Final drive gear set, recommended sequence for adjusting

If the pinion shaft and ring gear have to be re-adjusted, the following sequence is recommended for maximum efficiency:

1.) Determine total shim thickness Stotal for S1 + S2 for the specified tension of the tapered roller bearing for differential.

2.) Determine total shim thickness S3, so that pinion shaft obtains the specified installed position determined by the test machine in production.

3.) Split up total shim thickness Stotal for S1 + S2, so that the specified torsional backlash exists between ring gear and pinion shaft.

Note:

Overview of components and shims ⇒ *Page 39-149* .

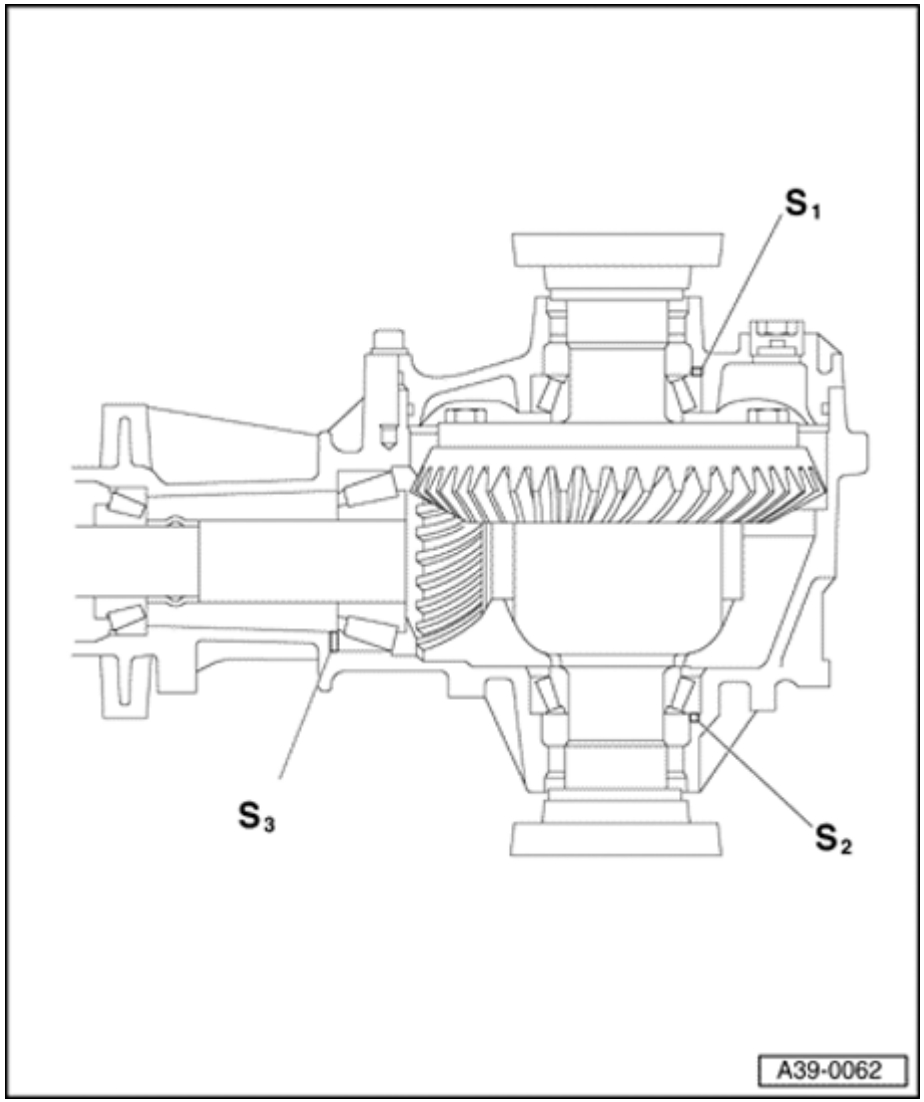
List of adjustments

Note:

If repairs have been carried out on the final drive, it is only necessary to adjust the pinion shaft or final drive set if components which have a direct effect on the adjustment of the final drive have been replaced. Observe the following table to avoid unnecessary adjustments:

Component to be adjusted: **Component being replaced:**	Ring gear (S1 + S2)1) ⇒ Page 39-162	Pinion shaft (S3)1) via deviation "r" ⇒ Page 39-153	Backlash checking ⇒ Page 39-168
Final drive housing	X	X	X
Differential housing	X		X
Tapered roller bearing for pinion shaft		X	X
Tapered roller bearing for differential	X		X
Final drive gear set2)	X	X	X
Final drive cover	X		X
1) Shims, installation position ⇒ Page 39-150 .			
2) Pinion shaft and ring gear, only replace together.			

