedial Action
E17: Pressure sensor rod side jib, faulty signal	Fault code E17 is set when the following applies: After 30 seconds of jib cylinder operation at a minimum speed of 50%, signal from the pressure sensor at the piston side of this cylinder remains unchanged.	Low crane speed Fault blink	Defective sensor	**Change of component** Try a new pressure sensor.
E19: Personnel basket, 3-position switch gives faulty signal	If the SPACE box records signal from 3-position switch to differ more than 1 mA from programmed current levels.	Low crane speed Low capacity Fault blink	a. Contact resistance in connections b. Defective 3-position switch	a. **Visual inspection of connections** Check connections between 3-position switch and SPACE box for oxidisation and contact resistance. Personnel basket box: Connection P1, P2, P3 Jib box: Connection P6.1-2 Cable reel box: Connection P1.1, P1.7, P4 Column box: Connection P1.2, P1.11, P8 SPACE box: Connection P8.2, P8.11 If no fault is found, continue at b. b. **Supply voltage, 3-position switch** Is there a voltage (approx 24 V) at connection P2.2 and P3.2 in the personnel basket box? Yes: Continue at c. No: Try a new personnel basket box. c. **3-position switch** Measure voltage at connection P2.3 and P3.3 in the personnel basket box while having the switch in its various positions. ON must give voltage at P2.3 RELEASE must give voltage P3.3 Are readings correct? Yes: Try a new personnel basket box No: Try a new 3-position switch.
E20: SPACE box, processor stop	Fault code E20 is set if the processor stops. A stop may be due to a parameter error or to shutdown from terminal. During spool sensor calibration the processor stops and fault code E20 is shown, which however, is cancelled after completed calibration.	Fault blink	a. Parameter error b. Manual shutdown	a. **Restarting SPACE** Turn off SPACE. Start SPACE again. If fault remains, continue at b. b. **Incorrect parameter** Read error message on terminal, at top of main menu. Which type of fault is indicated? 'Checksum': continue at c 'Uninitialized', or 'out of range': change SPACE box. c. **Parameter change** Checksum faults may appear if voltage to SPACE is broken during a parameter change and is rectified as follows: Make a 'dummy'-change of the incorrect parameter, i.e.. change it to same value as before. Go to main menu. Make sure that the value of parameter being changed when voltage was broken is correct.

Table 42 Space Error Code List (Continued)

Code	Condition	Symptom	Probable Cause	Remedial Action
E21: Supply voltage to column box too low	If the SPACE box records a supply voltage to column box below the value set for parameter **min_volt_in**, fault code E21 is set VARS, Analog inputs, line 3, value 5).	Crane stops Fault blink	a. Vehicle battery voltage too low b. Contact resistance in connections or fuse holders c. Voltage cable to a boom sensor short circuited to ground	a. **Supply voltage check** Measure voltage from vehicle at MPCB box connection +. Voltage shall be approx 24 V, engine off. If voltage too low, continue at 2. If voltage correct, continue at 3. b. **Visual inspection of connections** Check voltage supply from vehicle to MPCB-box. Check supply connections for contact resistance and oxidisation: MPCB box: Connections + and -, fuse holders. PSBI box: Connection P3, fuse holders, external contact piece (right). SPACE box: Connection P14.4. c. **Visual inspection of cables and connections** Check cables from SPACE box to boom system sensors visually. Check column box and sensors for damage. If no fault is found, continue at d. d. **Checking supply voltage cable to column box** Remove voltage supply from column box connection P1.2. Measure voltage in cable. Voltage must be roughly equal to battery voltage. If OK, continue at f. If not OK, continue at e. e. **Checking cable to column box** Check cable between SPACE box connection P8.2 and column box connection P1.2 for short circuit to ground. f. **Checking voltage cables to sensors** Disconnect voltage cables for sensors in the column box. Column box connections: P2.1, 3.1, 4.1, 5.1, 6.1, 7.1, P8.1. Check voltage cables for short circuits to ground.
E22: Tilt indicator outer boom, signal missing E34: Tilt indicator outer boom, signal too high or too low	If the SPACE box records signal from outer boom tilt indicator to be completely missing, fault code E22 is set, followed by E34. If the signal exists but be too high or too low, fault code E34 is set. The signal is too high when the analog value is above 240, too low when below 16 (VARS, Analog inputs, line 2, value 2).	Low crane speed Low capacity Fault blink	a. Signal line shorted to voltage b. Contact resistance in connections c. Break in voltage or signal cable d. Voltage or signal cable shorted to ground e. Defective indicator	a. **Checking other fault codes** Are other fault codes stored for sensors connected to the column box? Yes: Continue at b. No: Continue at c. b. **Other fault codes** Other fault codes for sensors connected to the column box are stored: this indicates a fault in the common voltage feed to the sensors. Check voltage between SPACE box connection P8.2 and column box connection P1.2. Must be roughly equal to battery voltage. c. **Visual inspection of cables and connections** Check cables from tilt indicator to SPACE box visually. Make sure that column box and indicator are undamaged. Open column box and SPACE box. Make sure that indicator cables are properly fastened. Column box: Connections P4.1, P4.2, P1.5 SPACE box: Connection p8.5. Check connections and contact pieces for contact resistance and oxidisation. If no fault is found continue at d. d. **Checking cables to indicator** Check indicator cables to column box for breaks, short circuits to ground and voltage. Check signal cable between column box connection P1.5 and SPACE box connection P8.5 for break, short circuits to ground a voltage. If no fault is found, try a new tilt indicator.

