ASTER FLUIDTECHNIK

# COMPONENT MAINTENANCE MANUAL

## WITH ILLUSTRATED PARTS LIST

## SERVO-HYDRAULIC ACTUATOR SHA-40

| PART NUMBER | DESCRIPTION | EFFECTIVITY CODE |
|---|---|---|
| 40-1100-03 | Actuator, servo-hydraulic, single LVDT | A |
| 40-1100-04 | Actuator, servo-hydraulic, dual LVDT | B |

| | |
|---|---|
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# RECORD OF REVISIONS

Insert revised pages and destroy superseded pages. Enter the revision number, the date inserted and your initials. Revision 4 replaces all previous issues.

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*Temporary revisions 29-10-45-07 and -08 are incorporated in Revision 4.*

# SERVICE BULLETIN LIST

| SERVICE BULLETIN | SUBJECT | DATE INCORPORATED | REVISION |
|---|---|---|---|
| SHA40-29-003 | Introduction of piston cap seal P/N 40-1162-02 with improved low-temperature performance | 28 Feb 2025 | 3 |
| SHA40-29-004 | Reduced internal leakage limit after cap seal change | 15 Sep 2026 | 4 |
| SHA40-29-005 | LVDT connector with improved strain relief, P/N 40-1300-02 / -03 | 15 Sep 2026 | 4 |

# SUMMARY OF CHANGES IN REVISION 4

| PAGE BLOCK | CHANGE |
|---|---|
| 101 | Internal leakage limit reduced from 150 to 120 cm³/min (SB SHA40-29-004). |
| 501 | Penetrant inspection of the rear mounting eye added; inspection record expanded. |
| 801 | Wear limit of piston outer diameter revised; torque of gland nut corrected. |
| 1001 | Items 100 and 240: part numbers updated (SB SHA40-29-003, -005). |

# LIST OF EFFECTIVE PAGES

An asterisk (*) indicates pages changed, added or deleted by the current revision.

| SUBJECT | PAGE | DATE | SUBJECT | PAGE | DATE |
|---|---|---|---|---|---|
| **Title Page** | * TP-1 | 15 Sep 2026 | **Schematics And Diagrams** | 201 | 15 Sep 2026 |
| **Record Of Revisions** | * RR-1 | 15 Sep 2026 | **Disassembly** | 301 | 15 Sep 2026 |
| **List Of Effective Pages** | * LEP-1 | 15 Sep 2026 | **Cleaning** | 401 | 15 Sep 2026 |
| **Table Of Contents** | * TOC-1 | 15 Sep 2026 | **Check** | * 501 | 15 Sep 2026 |
| | * TOC-2 | 15 Sep 2026 | **Repair** | 601 | 15 Sep 2026 |
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| | * INTRO-2 | 15 Sep 2026 | **Fits And Clearances** | * 801 | 15 Sep 2026 |
| **Description And Operation** | 1 | 15 Sep 2026 | **Special Tools, Fixtures, Equipment And Consumables** | 901 | 15 Sep 2026 |
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| **Testing And Fault Isolation** | * 101 | 15 Sep 2026 | | 1002 | 15 Sep 2026 |
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# INTRODUCTION

## 1. GENERAL

A. This Component Maintenance Manual (CMM) gives the data necessary for the shop maintenance of the servo-hydraulic actuator SHA-40 and its variants. It is prepared in accordance with ATA iSpec 2200 and is to be used with the standard shop practices of the maintenance organisation.

B. The procedures in this manual were verified by performance at the Aster Fluidtechnik repair station in Friedrichshafen on actuators with serial numbers 21-0417 and 23-1182.

## 2. ARRANGEMENT OF THE MANUAL

A. The manual is divided into page blocks. Each block starts with a new page number range:

| SUBJECT | PAGE BLOCK |
|---|---|
| Description and operation | 1 |
| Testing and fault isolation | 101 |
| Schematics and diagrams | 201 |
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## 3. WARNINGS, CAUTIONS AND NOTES

A. Warnings, cautions and notes are used in this manual as follows. They are placed immediately before the step to which they apply.

**WARNING**

**A WARNING calls attention to a procedure or condition that, if not followed exactly, can cause injury or death.**

**CAUTION**

A CAUTION calls attention to a procedure or condition that, if not followed exactly, can cause damage to the equipment.

**NOTE**

A NOTE gives information that makes a procedure easier to do or to understand.