39-150



Position of shims

Note:

List of adjustments when replacing individual components of final drive ⇒ *Page 39-149* .

S1 - Shim for ring gear in final drive cover

S2 - Shim for ring gear in final drive housing

S3 - Shim for pinion shaft in final drive housing

39-151

Special tools and equipment

- VW382/10 extension pin
- VW385/1 universal mandrel
- VW385/2 centering disc
- VW385/3 centering disc
- VW385/14 measuring rod
- VW385/15 extension pin
- VW385/17 measuring plate
- VW385/30 master gauge-adjustable
- VW385/33 end dimension plate
- VW387 dial indicator holder
- VW388 measuring lever
- VW401 thrust plate

- VW402 thrust plate
- VW408A punch
- VW457 support channels

39-152

- VW521/4 adjustment for ring gear
- VW521/8 adjustment for ring gear
- VW540 engine and transmission support
- 30-205 thrust pad
- 2003/3 mounting ring
- 2052/2 assembly tool for pinion shaft
- 3005 thrust pad
- 3028 retainer
- 3062 thrust pad
- 3253 wheel bearing assembly set with 3253/3 and 3253/4
- 3304 bracket
- VAG1383A engine/transmission

- VAG1359/2 universal mount
- Dial indicator extension 30 mm
- Dial indicator
- Torque gauge 0-600 Ncm (53 in. lb)

39-153

Pinion shaft, adjusting

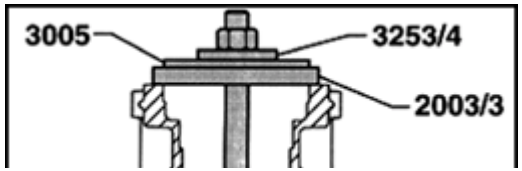
Notes:

- *Adjust the ring gear before adjusting the pinion shaft (determine total shim thickness Stotal for shims S1 + S2)* ⇒ *Page 39-162* .
- *The pinion shaft only has to be readjusted if the final drive gear set (pinion shaft and ring gear), tapered roller bearings for pinion shaft or the final drive housing are replaced. List of adjustments* ⇒ *Page 39-149* .
- *Do not additionally oil new tapered roller bearings for the friction torque measurement. The bearings have already been treated with a special oil by the manufacturer.*

Determine thickness of shim "S3"

Setting preload of tapered roller bearing for pinion shaft

- Mount rear final drive to repair stand ⇒ Page 39-110 .

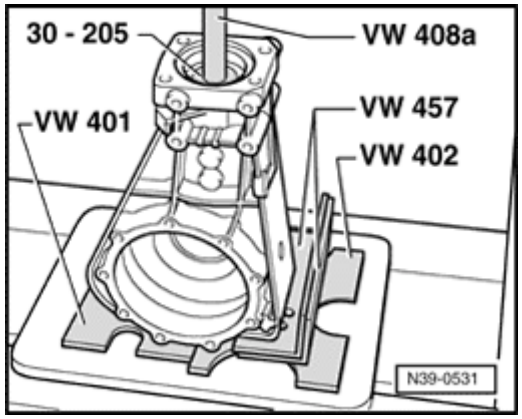


- Install large tapered roller bearing outer race into housing without shim.

Note:

The marking "Oben" on 3253/4 thrust piece faces the nut of the puller.

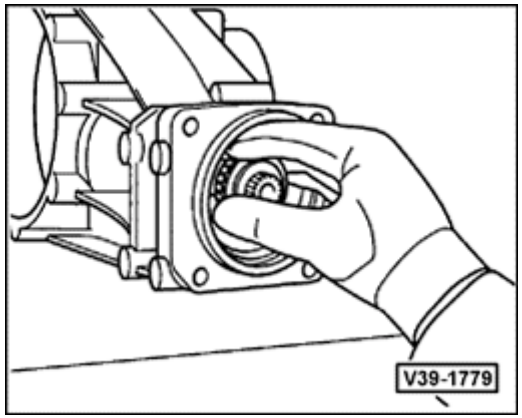
39-154



- Install small tapered roller bearing outer race into housing.
- Lubricate outer race with oil and install using VW408A punch and 30-205 thrust pad.
- Insert pinion shaft without spacer sleeve.