Table 42 Space Error Code List (Continued)

Code	Condition	Symptom	Probable Cause	Remedial Action
E23: Tilt indicator inner boom, signal missing E35: Angle sensor/tilt indicator inner boom, signal too high or too low	If the SPACE box records signal from inner boom tilt indicator to be completely missing, fault code E23 is set followed by E35. If the signal exists but be too high or too low, fault code E35 is set. The signal is too high when the analog value is above 240, too low when below 16 (VARS, Analog inputs, line 2, value 3).	Low crane speed Low capacity Fault blink	a. Signal line shorted to voltage b. Contact resistance in connections c. Break in voltage or signal cable d. Voltage or signal cable shorted to ground e. Angle sensor incorrectly adjusted f. Defective sensor	a. **Checking other fault codes** Are other fault codes stored for sensors connected to the column box? Yes:Continue at b. No: Continue at c. b. **Other fault codes** If fault codes for sensors connected to the column box are stores: this indicates a fault in the common voltage feed to the sensors. Check voltage between SPACE box connection P8.2 and column box connection P1.2. Must be roughly equal to battery voltage. c. **Visual inspection of cables and connections** Check cables from tilt indicator/sensor to SPACE box visually. Make sure that column box and indicator/sensor are undamaged. Open column box and SPACE box. Make sure that indicator cables are properly fastened. Column box: Connections P5.1, P5.2, P1.6 SPACE box: Connection P8.6.} Check connections and contact pieces for contact resistance and oxidisation. If no fault is found, continue at d. d. **Checking cables to sensor** Check indicator cables to column box for breaks, short circuits to ground and voltage. Check signal cable between column box connection P1.6 and SPACE box connection P8.6 for break, short circuits to ground and voltage. For SPACE with tilt indicator: If no fault is found, try a new tilt indicator. For SPACE with angle sensor: Check angle sensor adjustment according to Repairs. If no fault is found, try a new sensor.
E24: Pressure sensor outer boom, faulty signal	Fault code E24 is set when the following applies: After 30 seconds of outer boom cylinder operation at a minimum speed of 50%, signal from the pressure sensor of this cylinder remains unchanged.	Low crane speed Fault blink	Defective sensor	**Change of component** Try a new pressure sensor.
E25: Supply voltage to sensors too high	If the SPACE box records a supply voltage to sensors above the analog value 255, fault code E25 is set (VARS, Analog inputs, line 1, value 1).	Low crane speed Fault blink	Vehicle alternator voltage too high	**Check of vehicle voltage** Check vehicle alternator voltage.

Table 42 Space Error Code List (Continued)

Code	Condition	Symptom	Probable Cause	Remedial Action
E26, E27, E28, E29, E30, E31, E32: Spool sensor signal too high or too low	If the SPACE box records signal from a spool sensor being too low or too high, on e of the fault condes E26-E32 is set, depending on sensor. Signal is too low when the analog value is below 16, too high when above 240 (VARS, Analog inputs, line 1, value 2-8).	Low capacity Fault blink	a. Signal cable shorted to voltage b. Contact resistance in connections c. Break in signal or voltage cable d. Voltage or signal cable shorted to ground e. Defective sensor	a. **Visual inspection of cables and components** Check cables from sensor to SPACE box visually. Check sensor for external damage. Open the SPACE box. Make sure that sensor cables are properly fixed. SPACE box: Connections P9, P10, P11. Check connections for contact resistance and oxidisation. If no fault is found, continue at b. b. **Checking supply voltage to sensor** Check supply voltage to sensor from SPACE box. Must be approx battery voltage. SPACE box: Connection P9.2 for fault code E26 Connection P10.2 for fault codes E27, E28, E29 Connection P11.2 for fault codes E30, E31, E32 If no fault is found, try a new spool sensor.
E31 or E51: Pressure sensor outer boom, signal too high or too low	If the SPACE box records too high or too low signal from outer boom cylinder pressure sensor, fault conde E33 or E51 is set. The signal is too high when the analog value is above 240, too low when below 16 (VARS, Analog inputs, line 2, value 1).	Low crane speed Impossible to run extension out Fault blink	a. Signal line shorted to voltage b. Contact resistance in connections c. Break in voltage or signal cable d. Voltage or signal cable shorted to ground e. Defective sensor	a. **Checking other fault codes** Are other fault codes stored for sensors connected to the column box? Yes: Continue at b. No: Continue at c. b. **Other fault codes** If fault codes for sensors connected to the column box are stored: this indicates a fault in the common voltage feed to the sensors. Check voltage between SPACE box connection P8.2 and column box connection P1.2. Must be roughly equal to battery voltage. c. **Visual inspection of cables and components** Check cables from sensor to SPACE box visually. Make sure that column and sensor are OK. Open column box and SPACE box. Make sure that sensor cables are properly fastened. Column box: Connections P3.1, P3.2, P1.4. SPACE box: Connection P8.4. Check connections and contact pieces for contact resistance and oxidisation. If no fault is found, continue at 4. d. **Checking cables to sensor** Check sensor cables to column box for breaks, short circuits to ground and voltage. Check signal cable between column box connection P1.4 and SPACE box connection P8.4 for break, short circuit to ground and voltage. If no fault is found, try a new pressure sensor.

