Harmonic Drive SHA58A swivel evaluation

FOR	Internal
DATE	28 Oct 2026

Verdict

Yes. The Harmonic Drive SHA58A81SG is sufficient for the M08 swivel. With the same method and × 1.25 margin as the 27 Oct update, every check passes. The closest is the tilting moment: 1,402 Nm calculated, 1,753 Nm required, 2,180 Nm permitted. It controls position and speed, with an absolute encoder that keeps the angle through power-off.

AT 60°/S AND 90°/S², ARM STRETCHED, 20 KG CARTON	CALCULATED	REQUIRED (× 1.25)	SHA58A81SG	STATUS
Tilting moment on the output bearing	1,402 Nm	≥ 1,753 Nm	2,180 Nm permissible	**Pass**
Torque, swivel accelerating	638 Nm	≥ 797 Nm	1,924 Nm max	**Pass**
Torque, swivel + robot base joint together	838 Nm	≥ 1,047 Nm	1,924 Nm max	**Pass**
Average torque over a carton cycle	246 Nm	≥ 307 Nm	714 Nm continuous	**Pass**
Axial load	2,194 N	≥ 2,743 N	171 kN static	**Pass**
Radial load	243 N	≥ 304 N	171 kN static	**Pass**
Output speed	10 r/min	≥ 10 r/min	37 r/min	**Pass**

In the lab, M08 with the SHA58A passes the swivel test at 45°/s and 90°/s²: all four wheels stay loaded, the lightest at 198 N.

1 · The drive

The SHA58A81SG is one hollow-shaft unit: output bearing, an 81:1 Harmonic Drive gear, servo motor, absolute encoder and holding brake. It replaces five parts: the RDR-050C gearbox, its right-angle input, the Delta servo, the CH flange and the bushing (C7 swivel design shows how those carried the loads). Order code: SHA58A81SG-A21B200-10S17bA-C (B = brake, 200 = 200 V, S17b = 17-bit absolute encoder, C = standard connectors).

ITEM	SHA58A81SG
Mass	32 kg with brake, against 43.5 kg for the RDR-050C, Delta servo and CH flange
Output bearing	Cross-roller, 195 mm pitch circle, 87.4 kN dynamic rating
Tilt stiffness	531 × 10^4 Nm/rad (RDR-050C: 674 × 10^4)
Rotor inertia at the output	106 kg·m² with brake
Hollow bore	Ø65 mm, all the way through
Size	Ø247 flange, 213 mm long, plus 100 mm below for the motor cable plug
Supply and driver	200 V AC; HA-800□-24D/E-200 or REL-230-40

Sources: SHA series manual (ratings p. 1-8 and 1-9, outline p. 1-28, bearing p. 2-6, bolts p. 3-3) and the SHA-SG product page. The STEP from that page is an outline model; it matches the drawing in every dimension.

2 · Position and velocity control

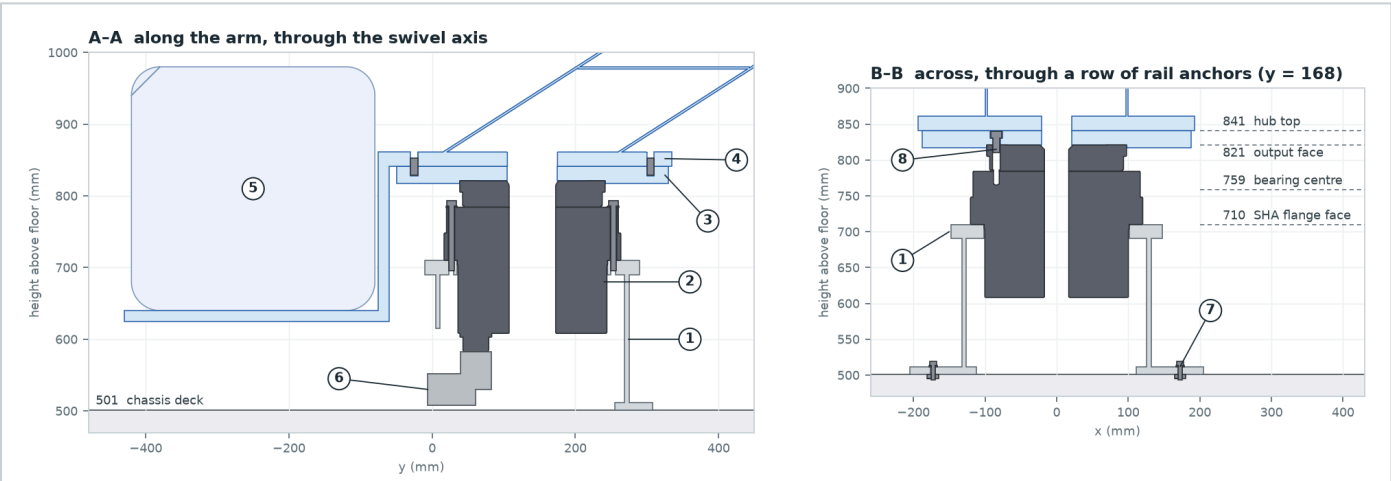
Yes. The SHA runs on Harmonic Drive's own servo driver, which controls position, speed or torque from the motor encoder, just as the Delta ASDA-B3 does today.