WARNING!

Wear protective gloves.

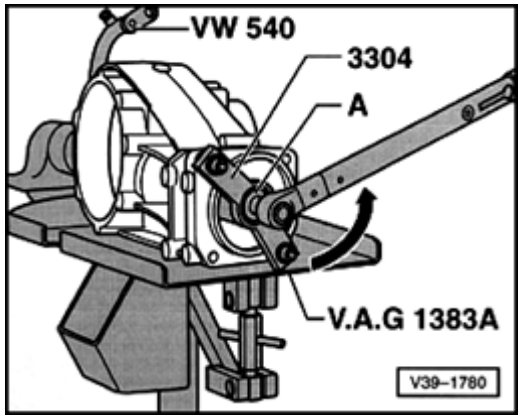


- Heat tapered roller bearing inner race to approx. 100 ° C (212 ° F) and install onto pinion shaft.

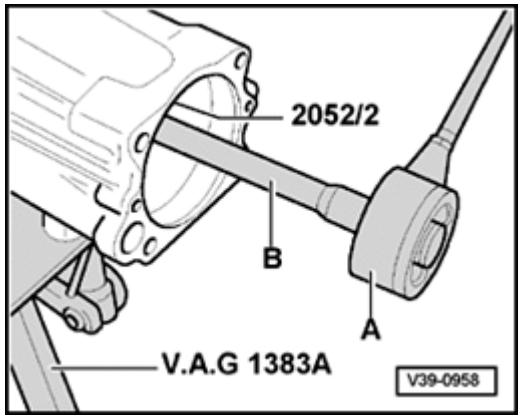
Notes:

- *Do not additionally oil new tapered roller bearings for friction torque measurement. The bearings have already been treated with a special oil by the manufacturer.*
- *Install spacer sleeve only for final friction torque measurement (after determining shim S3).*

39-155



- Bolt on 3304 bracket with two hex-head bolts M8 x 30.
- Differential must be supported when tightening nut (e.g. using VAG1359/2 universal mount and transmission hoist VAG1383A).
- Replace pinion shaft nut.
- Tighten pinion shaft nut, until no play can be felt on pinion shaft.
- Increase tightening torque until specified friction torque is attained, measuring friction torque several times during this process.



A - Torque gauge, 0-600 Ncm (commercially available)

B - Socket extension, 36 mm

- Adjust friction torque as follows:

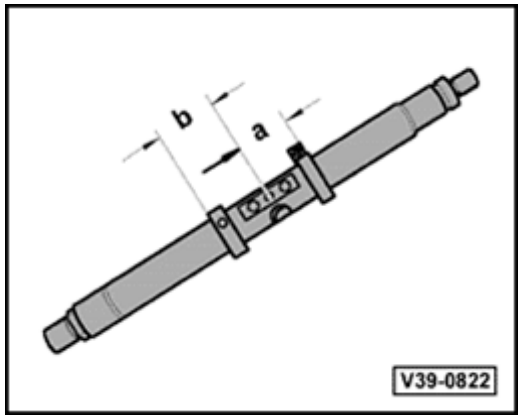
New bearings	Used bearings1)
200-250 Ncm (18-22 in. lb)	30-60 Ncm (3-5 in. lb)

1) Must have run at least 50 km (30 miles)

Note:

If the specified friction torque is exceeded, the spacer sleeve must be replaced and the adjustment repeated. A spacer sleeve that has been over-compressed at any time cannot be reused.

39-156

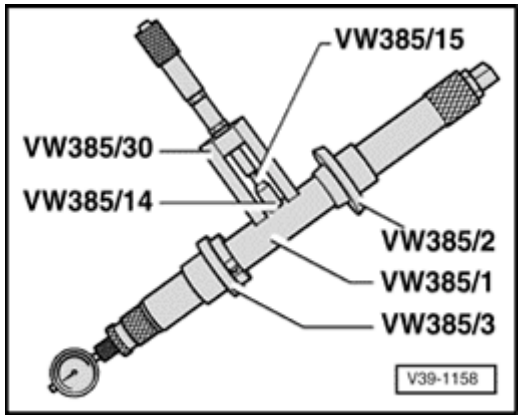


- Set adjustment ring of VW385/1 universal mandrel.

Dimension -a-: 60 mm (2.36 in.)

- Set sliding adjustment ring.