Table 42 Space Error Code List (Continued)

Code	Condition	Symptom	Probable Cause	Remedial Action
E36: Pressure sensor jib, rod side: signal too high or too low	If the SPACE box records too high or too low signal from job cylinder rod side pressure sensor, fault code E36 is set. The signal is too high when the analog value is above 240, too low when below 16 (VARS, Analog inputs, line 2, value 4).	Low crane speed Fault blink	a. Signal line shorted to voltage b. Contact resistance in connections c. Break in voltage or signal cable d. Voltage or signal cable shorted to ground e. Defective sensor	a. **Checking other fault codes** Are other fault codes stored for sensors connected to the column box? Yes: Continue at b. No: Continue at c. b. **Other fault codes** If fault codes for sensor connected to the column box are stored: this indicates a fault in the common voltage feed to the sensors. Check voltage between SPACE box connection P8.2 and column box connection P1.2. Must be roughly equal to battery voltage. c. **Visual inspection of cables and components** Check cables from sensor to SPACE box visually. Make sure that column box and sensor are OK. Open column box and SPACE box. make sure that sensor cables are properly fastened. Column box: Connections P6.1, P6.2, P1.7. SPACE box: Connection P8.7. Check connections and contact pieces for contact resistance and oxidisation. If no fault is found, continue at d. d. **Checking cables to sensor** Check sensor cables to column box for breaks, short circuits to ground or voltage. Check signal cable between column box connection P1.6 and SPACE box connection P8.6 for break, short circuit to ground or voltage. If no fault is found, try a new pressure sensor.
E37: Pressure sensor jib, piston side: signal too high or too low	If the SPACE box records too high or too low signal from jib cylinder piston side pressure sensor, fault code E37 is set. The signal is too high when the analog value is above 240, too low when below 16 (VARS, Analog inputs, line 2, value 5).	Low crane speed Fault blink	a. Signal cable shorted to voltage b. Contact resistance in connections c. Break in voltage or signal cable d. Voltage or signal cable shorted to ground e. Defective sensor	a. **Checking other fault codes** Are other fault condes stored for sensors connected to the column box? Yes: Continue at b. No: Continue at c. b. **Other fault codes** If fault codes for sensors are connected to the column box are stored: this indicates a fault in the common voltage feed to the sensors. Check voltage between SPACE box connection P8.2 and column box connection P1.2. Must be roughly equal to battery voltage. c. **Visual inspection of cables and components** Check cables from sensor to SPACE box visually. Make sure that column box and sensor are OK. Open column box and SPACE box. Make sure that sensor cables are properly fastened. Column box: Connections P6.1, P6.3 P1.8. SPACE box: Connection P8.8. Check connections and contact pieces for contact resistance and oxidisation. If no fault is found, continue at d. d. **Checking cables to sensor** Check sensor cables to column box for breaks, short circuits to ground or voltage. Check signal cable between column box connection P1.8 and SPACE box connection P8.8 for break, short circuit to ground or voltage. If no fault found, try a new pressure sensor.

Table 42 Space Error Code List (Continued)

Code	Condition	Symptom	Probable Cause	Remedial Action
E38: Tilt indicator on jig, signal too high or too low	If the SPACE box records signal from the jib tilt indicator to be too high or too low, fault code E38 is set. Signal is too high when the analog value is above 240, too low when below 16 (VARS, Analog inputs, line 2, value 6).	Low crane speed Low capacity Fault blink	a. Signal cable shorted to voltage b. Contact resistance in connections c. Break in signal or voltage cable d. Signal or voltage cable shorted to ground e. Defective indicator	a. **Checking other fault codes** Are other fault codes stored for sensors connected to the column box? Yes: Continue at b. No: Continue at c. b. **Other fault codes** If fault codes for sensors connected to the column box are stored, a fault in the common voltage supply to sensors is likely. Check voltage between SPACE box connection P8.2 and column box connection P1.2. Must be roughly equal to battery voltage. c. **Visual inspection of cables and components** Check cables between sensor and SPACE box visually. Make sure that column box and indicator are undamaged. Open column box and SPACE box. Make sure that column box and indicator are undamaged. Open column box and SPACE box. Make sure that sensor cables are properly fixed. Column box: Connection P6.1, P6.4, P1.9. SPACE box: Connection P8.9. Check connections and contact pieces for contact resistance and oxidisation. If no fault is found, continue at d. d. **Checking cables to indicator** Check indicator cables to column box for break, short circuits to ground and voltage. Check signal cable between column box connection P1.9 and SPACE box connection P8.9 for break, short circuits to ground and voltage. If no fault is found, try a new tilt indicator.
E39: Winch box signal too high or too low	If the SPACE box records too high or too low signal from the winch box, fault code E39 is set. The signal is too high when the analog value is above 240, too low when below 16 (VARS, Analog inputs, line 2, value 7).	Low crane speed Low capacity Fault blink	a. Contact resistance in connections b. Break in voltage or signal cable from winch box c. Signal cable from winch box shorted to ground d. Defective sensor	a. **Visual inspection of cables and components** Check cables between winch box and column box (alt jib box) visually. Open winch box and column box (alt jib box). Make sure that cables are properly fastened. Winch box: Connection P1 Column box: Connection P7 (Jib box: Connection P5) Check connections for contact resistance and oxidisation. If no fault is found, continue at b. b. **Checking cables** Check cables between winch box and column box (alt jib box) for breaks. Check signal cable between winch box and column box (alt jib box) for short circuits to ground or to voltage. If no fault is found, try a new pressure sensor.