## 4. UNITS, ABBREVIATIONS AND SYMBOLS

A. Dimensions are given in millimetres and torques in newton metres (N·m) with the US customary value in parentheses (lbf·in). Pressures are gauge pressures in bar (1 bar = 14.504 psi). Temperatures are in degrees Celsius (°C).

| ABBREVIATION | MEANING | ABBREVIATION | MEANING |
|---|---|---|---|
| ADT | Assembly drawing | LVDT | Linear variable differential transformer |
| CMM | Component maintenance manual | NDT | Non-destructive testing |
| EFF | Effectivity | P/N | Part number |
| FIN | Functional item number | $R_a$ | Arithmetic mean roughness |
| IPL | Illustrated parts list | RF | Reference (not stocked) |
| ID / OD | Inside / outside diameter | TIR | Total indicator reading |

## 5. REVISION SERVICE

A Revisions are issued when necessary. Changed text is identified by a black bar in the left margin, as shown next to this paragraph.

# DESCRIPTION AND OPERATION

## 1. DESCRIPTION

A. The SHA-40 is a double-acting, single-rod linear actuator with an integrated two-stage electro-hydraulic servo valve and an LVDT position transducer. It is used in primary flight-control and tilt-control applications where fast, accurate positioning against high loads is required.

B. The main assemblies are the cylinder barrel (200) with the rear end cap (220), the piston rod (80) with the piston (90), the rod gland (40), the manifold (180) with the servo valve (140), and the LVDT (240), which is installed in the gun-drilled piston rod. Item numbers refer to IPL Figure 1 in the ILLUSTRATED PARTS LIST.

**Figure 1 Sectional view of the SHA-40 actuator (rod retracted)**

**Table 1 Leading particulars**

| CHARACTERISTIC | VALUE | REMARKS |
|---|---|---|
| Bore Ø / rod Ø | 40 mm / 22 mm | $A_A$ = 1 256.6 mm²; $A_B$ = 876.5 mm² |
| Stroke | 80 mm (±40 mm about mid-stroke) | Mechanical end stops |
| Rated supply pressure | 207 bar (3 000 psi) | Return ≤ 5 bar |
| Proof / burst pressure | 310 bar / 518 bar | 1.5 × and 2.5 × rated |
| Stall force, extend / retract | 26.0 kN / 18.1 kN | At 207 bar |
| No-load rate | ≥ 95 mm/s | Command 10 mA |
| Servo valve rated current | ±10 mA, coil 200 Ω | Parallel coils |
| LVDT | ±40 mm; 5 V rms, 3 kHz excitation | Sensitivity 72 mV/V/mm |
| Hydraulic fluid | MIL-PRF-83282 or MIL-PRF-87257 | Cleanliness ISO 4406 15/13/10 |
| Operating temperature | −54 °C to +135 °C | Fluid and ambient |
| Mass (dry) | 3.9 kg (-03); 4.1 kg (-04) | |

## 2. OPERATION

**A. Hydraulic operation.** Supply pressure is connected to port P of the manifold. The servo valve meters fluid to chamber A (extend) or chamber B (retract) in proportion to the input current. The return flow from the opposite chamber goes through the valve to port T.

**B. Servo valve.** The torque motor deflects a flapper between two nozzles. The resulting pressure difference moves the second-stage spool until the force of the feedback spring balances the torque. The spool position, and therefore the flow, is proportional to the coil current.

**C. Position feedback.** The LVDT core is attached to the end cap and the coil assembly moves with the rod. The demodulated LVDT signal is compared with the position command in the external servo controller, which closes the position loop. Figure 201 in SCHEMATICS AND DIAGRAMS shows the hydraulic and electrical circuit.

## 3. INTERFACES

A. The hydraulic and electrical interfaces of the actuator are listed below. Connector pin assignments are shown in Figure 201.

**Table 2 Interfaces**

| INTERFACE | DESIGNATION | TYPE / SIZE | REMARKS |
|---|---|---|---|
| Supply | P | Port, MS33649-4 (7/16-20 UNF) | Manifold, marked P |
| Return | T | Port, MS33649-4 (7/16-20 UNF) | Manifold, marked R |
| Test ports | A, B | Port, MS33649-3 (3/8-24 UNF) | Capped in service; used for PT-A, PT-B |
| Servo valve | J1 | Connector, 4-pin, bayonet | Pins A/B coil 1, C/D coil 2 |
| LVDT | J2 (J2, J3 on -04) | Connector, 6-pin, bayonet | Excitation, secondary 1, secondary 2 |
| Mechanical | Rod end / eye | Ø 12.000 H7 spherical bearings | Pin-to-pin length 312.0 mm retracted |

# TESTING AND FAULT ISOLATION

## 1. GENERAL

A. This section gives the tests necessary to make sure that the actuator is serviceable after repair or overhaul, and the procedure to find the cause of a failure. Do the tests in the sequence given.