Dimension b: 55 mm (2.16 in.)



- Assemble universal mandrel as illustrated:

VW385/15 dial indicator extension = 9 mm long

- Set VW 385/30 master gauge-adjustable.

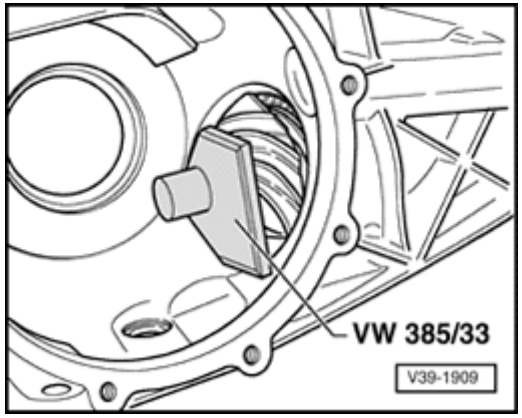
Ro = 57.50 mm (2.266 in.)

- Set dial indicator (3 mm measuring range) to "0" with 2 mm preload.

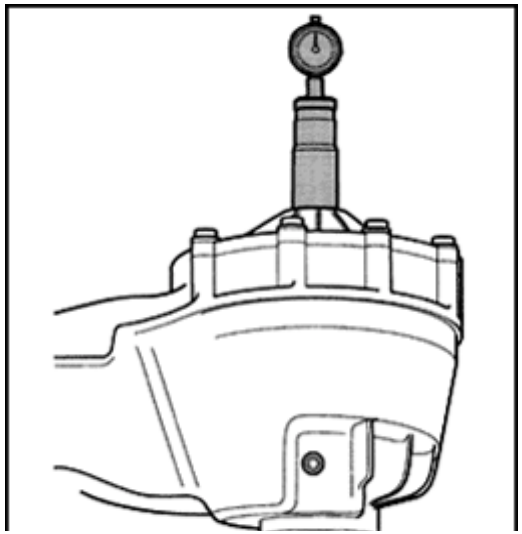
39-157

Note:

Before carrying out following measurements turn pinion shaft at least five turns in both directions, so that the tapered roller bearings settle. Otherwise a false reading will be obtained.



- Place VW 385/33 end dimension plate onto pinion shaft head.

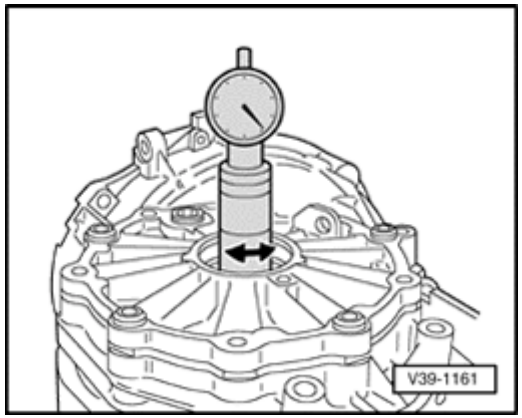


- Remove master gauge-adjustable and insert measuring mandrel in housing.

  385/3 centering disc faces final drive cover

- Install final drive cover and tighten 4 bolts.
- By turning adjustable ring, move 2nd centering disc out until mandrel can still just be turned by hand.

39-158



Determining measurement "e"

- Turn mandrel until dial indicator point touches end measuring plate on pinion shaft head, then measure maximum runout (return point). Measured value is dimension"e"(red scale).

Measurement in following example: e = 1.60 mm

Note:

Dimension "e" is required to determine thickness of shim S3.

- After removing universal mandrel, and with VW385/30 master gauge-adjustable in place, check once again whether dial indicator reads "0" with 2 mm preload, otherwise repeat measurement.

Determining shim thickness "S3"

Formula:

S3 = e - r

e = Measured value

r = Deviation (tolerance): marked on ring gear in 1/100 mm

Example:

	Measured value e	1.60 mm
-	Deviation r	0.42 mm
=	Thickness of shim S3	1.18 mm

- Determine shim(s) according to table. Part numbers ⇒ parts catalog

The following shims are available for "S3"

Shim thickness (mm)1)		
0.95	1.20	1.45
1.00	1.25	1.50
1.05	1.30	1.55
1.10	1.35	
1.15	1.40	

1) By using the shim tolerance variations it is possible to find the exact shim thickness required, insert two shims if necessary.

- Remove universal mandrel.