ITEM	SHA58A81SG WITH ITS DRIVER
Control modes	Position, speed and torque
Command interface	REL-230-40: EtherCAT, CANopen or DeviceNet · HA-800A: pulse or analog · HA-800B: MECHATROLINK-II · HA-800C: CC-Link
Encoder	17-bit absolute on the motor plus a 16-bit turn counter: 10,616,832 counts per output turn (0.12 arcsec)
After power-off	Keeps its absolute angle (driver battery or encoder capacitor), so no homing
Positioning accuracy	40 arcsec one-way: 0.5 mm at the tool, 2.4 m from the swivel axis
Brake	Holds 1,220 Nm at the output with the power off; 24 V DC

We would order the REL-230-40 and drive it over EtherCAT from our own controller (section 7). Harmonic Drive's SHA-SG page lists it for the SHA58A at 81:1; the 2021 manual's driver table still shows only the HA-800 for size 58. The brake is for holding at standstill; the servo does the stopping. When the base brakes at 1 m/s² with the arm stretched, the swivel sees about 125 Nm, a tenth of what the brake holds.

3 · New design

The drive is one bolted stack: a welded pedestal on the chassis rails, the SHA58A on top, and the swivel arm bolted to its output hub. The arm itself is described in Diagonal web swivel arm (M08 design study).

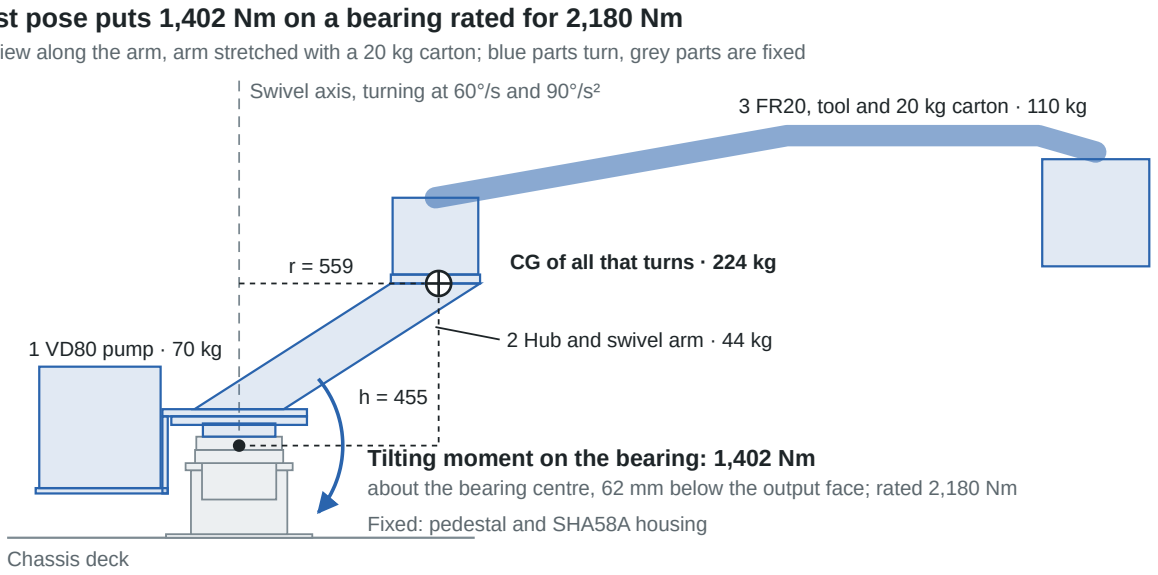


M08 drive stack, sections A–A and B–B from the CAD. Blue parts turn, grey parts are fixed, dark grey is the SHA58A.