B. Record the results on the test record sheet. The actuator is serviceable when all results are within the limits of Table 101.

## 2. TEST EQUIPMENT AND MATERIALS

A. Use the equipment listed below or an approved equivalent:

Hydraulic test bench, 0–350 bar, 20 L/min, fluid temperature control ..... TE-29-01
Servo controller / test console with LVDT demodulator ..... TE-29-04
Graduated cylinder, 250 cm³, 2 cm³ divisions ..... TE-29-05
LVDT calibration fixture with dial indicator, 0.01 mm ..... TE-29-06
Hydraulic fluid MIL-PRF-83282 ..... C-001

## 3. TEST PROCEDURE

A. Preparation

(1) Install the actuator on the test fixture with the rod end free. Connect the test-bench hoses as follows:

(a) Supply hose to port P and return hose to port T of the manifold.

(b) Electrical harness from the console to the servo valve connector (160) and the LVDT connector.

(2) Set the fluid temperature to 40 ± 5 °C. Cycle the actuator over the full stroke at low rate for 5 minutes to bleed the air, then open the bleed plugs (250) one turn until fluid free of air bubbles comes out. Tighten the plugs.

**WARNING**

**HYDRAULIC FLUID UNDER PRESSURE CAN CAUSE INJURY. RELEASE THE PRESSURE BEFORE YOU DISCONNECT ANY HOSE. WEAR SAFETY GLASSES AND GLOVES.**

B. Proof pressure test

(1) Move the piston to the retracted end stop. Apply 310 bar to chamber A for 3 minutes with chamber B open to return.

(2) Repeat with 310 bar in chamber B and chamber A open to return.

(3) There must be no external leakage, no permanent deformation and no damage.

C. External leakage test

(1) Apply 207 bar to port P and cycle the actuator for 50 full strokes at 50 mm/s.

(2) Leakage at the rod gland must not exceed one drop per 25 cycles. No leakage is permitted at static seals.

D. Internal leakage test

(1) Hold the piston at mid-stroke with the clamp of the test fixture. Apply 207 bar to chamber A and measure the flow out of port B for 3 minutes with the graduated cylinder.

(2) The internal leakage must not exceed 120 cm³/min. Repeat with pressure in chamber B.

E. Rate test

(1) Command a square wave of ±10 mA, 0.2 Hz, with the rod end free. Record the extend and retract rates between 10% and 90% of the stroke.

(2) The no-load rate must be at least 95 mm/s in both directions; the difference between extend and retract must not exceed 10%.

F. Null, polarity and LVDT check

(1) With the loop open, find the valve current at which the piston does not move (null current). It must be within ±0.6 mA.

(2) Make sure that positive current extends the actuator and that the LVDT output increases as the rod extends.

(3) Install the actuator in the LVDT calibration fixture. At -40, -20, 0, +20 and +40 mm, the LVDT output must be within ±0.5% of full stroke of the nominal value.

**Table 101 Test limits and test record**

| TEST | PARAGRAPH | REQUIREMENT | RESULT |
|---|---|---|---|
| Proof pressure | 3.B | 310 bar, 3 min each chamber: no leakage, no deformation | |
| External leakage | 3.C | ≤ 1 drop / 25 cycles at gland; static seals dry | |
| Internal leakage | 3.D | ≤ 120 cm³/min at 207 bar, each chamber | |
| No-load rate | 3.E | ≥ 95 mm/s; extend/retract difference ≤ 10% | |
| Null current | 3.F | Within ±0.6 mA | |
| LVDT linearity | 3.F | Within ±0.5% of full stroke | |