- Remove pinion shaft and large tapered roller bearing outer race and install together with measured shims S3 and spacer sleeve ⇒ Page 39-139 .

- Install small tapered roller bearing inner race and tighten nut for pinion shaft until specified friction torque is obtained ⇒ Page 39-144, Fig. 11 .

Notes:

- *Do not additionally oil new tapered roller bearings for the friction torque measurement. The bearings have already been treated with a special oil by the manufacturer.*

- *Increase tightening torque gradually and check friction torque at regular intervals, if the specified friction torque is exceeded, the spacer sleeve must be replaced and the adjustment repeated. A spacer sleeve that has been over-compressed at any time cannot be reused.*

- Adjust to following friction torques:

New bearings	Used bearings1)
200-250 Ncm (18-22 in. lb)	30-60 Ncm (3-5 in. lb)

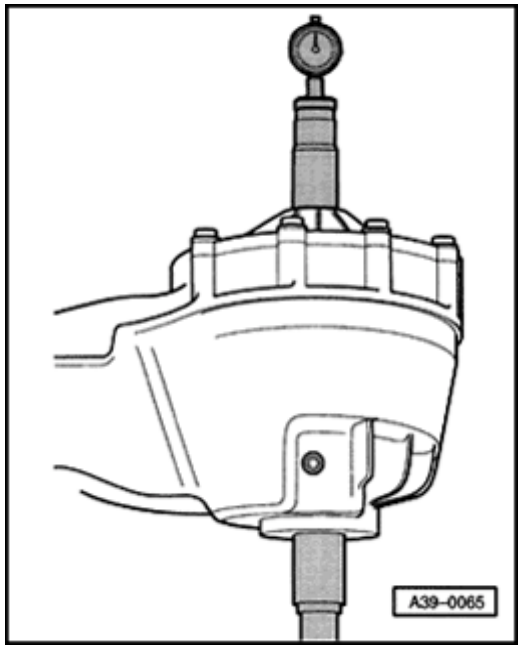
[1)] Must have run at least 50 km (30 miles)

39-161

Checking measurements

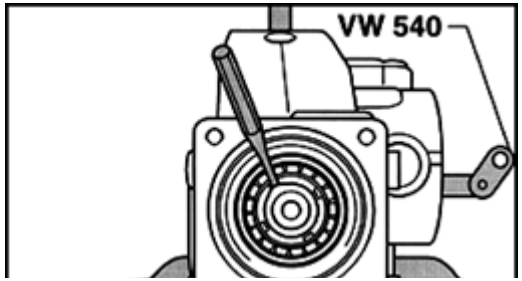
Checking dimension "r"

- Turn pinion shaft at least 5 turns in both directions.



- Insert universal mandrel and carry out check measurement.

If the shims have been correctly selected, the dial indicator should now display the value of "r" as marked on the ring gear, reading counterclockwise (red scale), within a tolerance of ± 0.04 mm.



- Secure pinion shaft nut using mandrel.

Ring gear, adjusting

Adjusting differential

The ring gear must be adjusted if any of the components have been replaced ⇒ table, ⇒ Page 39-149 .

Notes:

- *Differential tapered roller bearings are low friction bearings. Therefore the friction torque only has a limited use as a check. Correct adjustment is only possible by determining the total shim thickness Stotal.*

- *Do not additionally oil new tapered roller bearings for the friction torque measurement. The bearings have already been treated with a special oil by the manufacturer.*

Determining total shim thickness "Stotal" for shims S1 + S2

(Setting preload of tapered roller bearing for differential)

- Pinion shaft removed or ring gear removed from differential housing.

- Pry out drive flange seal using pry bar.

- Remove differential tapered roller bearing outer races and remove shims ⇒ Page 39-121 .

39-163

- Press left tapered roller bearing outer race for differential (housing side) with shim S2 into housing ⇒ Page 39-126, Fig. 2 . To perform the measurement use shim S2* with thickness of 1.00 mm (one 0.80 mm shim and one 0.20 mm shim).

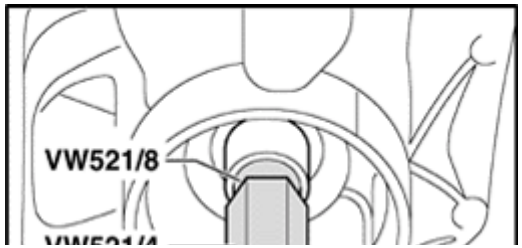
Note:

For measurement specification, a shim S2 of 1.0 mm thickness is initially inserted which will be designated S2 in the following. After determining the backlash S2* will be replaced by the correct shim S2.*

- Press in right tapered roller bearing outer race for differential (final drive cover side) without shims, until stop ⇒ Fig. 8, Page 39-130 .