Table 42 Space Error Code List (Continued)

Code	Condition	Symptom	Probable Cause	Remedial Action
E40: Personnel basket box, signal too high or too low	If the SPACE box records too high or too low signal from the personnel basket box, fault code E40 is set. The signal is too high when the analog value is above 240, too low when below 16 (VARS, Analog inputs, line 2, value 8).	Low crane speed Low capacity Fault blink	a. Contact resistance in connections b. Break in voltage or signal cable c. Signal cable shorted to ground or voltage	a. **Visual inspection of cables and components** Check boxes, cable reel, contact pieces and cables between personnel basket box and SPACE box for visual damage. Make sure that cables are properly fastened all the way from basket box to SPACE box. Personnel basket box: Connections P1, P2, P3. Jib box: Connection P6.1-2. Cable reel box: Connection P1.1, P1.7, P4. Column box: Connection P1.2, P1.11, P8. SPACE box: Connection P8.2, P8.11. Check connections for contact resistance and oxidisation. If not fault is found, continue at b. b. **Checking cables** Check signal and voltage cables between personnel basket box and SPACE box for breaks. Personnel basket box: Connections P1, P2, P3. Jib box: Connections P1.1, P1.7, P4. Column box: Connections p1.2, p1.11, p8. SPACE box: Connections P8.2, P8.11. If no fault is found, continue at c. c. **Checking signal cable** Check signal cable between personnel basket box and SPACE box for short circuits to ground or voltage. Personnel basket box: Connection P1.3. Jib box: Connections P1.7, P6.2. Cable reel box: Connections P1.7, P4.2. Column box: Connections P1.11, P8.2. SPACE box: Connection P8.11. If the fault remains, contact HIAB AB.
E41: OLP release button, signal too high	If the SPACE box records a too high signal from the release button, fault code E41 is set. The analog signal is too high when above 255 (VARS, Analog inputs, line 3, value 1)	Low crane speed Fault blink	Vehicle alternator voltage is too high	**Check of vehicle voltage** Check alternator voltage in vehicle.
E42: Dump valve, signal too high	If the SPACE box records a too high dump valve signal from the PSBI box to the SPACE box, fault code E42 is set. The signal is too high when above 240 (VARS, Analog inputs, line 3, value 2).	Low crane speed Fault blink	Vehicle alternator voltage too high.	**Check of vehicle voltage** Check alternator voltage in vehicle.
E44: Manual/remote control selector, signal too high	If the SPACE box records signal too high from manual/remote selector, fault code E44 is set. The analog signal is too high when above 240 (VARS, Analog inputs, line 3, value 4).	Low crane speed Fault blink	Vehicle alternator voltage too high	**Check of vehicle voltage** Check alternator voltage in vehicle.

Table 42 Space Error Code List (Continued)

Code	Condition	Symptom	Probable Cause	Remedial Action
E45: Voltage supply to column box too high	If SPACE records supply voltage to column box being too high, fault code E45 is set. It is too high if the analog value exceeds 240 (VARS, Analog inputs, line 3, value 5).	Low crane speed Low capacity Fault blink	Vehicle alternator voltage too high	**Check of vehicle voltage** Check alternator voltage in vehicle
E46: Slew angle sensor, signal too high or two low	If the SPACE box records too high or too low signal from a slew angle sensor, fault code E46 is set. The signal is too high when above 240, too low when below 16 (VARS, Analog inputs, line 3, value 6).	Low crane speed Low capacity Fault blink	a. Signal cable shorted to voltage b. Contact resistance in connections c. Break in voltage or signal cable d. Voltage or signal cable shorted to ground e. Defective sensor	a. **Visual inspection of cables and sensors** Check the sensors and the cables to the SPACE box visually. Open the SPACE box. Make sure that cables are properly fastened. SPACE box: Connection P6. Check connections and contact pieces for oxidisation and contact resistance. If no fault is found, continue at b. b. **Cable check** Check sensor cables for breaks, short circuits to ground or to voltage. If no fault is found, try with a new sensor.
E47: Temperature sensor, signal too high or too low	If the SPACE box records too high or too low signal from the temperature sensor, fault code E47 is set. The signal is too high when above 240, too low when below 16 (VARS, Analog inputs, line 3, value 7).	Low crane speed Fault blink	a. Signal cable shorted to voltage b. Contact resistance in connections c. Break in voltage or signal cable d. Voltage or signal cable shorted to ground e. Defective sensor	a. **Visual inspection of cables and components** Check the cables from sensor to SPACE box visually. Make sure that the sensor is OK. Open the SPACE box. Make sure that the sensor cables are properly fastened. SPACE box: Connection P7. Check connections and if applicable, contact pieces for oxidisation and contact resistance. SPACE box: Connection P7. If no fault is found, try with a new sensor.
E48 or E50: Pressure sensor, inner boom: signal too high or too low	If the SPACE box records too high or too low signal from the inner boom cylinder pressure sensor, fault code E48 or E50 is set. The signal is too high when the analog value is above 240, too low when below 16 (VARS, Analog inputs, line 3, value 8).	Low crane speed Impossible to run extension out Fault blink	a. Signal line shorted to voltage b. Contact resistance in connections c. Break in voltage or signal cable d. Voltage or signal cable shorted to ground e. Defective sensor	a. **Checking other fault codes** Are other fault codes stored for sensors connected to the column box? Yes: Continue at 2. No: Continue at 3. b. **Other fault codes** If fault codes for sensors connected to the column box are stored: this indicates a fault in the common voltage feed to the sensors. Check voltage cable between SPACE box connection P8.2 and column box connection P1.2. Must be roughly equal to battery charge. c. **Visual inspection of cables and components** Check cables from sensor to SPACE box visually. Make sure that column box and sensor are OK. Open column box and SPACE box. Make sure that sensor cables are properly fastened. Column box: Connections P2.1, P2.2, P1.3. SPACE box: Connection P8.3. Check connections and contact pieces for contact resistance and oxidisation. If no fault is found, continue at d. d. **Checking cables to sensor** Check sensor cables to column box for breaks, short circuits to ground or to voltage. Check signal cable between column box connection P1.3 and SPACE box connection P8.3 for break, short circuit to ground or to voltage. If no fault is found, try a new pressure sensor.