## 4. FAULT ISOLATION

A. If the actuator does not pass a test, use Table 102 and the flowchart in Figure 101 to find the cause.

**Table 102 Fault isolation**

| SYMPTOM | PROBABLE CAUSE | CORRECTIVE ACTION |
|---|---|---|
| External leakage at rod gland | Worn or damaged rod seal (50) or wiper (30); scored rod (80) | Replace seals; inspect rod per CHECK, repair per REPAIR |
| External leakage at manifold | Damaged O-rings (170); loose screws (190) | Replace O-rings; torque screws per FITS AND CLEARANCES |
| High internal leakage | Worn piston seal (100); scored barrel bore (200) | Replace seal and wear rings; inspect bore |
| Drift with zero command | Servo valve null shift | Adjust null; replace valve if out of range |
| Low rate in one direction | Contaminated servo valve filter; blocked passage | Replace valve filter; clean manifold |
| Erratic position signal | Damaged LVDT connector or cable | Replace LVDT (240) |

**Figure 101 Fault isolation – actuator slow or does not reach full stroke**

# SCHEMATICS AND DIAGRAMS

**Figure 201 Hydraulic and electrical schematic, actuator installed on test bench (sheet 1 of 1)**

**NOTES**
1. Test bench shown for reference only; see the bench manual for its maintenance.
2. Pressures in bar (gauge). Rated supply 207 bar; relief valve set to 230 bar.
3. Positive valve current connects P to A and extends the actuator.
4. PT-A and PT-B are used for the internal leakage and rate tests (TESTING AND FAULT ISOLATION, paragraph 3).

| ASTER FLUIDTECHNIK GMBH | | |
|---|---|---|
| **Title** | SHA-40 hydraulic and electrical schematic | |
| **Drawing no.** | SD-40-1100-201 | Sheet 1 of 1 |
| **Scale** | Not to scale | Rev. 4 15 Sep 2026 |
| **Symbols** | ISO 1219-1 / IEC 60617 | |

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# DISASSEMBLY

## 1. GENERAL

A. Disassemble the actuator only as necessary to correct a fault found during testing, or for overhaul. Put the parts on a clean bench covered with lint-free cloth (C-006) and identify them with the IPL item numbers.

**NOTE**

Discard all seals, O-rings, the self-locking nut (120) and the tab washer (130). Install new parts from seal kit 40-1100-SK4 at assembly.

## 2. PROCEDURE

A. Remove the servo valve

(1) Drain the fluid from ports P, T, A and B into a suitable container.

(2) Remove the four bolts (150) and lift the servo valve (140) from the manifold. Remove and discard the O-rings (170).

**CAUTION**

DO NOT DISASSEMBLE THE SERVO VALVE. RETURN A DEFECTIVE VALVE TO THE MANUFACTURER. PUT PROTECTIVE COVERS ON THE VALVE PORTS IMMEDIATELY.

(3) Remove the two screws (190) and the manifold (180).

B. Remove the LVDT

(1) Disconnect the LVDT connector. Loosen the LVDT body nut and pull the LVDT (240) straight out of the end cap. Do not bend the probe.

C. Remove the rod end and the gland

(1) Hold the piston rod with the rod holding fixture T-29-11. Loosen the jam nut (20) and unscrew the rod end (10).

(2) Unscrew the gland nut (40) with the spanner T-29-10 and pull it off the rod. Remove the wiper (30), the rod seal (50), the O-ring (60) and the bearing bush (70) only if they are to be replaced.

D. Remove the piston rod assembly

(1) Pull the piston rod assembly out of the barrel (200) in a straight line.

**CAUTION**

THE CHROME SURFACE OF THE PISTON ROD IS EASILY DAMAGED. DO NOT HOLD THE ROD WITH PLIERS OR A VICE. USE THE ROD HOLDING FIXTURE T-29-11 ONLY.

(2) Straighten the tab washer (130), remove the self-locking nut (120) and pull the piston (90) off the rod.

(3) Cut and remove the piston seal (100) and the wear rings (110). Do not scratch the seal grooves.

E. Remove the rear end cap

(1) Unscrew the end cap (220) from the barrel. Remove and discard the O-ring (210).

(2) Remove the bleed plugs (250), springs (260) and balls (270).

# CLEANING

## 1. GENERAL

A. Clean all parts before inspection. Cleaning materials are listed in SPECIAL TOOLS, FIXTURES, EQUIPMENT AND CONSUMABLES.

**WARNING**

**CLEANING SOLVENT IS FLAMMABLE AND TOXIC. USE IT IN A WELL-VENTILATED AREA AWAY FROM SPARKS AND FLAMES. WEAR GLOVES AND EYE PROTECTION.**

## 2. PROCEDURE

A. Metal parts

(1) Immerse the parts in solvent C-003 and brush with a soft non-metallic brush.