1. **Pedestal**, one 6082-T6 weldment: 10 mm base plate on the FR-max rails, Ø270 × 6 rolled tube with a rear opening, four gussets, 20 mm top flange. Machined after welding: top face, Ø210 H7 bore, 16 × M8 tapped, Ø8 H7 dowel hole.
2. **SHA58A81SG**, housing bolted to the pedestal with 16 × M8 × 90 and washers (37 Nm), located by its Ø210 spigot and the dowel.
3. **Output hub**, Ø380 × 24 mm 6082-T6: 8 × M12 tapped (helicoils) and two Ø10 dowels for the arm.
4. **Swivel arm**, one 6082-T6 weldment: 20 mm base plate on the hub, 200 × 135 × 3 mm box web, 25 mm robot plate, drop wall and pump pad.
5. **Wordfik VD80 pump**, 70 kg, on the pad as the counterweight.
6. **Motor and encoder cable plugs**; the cables leave through the pedestal's rear opening.
7. **12 × M6** into the rail slot nuts.
8. **12 × M10** from the hub into the SHA output (74 Nm).

The hub top sits at 841 mm, 60 mm higher than M07's adapter. The motor plug needs 100 mm under the SHA, and Harmonic Drive offers no side cable exit in size 58.

4 · Tilting moment



M08 with the SHA58A and the VD80; masses from the M08 CAD and the FR20 model; r and h in mm.

Everything the swivel turns acts as one 224 kg body. Its weight, plus the outward pull and the push from turning, tip the output bearing, as in the 27 Oct method:

$$M = \sqrt{(m\,g\,r + K\omega^2)^2 + (K\alpha)^2} = \sqrt{(1227 + 157)^2 + 225^2} \approx 1402\ \text{Nm}$$

Here K = Σ m·r·h = 143 kg·m², ω = 1.05 rad/s and α = 1.57 rad/s². That is the worst of 14,725 arm poses. Normal picking puts less on it: half the pick poses stay under 804 Nm, 95 % under 1,209 Nm. The worst case is just above the 1,400 Nm in the supplier request, which used M06 in the lab pose.

The bearing has a static safety factor of 11: P0 = Fr + 2M/dp + 0.44·Fa = 0.24 + 14.38 + 0.97 = 15.6 kN against C0 = 171 kN. In the worst pose it tilts 0.26 mrad, which moves the tool 0.6 mm (0.5 mm with the RDR-050C).

5 · Required torque

The motor has three jobs: turn the swivel, hold still while the robot's base joint swings, and do both all day. The worst of these, 838 Nm, is 44 % of what the SHA can give.

$$T_{\text{swivel}} = (J + J_{\text{rotor}})\,\alpha = (300 + 106) \times 1.57 = 638\ \text{Nm}$$

$$T_{\text{together}} = T_{\text{swivel}} + T_{\text{J1}} = 638 + 200 = 838\ \text{Nm}$$

$$T_{\text{average}} = \sqrt{\frac{638^2 \times 1.0 + 200^2 \times 1.6}{7.8}} = 246\ \text{Nm}$$

- **J = 300 kg·m²**: everything the swivel turns, with the arm stretched and a 20 kg carton (M08 CAD and the FR20 model). M07 in the lab pose was 156 kg·m².
- **J_rotor = 106 kg·m²**: the SHA's own motor and brake, felt through the 81:1 gear. At 161:1 it would be 420 kg·m², which is why we take 81:1.
- **T_J1 = 200 Nm**: the FR20 base joint's torque limit in the robot model, as on 27 Oct.
- **Duty**: per 7.8 s carton, one swivel move (1.0 s accelerating and braking) and two J1 swings (4 × 0.4 s at 450°/s²). One swivel move per carton is an assumption; if the swivel only moves between rows, the average is lower.

Upper bound if the robot model's 200 Nm is wrong: accelerating J1 at 450°/s² with the arm stretched and a carton takes about 1,170 Nm at the FR20's own base joint. The swivel would then see 1,571 Nm, still under 1,924 Nm, and the average would rise to about 600 Nm against 714 Nm continuous. That 714 Nm assumes the SHA bolted to a 650 × 650 × 30 mm aluminium plate; our pedestal flange is smaller, so the real continuous figure is somewhat lower.