Table 42 Space Error Code List (Continued)

Code	Condition	Symptom	Probable Cause	Remedial Action
E49: Boom angle sensor, faulty signal	If the SPACE box records no change in signal from the boom angle sensor after 30 seconds of inner boom operation at a speed above 50%, fault code E49 is set.	Low crane speed Fault blink	a. Sensor incorrectly adjusted b. Faulty sensor	a. **Sensor check** Make sure that the sensor is adjusted according to Repairs. If no fault is found, try a new sensor.
E52: Levers not centred at start-up	If spool sensors detect a lever to be actuated when SPACE is switched on or when the stop button is pulled out, fault code E52 is set.	Crane stops Fault blink	a. Something is acting on the control levers b. Control levers stick and do not return to neutral c. Spool sensors incorrectly calibrated	a. **Control levers** Make sure that nothing touches levers, that no object is blocking them. Make sure that control levers run smoothly and return to neutral. If no fault is found, continue at b. b. Calibrating of spool sensors Calibrate spool sensors according to section Terminal.
E53: Remote control levers not centred at start-up	If the SPACE box records a lever on the controller to be actuated when remote control is selected on the PSBI box or when the stop button is pulled out, fault code E53 is set.	Crane stops Fault blink	Something is acting on the control levers	Resetting Push in the stop button. Make sure that nothing interferes with the control levers, pull out the stop button. If the fault remains, search for faults in the controller according to Table 43.
E54: Remote control, lever fault	From CombiDrive, SPACE receives info about a fault in one of the remote controller levers, indicating this as a fault code E54.	The function connected to relevant lever stops Fault blink	Defective control lever	Search for remote control fault according to Table 43.
E55: Remote control, radio connection missing	From CombiDrive, SPACE receives info about radio receiver losing contact with controller, indicating this as a fault code E55.	Crane stops Fault blink	Poor conditions for transmission /reception	Search for remote control fault according to Table 43.
E56: Remote control, radio transmission fault	From CombiDrive, SPACE receives indication that the radio signal from controller is faulty, indicating this as a fault code E56.	Crane stops Fault blink		Search for fault in remote control according to Table 43.

Table 42 Space Error Code List (Continued)

Code	Condition	Symptom	Probable Cause	Remedial Action
E57 Support legs are not set	If the SPACE box records signal from support leg indicator missing during 5 seconds, it is assumed that legs are not lowered. Fault code E57 is set.	Low capacity Fault blink	a. Indicators incorrectly fixed b. Contact resistance in connections c. Break in voltage or signal code d. Voltage or signal cable shorted to ground e. Defective indicator	a. **Checking other fault codes** Are fault codes E58, E59 or E60 shown? Yes: Search for fault after these fault codes. No: Continue at b. b. **Checking indicator fastening** Extend support legs and lower them. Make sure that all indicators are influenced. c. **Visual inspection of cables and components** Check cables from MUX box to indicators. Check indicators for damage. Open the MUX box. Make sure that cables are properly connected. Check connections for oxidisation and contact resistance. If no fault is found, continue at d. d. **Locating defective circuit** This part may be omitted if only few indicators are fitted. Make sure that all support legs are properly set. On the terminal, read off the variable 'muxin' for the MUX box to which the indicators are connected. Find out which plinths the indicators are connected to. Add up values corresponding to plinths. Compare with value for 'muxin'. The difference between value read off and calculated value corresponds to a plinth in the MUX box. The circuit connected to this plinth is faulty since it gives no signal although indicator is active. Continue at e. e. **Checking cables to indicator** Check cables from MUX box to the defective indicator for break and short circuit to ground. If the fault remains, change the indicator.
E58, E59, E60: MUX box, faulty signal	If the SPACE box records a faulty signal from the MUX box, fault code E58, e59 or E60 is set, depending on MUX box concerned.	Low crane speed Fault blink	a. Contact resistance in connections b. Cable break c. Signal cable shorted to ground	a. **Visual inspection of cables and connections** Check cables between MUX box and SPACE box for visual damage. Check connections in MUX box and SPACE box for oxidisation and contact resistance. MUX box: Connection P1. SPACE box: Connection P12. If no fault is found, continue at b. b. **Cable check** Check cables between MUX box and SPACE box for break, short circuit to ground or voltage.