(2) Clean the barrel, manifold and end cap in an ultrasonic bath with solvent C-003 at 30 to 40 °C for 10 minutes. Flush all internal passages.

(3) Dry with filtered, dry compressed air at a pressure of not more than 2 bar.

**CAUTION**

DO NOT CLEAN ELASTOMER PARTS OR THE LVDT IN SOLVENT. DO NOT USE STEEL WOOL OR ABRASIVES ON THE CHROME SURFACE OF THE PISTON ROD OR ON THE BARREL BORE.

B. Servo valve and LVDT

(1) Clean the external surfaces with a lint-free cloth (C-006) moistened with clean hydraulic fluid C-001.

C. Protection after cleaning

(1) Apply a thin coat of hydraulic fluid C-001 to all machined surfaces and cover the parts until inspection.

# CHECK

## 1. GENERAL

A. Examine all parts for damage, wear and corrosion. Replace parts that are not within the limits given in FITS AND CLEARANCES or in Table 501. Record the results in the inspection record (Table 502).

## 2. VISUAL INSPECTION

**Table 501 Visual inspection criteria**

| ITEM | PART | INSPECT FOR | LIMIT |
|---|---|---|---|
| 80 | Piston rod | Scratches, pitting, chrome flaking | No defect deeper than 0.01 mm in the seal area |
| 200 | Cylinder barrel | Scoring of bore, corrosion of ports | No scoring; $R_a \leq 0.2$ µm |
| 10 | Rod end | Cracks, bearing play | No cracks; radial play ≤ 0.06 mm |
| 220 | End cap and mounting eye | Cracks, thread damage, corrosion | No cracks; threads undamaged |
| 180 | Manifold | Damaged sealing faces, blocked passages | Flatness ≤ 0.01 mm |

## 3. DIMENSIONAL CHECK

A. Measure the dimensions given in FITS AND CLEARANCES at 20 ± 2 °C. Measure the barrel bore at three positions along the stroke and in two planes 90° apart.

## 4. NON-DESTRUCTIVE TESTING

A. Do a fluorescent penetrant inspection (penetrant C-007, Type 1, sensitivity level 3) of the rod end (10) and of the rear mounting eye of the end cap (220). No linear indications are permitted.

B. Do a magnetic particle inspection of the piston rod (80) before chrome plating, if the rod is repaired.

## 5. INSPECTION RECORD

A. Complete the following record for each actuator. The fields can be filled in on screen; print the completed record and file it with the work order.

| | | | |
|---|---|---|---|
| **Work order** | WO-26-04418 | **Serial no.** | 21-0417 |
| **Part number** | **40-1100-03** | **Date** | 22 Sep 2026 |

**Table 502 Inspection record**

| INSPECTED ITEM | MEASURED VALUE | RESULT | DONE | REMARKS |
|---|---|---|---|---|
| Piston rod (80) | 21.986 | **Serviceable** | ☒ | – |
| Barrel bore (200) | 40.021 | **Serviceable** | ☒ | – |
| Bearing bush (70) | 22.061 | **Repair required** | ☒ | Bush replaced, see REPAIR 3 |
| Rod end (10), penetrant | No indication | **Serviceable** | ☒ | – |
| End cap eye (220), penetrant | No indication | **Serviceable** | ☒ | – |
| Manifold (180) | 0.006 flatness | **Serviceable** | ☒ | – |
| Piston (90) | 39.958 | **Serviceable** | ☐ | – |
| **Inspector** | J. Brandt | **Stamp** | AF-QA 117 | |

# REPAIR

## 1. GENERAL

A. The repairs in this section are the only repairs approved by Aster Fluidtechnik. Replace parts that cannot be repaired within the limits given.