6 · Machine checks

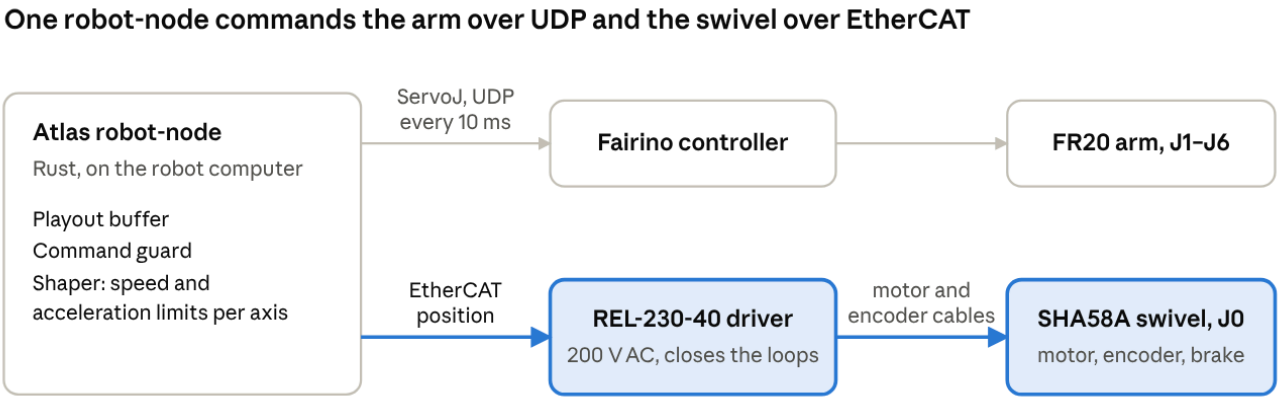
M08 with the SHA58A on its new pedestal passes the CAD and lab checks. The whole machine is now 18 kg over the FR-max payload, because of the 70 kg VD80 rather than the drive.

CHECK	M08 WITH SHA58A	M07 (27 OCT)
Lightest wheel, lab swivel test at 45°/s and 90°/s²	198 N, all four loaded	43 N
Peak swivel torque in that test (arm in the test pose)	261 Nm	245 Nm (calculated, J·α)
Carried mass, 20 kg carton	318 kg of 300 kg	297.3 kg
Closest gap over the ±90° swivel	20.7 mm	—
Bolts in the drive stack	every bolt passes a clearance hole and threads into its part	—
Tool deflection from the structure, 1 kN·m tip	2.7 mm	5.6 mm

The four VD80 foot bolts sit at ±300 mm, 32 mm outside the arm's ±260 mm pump pad: the pad has to widen, or the Wordfik foot pattern is narrower than modelled. The lab still models the drive as the RDR-050C (1,764 Nm, 490 Nm drive cap), which is stricter than the SHA58A.

7 · Buying and controlling it

We do need to buy the driver: the SHA has the motor, encoder and brake, but no drive electronics. Our controller is the Atlas robot-node, the Rust process on the robot computer that already streams the FR20 to the Fairino controller (Fairino Communication). The swivel becomes a seventh axis in that process.



Atlas control chain today (FR20) and the proposed swivel link.

BUY	PART	NOTE
Actuator	SHA58A81SG-A21B200-10S17bA-C	With brake
Driver	REL-230-40	EtherCAT or CANopen, 200 V AC
Cables	Motor and encoder extension cables	3, 5 or 10 m, from the drive to the pedestal's rear opening
Power	200 V AC for the driver, 24 V DC (0.9 A) for the brake	The FR20 control box already needs AC on board

How it runs: the robot-node passes swivel targets through the same playout buffer, command guard and shaper as the arm (how those work), limited to 60°/s and 90°/s². It sends a position setpoint every tick over EtherCAT; the driver closes the

position, speed and current loops on the SHA's encoder. The absolute encoder means no homing at start-up. On an emergency stop the driver cuts the torque and the brake holds.

To confirm with **Harmonic Drive**:

- ☐ REL-230-40 with SHA58A81SG-A21B200 at 81:1: EtherCAT cyclic position mode (CiA 402), cycle time, safe torque off for our e-stop.
- ☐ Duty-cycle and heat check with our cycle (7.8 s, one swivel move, two J1 swings); our pedestal is a smaller heat sink than the one behind the 714 Nm rating.
- ☐ Motor plug envelope and extension-cable bend radius; in CAD the plug clears the chassis deck by 6.8 mm.
- ☐ Price and lead time for actuator, driver and cables.

To confirm with **Fairino**, **Wordfik** and the **FR-max** supplier:

- ☐ Fairino: the FR20 base joint's real torque limit, to replace the robot model's 200 Nm.
- ☐ Wordfik: the VD80 foot pattern, so the pump pad matches it.
- ☐ FR-max: rail profile and slot-nut pull-out for the pedestal's 12 × M6 anchors, and 200 V AC and 24 V DC capacity on board.