Table 42 Space Error Code List (Continued)

Code	Condition	Symptom	Probable Cause	Remedial Action
E61: Two-position switch for personnel basket selection, faulty signal	If the SPACE box records a faulty signal from the two-position switch, fault code E61 is set. (This switch shall always give a signal to one MUX box channel).	Low crane speed Low capacity Fault blink	a. Signal cable shorted to ground b. Contact resistance in connections c. Break in voltage or signal cable d. Defective two-position switch	a. **Visual inspection of cables and connections** Check cables between two-position switch and MUX box visually. Make sure that cables are properly fixed in tow-position switch and MUX box. Check connections in two-position switch and MUX box for oxidisation and contact resistance. If no fault is found, continue at b. b. **Checking cables to two-position switch** Check cables between two-position switch and MUX box for break and short circuit to ground. If no fault is found, try a new two-position switch.
E65: Incorrect date given from SPACE box clock	If date has been erased, fault code E65 is set.		Battery in SPACE box defective	**Date setting** Set correct date using terminal according to section Terminal.
E66: Key switch for manual extensions, faulty signal	If the SPACE box records a faulty signal from the key switch, fault code E66 is set.	Low capacity Fault blink	a. Signal cable shorted to ground b. Contact resistance in connections c. Break in voltage or signal cable d. Defective key switch	a. **Visual inspection of cables and connections** Check cables between key switch and SPACE box alt MUX box visually. Check connections in key switch and SPACE box alt MUX box for oxidisation and contact resistance. SPACE box: Connection P12. MUX box: Not specified, follow cable. If no fault is found, continue at b. b. **Checking cables to key switch** Check cables between key switch and SPACE box, alt MUX box for break and short circuit to ground. If the fault remains, try with a new switch.
E67: Load sensor signal too high or too low	If the SPACE box records too high or too low signal from the load sensor, fault code E67 is set. The signal is too high when the analog value is above 240, too low when below 16.	Low crane speed Low capacity Fault blink	a. Signal line shorted to voltage b. Contact resistance in connections c. Break in voltage or signal cable d. Voltage or signal cable shorted to ground. e. Defective sensor.	a. **Visual inspection of cables and connections** Check cables between sensor and SPACE box alt MUX box visually. Check connections in sensor and SPACE box alt MUX box for oxidisation and contact resistance. SPACE box: Connection P12. MUX box: Not specified, follow cable. If no fault is found, continue at b. b. **Checking cables to sensor** Check cables between sensor and SPACE box, alt MUX box for break and short circuit to ground. If the fault remains, try with a new sensor.
E68: Key switch for manual extensions/load sensor, signal missing	If parameter settings indicate existence of key switch/sensor but signal to SPACE box is missing, fault code E68 is set.	Low crane speed Low capacity Fault blink	a. Break in voltage or signal cable b. Contact resistance in connections c. Voltage or signal cable shorted to ground	a. **Visual inspection of cables and connections** Check cables between key switch/sensor and SPACE box alt MUX box visually. Check connections in key switch/sensor and SPACE box alt MUX box for oxidisation and contact resistance. SPACE box: Connection P12. MUX box: Not specified, follow cable. If no fault is found, continue at b. b. **Checking cables to sensor** Check cables between key switch/sensor and SPACE box, alt MUX box for break and short circuit to ground. If the fault remains, try with a new sensor.

Table 42 Space Error Code List (Continued)

Code	Condition	Symptom	Probable Cause	Remedial Action
E69: Hydraulic oil filter clogged	If the SPACE box receives a signal from the oil filter indicator, fault code E69 is set.	Low crane speed Fault blink	a. Filter clogged b. Signal cable shorted to voltage c. Defective indicator	a. **Hydraulic oil filter** Change the filter, run test. If the fault remains, continue at b. b. **Visual inspection of cables and components** Check indicator cables and indicator visually. Check connections in the SPACE box for oxidisation and contact resistance. SPACE box: Connection P7. If no fault is found, continue at c. c. **Checking indicator cables** Check indicator cables for shirt circuits between signal cable and voltage cable. If the fault remains, try with a new indicator.
E70: Oil temperature too high	If the SPACE box records that the signal from the oil temperature sensor is too high, fault code E70 is set.	Low crane speed Fault blink	a. Oil temperature too high b. Signal cable shorted to voltage c. Oil temperature sensor defective	a. **Oil temperature** Allow oil to cool. If this helps but the fault returns, the hydraulic system must be overhauled to rectify heat problem. If this does not help, continue at b. b. **Visual inspection of cables and temperature sensor** Check cables and sensor visually. If no fault is found, continue at c. c. **Checking sensor cables** Check cables for short circuits between voltage and signal cable. If no fault is found, try with a new temperature sensor.
E71: PLC-program missing	If the SPACE box lacks PLC-program, fault code E71 is set.	Fault blink	PLC-program has been erased	Contact HIAB AB for further information.
E72: PLC-program error	If the end of the PLC-program is not executed, fault code E72 is set.	Fault blink	PLC-program too long	Contact HIAB AB for further information.
E73-E76: PLC-program error 1-4	The fault codes E71-E76 are unique for every PLC-program. Further fault code information is to be found in the PLC-program description.	Fault blink		Contact HIAB AB for further information.

COMBIDRIVE SYSTEM FAULT FINDING

224. Table 43 details the likely symptoms, the probable causes and the remedial actions required when fault finding problems with the CombiDrive remote control system. Refer to Figure 39 in conjunction with the table.