**Table 601 Approved repairs**

| REPAIR | PART | LIMIT | PARAGRAPH |
|---|---|---|---|
| Rechrome piston rod | 80 | Rod OD after grinding ≥ 21.900 mm before plating | 2 |
| Replace bearing bush | 70 | Bush ID > 22.080 mm | 3 |
| Thread repair with insert | 180, 220 | Max. one insert per thread | 4 |

## 2. RECHROME THE PISTON ROD

A. Strip the chrome plating chemically. Do a magnetic particle inspection of the base metal.

B. Grind the rod to a diameter of 21.900 to 21.910 mm. Plate with hard chrome to a thickness of 0.040 to 0.060 mm.

C. Within 4 hours after plating, bake the rod at 190 ± 14 °C for at least 23 hours to relieve hydrogen embrittlement.

D. Grind to 21.980 to 21.993 mm (f7) and polish to $R_a$ <= 0.1 µm. The final chrome thickness must be 25 to 40 µm.

## 3. REPLACE THE BEARING BUSH

A. Press the bush (70) out of the gland nut with a press tool. Heat the gland nut to 120 °C and press in a new bush flush with the inner face. Ream the bush to 22.020 to 22.053 mm.

## 4. THREAD REPAIR

A. Repair damaged threads in the manifold (180) and end cap (220) with helical coil inserts of the same thread size. Install one insert per thread at most; record the repair on the inspection record.

# ASSEMBLY

## 1. GENERAL

A. Use new seals, O-rings and locking parts from seal kit 40-1100-SK4. The kit contains the following parts:

`40-1131-02` Ring, wiper (30) ..... 1
`40-1132-01` Seal, rod, step type (50) ..... 1
`40-9101-238` ..... O-ring, 38.0 × 2.5 (60) 1
`40-1162-02` Seal, piston, cap type (100) ..... 1
`40-1163-01` Ring, wear (110) ..... 2
`40-9015-14` Nut, self-locking, M14 × 1.5 (120) ..... 1
`40-1165-01` Washer, tab (130) ..... 1
`40-9101-012` ..... O-ring, 7.0 × 1.5 (170) 4
`40-9101-245` ..... O-ring, 45.0 × 2.5 (210) 1

B. Lubricate all seals and sliding surfaces with seal assembly lubricant C-002 before installation. Torque values are given in Table 802.

## 2. PROCEDURE

A. Assemble the piston

(1) Install the wear rings (110) and the piston seal (100) on the piston (90). Use the seal sizing sleeve T-29-13 for 10 minutes to resize the cap seal.

(2) Install the piston on the rod (80) with a new tab washer (130) and self-locking nut (120). Torque the nut to 55 ± 3 N·m (487 ± 27 lbf·in) and bend the tab washer against a flat of the nut.

B. Install the piston rod assembly

(1) Install the seal installation cone T-29-12 on the barrel (200). Push the piston rod assembly into the barrel in a straight line until the piston passes the cone.

**CAUTION**

DO NOT TURN THE PISTON ROD WHILE THE PISTON SEAL PASSES THE PORT HOLES. THE SEAL CAN BE CUT.

C. Install the gland

(1) Install the bearing bush (70), the O-ring (60), the rod seal (50) and the wiper (30) in the gland nut (40), using the rod seal installation tool T-29-14.

(2) Slide the gland nut over the rod and screw it into the barrel. Torque to 120 ± 6 N·m (1 062 ± 53 lbf·in) with the spanner T-29-10.

(3) Install the jam nut (20) and the rod end (10). Set the rod-end dimension to 312.0 ± 0.2 mm from the mounting eye centre (rod retracted) and torque the jam nut to 45 ± 3 N·m. Safety with lockwire C-004.

D. Install the rear end cap, LVDT and servo valve

(1) Install a new O-ring (210) and screw the end cap (220) into the barrel. Torque to 150 ± 8 N·m.

(2) Insert the LVDT (240) carefully into the gun-drilled rod. Torque the LVDT body nut to 25 ± 2 N·m.

(3) Install the manifold (180) with the screws (190), torque 11 ± 0.5 N·m. Install new O-rings (170) and the servo valve (140). Torque the bolts (150) in a cross pattern in two steps to 6.8 ± 0.3 N·m.

**NOTE**

Do the tests in TESTING AND FAULT ISOLATION after assembly. Fill the actuator with fluid C-001 and cap all ports for storage.

## 3. STORAGE

A. Store serviceable actuators filled with hydraulic fluid C-001, with all ports closed by metal blanking caps and the piston rod fully retracted. Fit the rod protection sleeve supplied with the unit.

B. Store in a clean, dry room at 5 to 35 °C and a relative humidity below 65%. Keep elastomer parts and seal kits away from ozone sources, direct sunlight and electric motors.

C. Actuators stored for more than 24 months must be tested again in accordance with TESTING AND FAULT ISOLATION before installation. Seal kits have a shelf life of 5 years from the cure date marked on the bag.