Table 43 CombiDrive Remote Control System Fault Finding

Symptom		Probable Cause	Action
1	No functions work – LA not lit	a. There is no power supply via cable CA.	Check the cable and rectify as necessary.
		b. Main fuse (7.5 A) in power supply box is blown.	a. Replace the fuse. b. If the fuse has blown, there may be a short circuit in one of the cables CC, CB, or CX. Check and rectify as necessary.
		c. The battery cables are connected the wrong way around.	Refit correctly.
2	No functions work – LA and LB lit LC not lit	a. The switch on the PSBI box is in the manual mode.	Select the remote mode.
		b. If the valve cannot be operated manually, cable CC may be damaged or the dump valve solenoid coil may be damaged.	Check and rectify as necessary.
3	No functions work – LA lit LB and LC not lit	The glass fuse (315 mA) in power supply box is blown.	a. Replace the fuse. b. If the fuse has blown, there may be a short circuit in cable CM. Check and rectify as necessary.
4	No functions work – LA and LC lit LB not lit LD does not flash	a. The stop button on the controller is faulty.	Replace the faulty stop button.
		b. The fault may be in cable CM.	Check the cable for damage or poor connection and rectify as necessary.
5	No functions work – LA, LB, and LC lit LD flashing LE not flashing	a. The fault is in cable CB.	Check the cable for damage or poor connection and rectify as necessary.
6	No functions work – LA, LB, and LC lit LD and LE flashing LF & LG lit when function is activated	a. The DA modules are not correctly connected.	Check the DA module connections. Power is supplied to the servo controls which, despite this are not activated.
		b. If manual control is not possible, cable CC may be damaged.	Check the cable for damage or poor connection and rectify as necessary.
		c. If manual control is possible, the dump valve is closed. Check if the servo controls are receiving servo pressure (min 15 bar). If there is no pressure, the filter is blocked.	Replace the filter element.
7	One or more functions do not work – LA, LB, and LC lit LD flashing LE flashing on all DA modules except, for instance, nos. 3 & 4	Cable CX between DA modules 2 and 3 may be faulty.	Check the cable for damage or poor connection and rectify as necessary.
8	One or more functions do not work – LA, LB, and LC lit LD flashing LE flashing slowly on one DA module	a. DA module programming faulty.	Reprogram the DA module.
		b. Short circuit in cable CX.	Check the cable for damage and rectify as necessary.
		c. Short circuit in servo control solenoid.	Check the solenoid for damage and rectify as necessary.

Table 43 CombiDrive Remote Control System Fault Finding (Continued)

	Symptom	Probable Cause	Action
9	One function does not work in either direction, or in one direction – LA, LB, and LC lit LD flashing LE flashing on DA modules LF or LG do not light on one DA module when function is activated using lever on remote controller	a. Faulty servo control. b. DA module programming faulty. c. Faulty remote controller lever.	a. Substitute the DA module from a working function and check the suspect function again. - If the fault is cured, the DA module is faulty. Reprogram or replace as necessary - If the fault remains, the servo control or remote controller lever is faulty. Continue with sub-para (b) below. b. Substitute the remote controller lever from a working function and check the suspect function again. - If the fault is cured, the remote controller lever is faulty. Replace the lever assembly. - If the fault remains, the servo control is faulty. Replace the servo control.

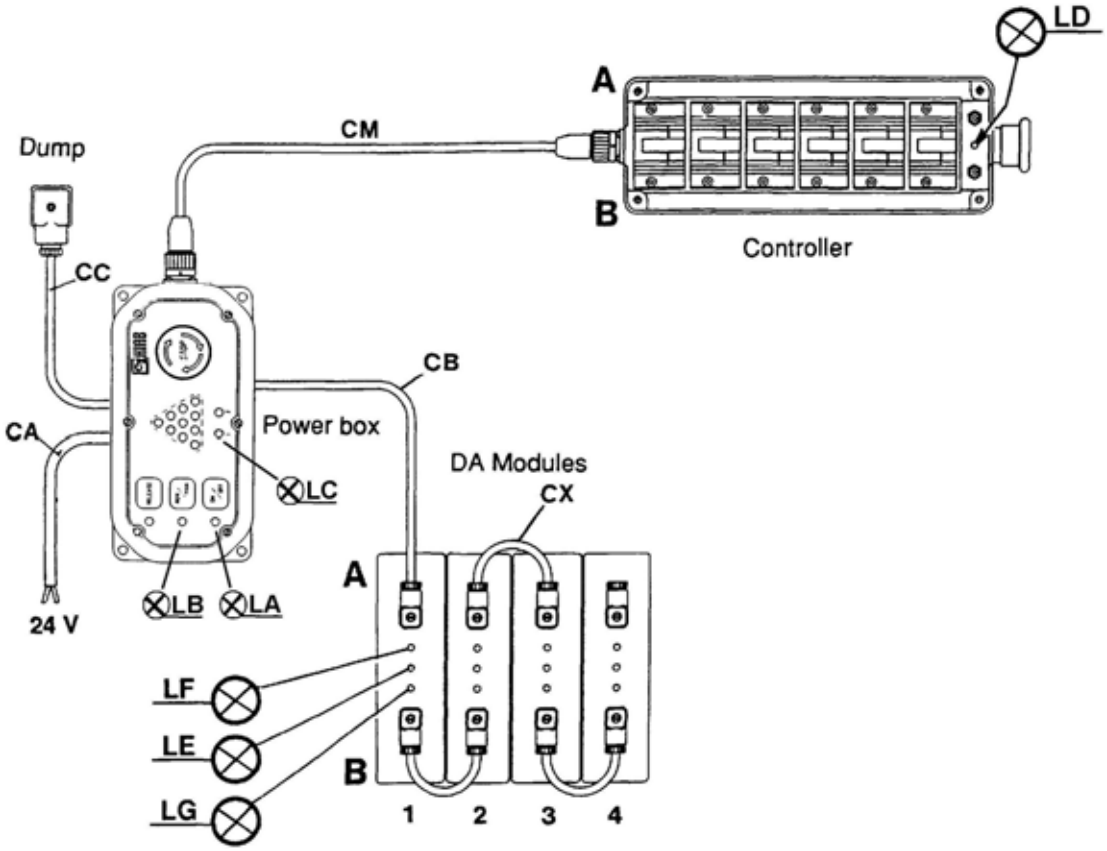


Figure 39 CombiDrive Troubleshooting Diagram

HYDRAULIC SYSTEM FAULT FINDING

225. Table 44 details the likely symptoms, the probable causes and the remedial actions required when fault finding problems with the Hydraulic functions of the crane.