# FITS AND CLEARANCES

## 1. FITS AND CLEARANCES

A. Table 801 gives the design dimensions and wear limits. Dimensions are in millimetres at 20 °C. Ref. letters refer to Figure 1.

**Table 801 Fits and clearances**

| REF. | ITEM / DIMENSION | DESIGN MIN. | DESIGN MAX. | WEAR LIMIT | REMARKS |
|---|---|---|---|---|---|
| A | Barrel bore Ø (200) | 40.000 | 40.039 | 40.060 | H8; $R_a$ ≤ 0.2 µm; ovality ≤ 0.010 |
| B | Piston OD Ø (90) | 39.950 | 39.975 | 39.935 | Rev. 4: wear limit was 39.930 |
| A/B | Clearance piston – bore | 0.025 | 0.089 | 0.125 | Diametral |
| C | Piston rod OD Ø (80) | 21.980 | 21.993 | 21.970 | f7; chrome 25–40 µm; $R_a$ ≤ 0.1 µm |
| D | Bearing bush ID Ø (70) | 22.020 | 22.053 | 22.080 | Replace bush if exceeded |
| C/D | Clearance rod – bush | 0.027 | 0.073 | 0.110 | Diametral |
| E | Rod straightness (80) | – | 0.02 / 100 | 0.03 / 100 | TIR, rod on V-blocks |
| F | Rod end bearing radial play (10) | 0 | 0.03 | 0.06 | Under 50 N reversing load |
| G | Spring free length (260) | 11.8 | 12.2 | 11.5 | Load 4.5 ± 0.3 N at 9.0 mm |

## 2. TORQUE VALUES

**Table 802 Torque values**

| ITEM | DESCRIPTION | THREAD | TORQUE N·M | TORQUE LBF·IN | REMARKS |
|---|---|---|---|---|---|
| 20 | Nut, jam (rod end) | M14 × 1.5 | 45 ± 3 | 398 ± 27 | Lockwire after torquing |
| 40 | Nut, gland | M42 × 1.5 | 120 ± 6 | 1 062 ± 53 | Spanner T-29-10; Rev. 4 correction |
| 120 | Nut, self-locking (piston) | M14 × 1.5 | 55 ± 3 | 487 ± 27 | Replace at each removal |
| 150 | Bolt, servo valve (4×) | M5 | 6.8 ± 0.3 | 60 ± 3 | Cross pattern, two steps |
| 190 | Screw, manifold (2×) | M6 | 11 ± 0.5 | 97 ± 4 | Lubricate threads with C-001 |
| 220 | Cap, end, rear | M48 × 1.5 | 150 ± 8 | 1 328 ± 71 | |
| 240 | LVDT body nut | M16 × 1 | 25 ± 2 | 221 ± 18 | |
| 250 | Plug, bleed | M8 × 1 | 8 ± 0.5 | 71 ± 4 | |

*Torque conversion: 1 N·m = 8.851 lbf·in. Tolerances apply to the final torque. Thread-locking compound C-005 is not used on this actuator.*

# SPECIAL TOOLS, FIXTURES, EQUIPMENT AND CONSUMABLES

## 1. SPECIAL TOOLS AND TEST EQUIPMENT

**Table 901 Special tools and test equipment**

| TOOL NUMBER | DESCRIPTION | USED IN |
|---|---|---|
| T-29-10 | Spanner, gland nut, 4-pin | Disassembly 2.C; Assembly 2.C |
| T-29-11 | Fixture, rod holding, with PTFE jaws | Disassembly 2.C, 2.D |
| T-29-12 | Cone, seal installation, piston | Assembly 2.B |
| T-29-13 | Sleeve, seal sizing, cap seal | Assembly 2.A |
| T-29-14 | Tool, rod seal installation | Assembly 2.C |
| TE-29-01 | Bench, hydraulic test, 0–350 bar | Testing 3 |
| TE-29-04 | Console, servo controller / test | Testing 3 |
| TE-29-06 | Fixture, LVDT calibration | Testing 3.F |

## 2. CONSUMABLES

A. Use the following consumable materials or approved equivalents:

Hydraulic fluid, MIL-PRF-83282 ..... C-001
Lubricant, seal assembly, fluid-compatible ..... C-002
Solvent, cleaning, MIL-PRF-680 Type II ..... C-003
Lockwire, 0.8 mm, corrosion-resistant steel ..... C-004
Thread-locking compound, medium strength ..... C-005
Cloth, lint-free ..... C-006
Penetrant, fluorescent, Type 1, sensitivity level 3 ..... C-007

# ILLUSTRATED PARTS LIST

## 1. INTRODUCTION

A. The illustrated parts list (IPL) lists and illustrates the parts that can be replaced. Item numbers in IPL Figure 1 correspond to the item numbers in the parts list.