Table 44 Hydraulic System Fault Finding

Symptom		Probable Cause	Action
1	No fluid flow – no pressure.	Fluid level in reservoir too low.	Top up with ISO Grade 68.
		Pump not receiving fluid.	Replace filter. Check for a blocked pump supply hose, clean or replace as necessary. Clean the reservoir breather vent then check the fluid level in the reservoir. Top up if necessary with ISO Grade 68.
		Power take-off to pump splined connection damaged.	If the pump only is damaged, replace. If the PTO is damaged, report.
		Air leaks in pump supply line.	Check hose connections. Tighten as necessary. Replace hose if necessary.
		Cavitation or aeration in pump.	Check for air leaks in the pump supply line and rectify. Clean or replace blocked pump supply line. Clean reservoir breather vent and if necessary change the system fluid.
2	Low fluid flow rate.	Fluid level in reservoir is incorrect.	Top up with ISO Grade 68.
		Leaking pipe or hose connections.	Tighten connections.
		Damaged or leaking pipes or hoses.	Replace.
		Fluid viscosity too high.	Warm fluid up to operating temperature. If viscosity is still too high, change fluid. Use only ISO Grade 68.
		Pump not operating at optimum capacity.	Replace the pump.
		Air leaks in pump supply line.	Check hose connections, tighten as necessary. Replace hose if necessary.
		Cavitation or aeration in pump.	Check for air leaks in the pump supply line and rectify. If the supply line is blocked, clean or replace as necessary. Ensure that the reservoir breather vent is clear and if necessary change the system fluid.
3	Excessive flow or movement.	Fluid viscosity too low.	Change fluid. Use only ISO Grade 68.
4	Low fluid pressure.	Inadequate flow rate.	Refer to 'No fluid flow – No pressure', or 'Low fluid flow'.
		Excessive external leakage.	Rectify leaks and fill reservoir to correct level with ISO Grade 68.
5	Erratic fluid pressure.	Air in fluid.	Repair or replace damaged hoses or pipes. Tighten leaking connections then fill the reservoir to correct level with ISO Grade 68.
		Hydraulic fluid contaminated.	Replace filter. Check for a blocked pump supply hose, clean or replace as necessary. Ensure that the breather vent is clear and if necessary change the system fluid. Use only ISO Grade 68.

Table 44 Hydraulic System Fault Finding (Continued)

Symptom		Probable Cause	Action
6	Excessive fluid pressure.	Incorrect oil viscosity.	Change fluid. Use only ISO Grade 68.
7	No movement.	Mechanical binding.	Report.
		Refer to 'No fluid flow – No pressure'.	——
		Pilot operated valves or flow control valves inoperative or incorrectly adjusted.	Report.
8	Slow movement.	Refer to 'Low fluid flow rate'.	——
		Insufficient control pressure for valves. Refer to 'Low fluid pressure'.	——
		Lack of lubrication of mechanical components.	Lubricate.
		Fluid viscosity too high.	Warm fluid up to operating temperature. If viscosity is still too high, change fluid. Use only ISO Grade 68.
9	Erratic movement.	Refer to 'Erratic fluid pressure'.	——
		Air in fluid.	Replace damaged hoses or pipes and tighten leaking connections. Fill reservoir to correct level with ISO Grade 68.
		Lack of lubrication of mechanical components.	Lubricate.
10	Noisy pump.	Air in fluid.	Replace damaged hoses or pipes and tighten leaking connections. Fill reservoir to correct level with ISO Grade 68.
		Fluid viscosity too high.	Warm fluid up to operating temperature. If viscosity is still too high, change fluid. Use only ISO Grade 68.
		Pump operating too fast.	Set truck engine speed to 1 100 rev/min.
		Cavitation in pump.	Replace filter. Check for a blocked pump supply hose, clean or replace as necessary. Ensure that the breather vent is clear and if necessary change the system fluid. Use only ISO Grade 68.
		Worn or damaged pump.	Replace pump.
11	Relief valve noise.	Worn poppet and seat.	Report.
12	Fluid overheated.	Fluid dirty or reservoir level low or incorrect fluid viscosity.	Replace fluid filter, if necessary change system fluid, ensure reservoir is filled to correct level with ISO Grade 68.
		System pressure too high.	Report.

Table 44 Hydraulic System Fault Finding (Continued)

Symptom		Probable Cause	Action
13	Pump overheated.	Refer to 'Fluid overheated'.	——
		Air in fluid.	Replace damaged hoses or pipes and tighten leaking connections. Fill reservoir to correct level with ISO Grade 68.
		Excessive load.	Ensure that crane is not overloaded then locate and correct any mechanical binding.
		Cavitation in pump.	Replace filter. Check for a blocked pump supply hose, clean or replace as necessary. Ensure that the breather vent is clear and if necessary change the system fluid. Use only ISO Grade 68.
		Worn or damaged pump.	Replace.
		Relief valve set too high.	Report.
14	Relief valve overheated.	Refer to 'Fluid overheated'.	——
		Valve setting incorrect.	Report.
		Worn or damaged valve.	Report.

END

Distribution List: **VEH G 52.0 – Code 3** (Maint Level)
(Sponsor: CGSVSPO, Med/Hvy B Vehicles)
(Authority: ECO CGSVSPO 32/11)