B. The NOMENCLATURE column shows the relationship of parts by indentation: one dot for parts of the top assembly, two dots for parts of a sub-assembly.

C. The EFF column gives the effectivity code of the actuator to which a part applies. A blank column means the part applies to all part numbers.

**Table 1001 Effectivity codes**

| CODE | PART NUMBER | DESCRIPTION |
|---|---|---|
| A | 40-1100-03 | Actuator, single LVDT |
| B | 40-1100-04 | Actuator, dual LVDT |

D. Units per assembly: RF means reference only; the quantity is given for one next-higher assembly.

**IPL Figure 1 SHA-40 servo-hydraulic actuator – exploded view**

**Table 1002 Parts list for IPL Figure 1**

| FIG. ITEM | PART NUMBER | NOMENCLATURE 1 2 3 4 5 6 7 | EFF. | UNITS PER ASSY |
|---|---|---|---|---|
| 1-1 | 40-1100-03 | ACTUATOR, SERVO-HYDRAULIC, SINGLE LVDT | A | RF |
| 1-1A | 40-1100-04 | ACTUATOR, SERVO-HYDRAULIC, DUAL LVDT | B | RF |
| –10 | 40-1121-01 | . ROD END, SPHERICAL BEARING | | 1 |
| –20 | 40-9014-15 | . NUT, JAM, M14 × 1.5 | | 1 |
| –30 | 40-1131-02 | . RING, WIPER | | 1 |
| –40 | 40-1140-03 | . NUT, GLAND | | 1 |
| –50 | 40-1132-01 | . . SEAL, ROD, STEP TYPE | | 1 |
| –60 | 40-9101-238 | . . O-RING, 38.0 × 2.5 | | 1 |
| –70 | 40-1145-02 | . . BUSH, BEARING | | 1 |
| –80 | 40-1150-03 | . ROD, PISTON | A | 1 |
| –80A | 40-1150-04 | . ROD, PISTON, DUAL LVDT | B | 1 |
| –90 | 40-1160-01 | . . PISTON | | 1 |
| –100 | 40-1162-02 | . . SEAL, PISTON, CAP TYPE (SUPERSEDES -01, SB SHA40-29-003) | | 1 |
| –110 | 40-1163-01 | . . RING, WEAR | | 2 |
| –120 | 40-9015-14 | . . NUT, SELF-LOCKING, M14 × 1.5 | | 1 |
| –130 | 40-1165-01 | . . WASHER, TAB | | 1 |
| –140 | 40-1200-07 | . VALVE, SERVO, 2-STAGE | | 1 |
| –150 | 40-9020-05 | . . BOLT, M5 × 40 | | 4 |
| –160 | 40-1210-01 | . . CONNECTOR, ELECTRICAL | | 1 |
| –170 | 40-9101-012 | . . O-RING, 7.0 × 1.5 | | 4 |
| –180 | 40-1170-02 | . MANIFOLD | | 1 |
| –190 | 40-9021-06 | . SCREW, CAP, M6 × 25 | | 2 |
| –200 | 40-1180-03 | . BARREL, CYLINDER | | 1 |
| –210 | 40-9101-245 | . O-RING, 45.0 × 2.5 | | 1 |
| –220 | 40-1190-02 | . CAP, END, REAR | | 1 |
| –230 | 40-1192-01 | . . BUSH, SPHERICAL | | 1 |
| –240 | 40-1300-02 | . TRANSDUCER, LVDT (SB SHA40-29-005) | A | 1 |
| –240A | 40-1300-03 | . TRANSDUCER, LVDT, DUAL (SB SHA40-29-005) | B | 1 |
| –250 | 40-1195-01 | . PLUG, BLEED | | 2 |
| –260 | 40-9030-08 | . SPRING, COMPRESSION | | 2 |
| –270 | 40-9031-04 | . BALL, STEEL, Ø 4 mm | | 2 |