- Insert differential into housing. Ring gear is positioned on right side (cover side).

- Install final drive cover and tighten bolts to 25 Nm (18 ft lb).

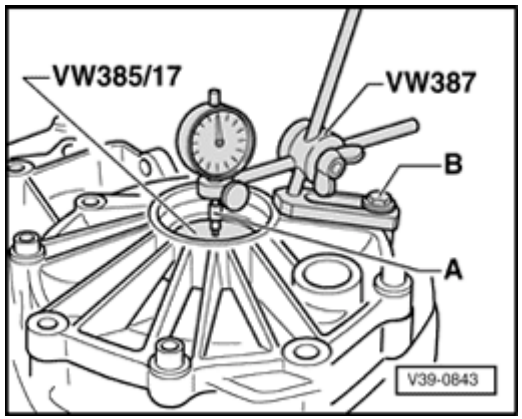


- Install special tools VW521/4 locking sleeve and 521/8 bushing on housing side into differential housing.
- Turn final drive housing so final drive cover faces upward.

39-164

- Turn differential 5 turns in both directions to settle tapered roller bearing.

- Place VW385/17 magnetic plate onto differential.

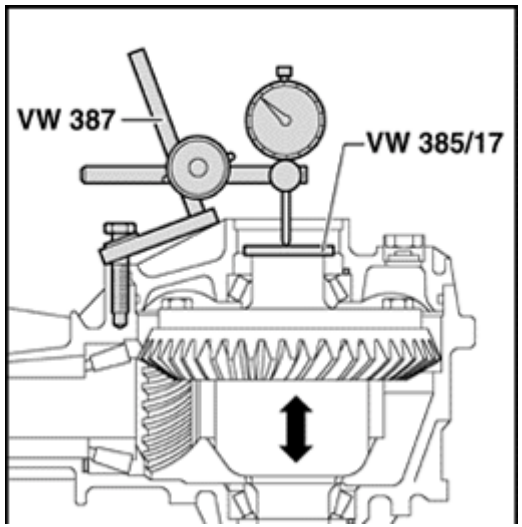


- Install measuring tools.

A - Dial indicator extension approx. 30 mm long

B - Hex-head bolt M8 x 45

- Place dial indicator extension on center of VW385/17 magnetic plate.
- Set dial indicator (3 mm measuring range) to "0" with 2 mm preload.



- Lift up differential without turning; read off play on dial indicator and note.

  Measurement in following example: 0.50 mm

Note:

If the measurement has to be repeated, the differential must again be turned 5 turns in each direction to settle the tapered roller bearing.

39-165

Formula:

Stotal = S2* + measurement + bearing preload

Example:

	Inserted shim(s) S2*	1.00 mm
+	Measured value	0.50 mm
+	Bearing preload (constant)	0.30 mm
=	Total shim thickness Stotal for shims S1 + S2	1.80 mm

Determining thickness of shim "S1*"

Notes:

- *The preliminary shim S1* will be replaced with the final shim S1 after determining the backlash.*
- *The total shim thickness Stotal remains unchanged.*

Formula:

S1* = Stotal - S2*

Example:

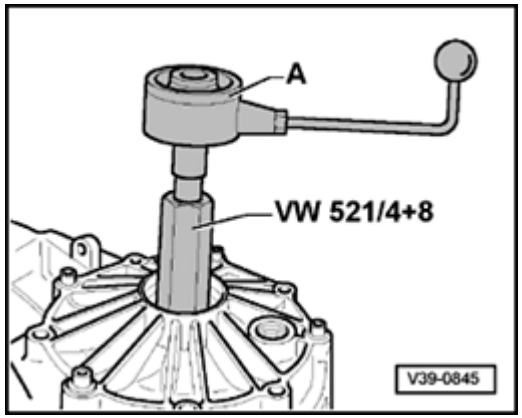
	Total shim thickness Stotal for shims S1 + S2	1.80 mm
-	Inserted shim(s) S2*	1.00 mm
=	Thickness of shim S1*	0.80 mm

- Determine shim(s) according to table ⇒ Page 39-171 .

39-167

Measuring friction torque

- Pinion shaft removed
- Differential with shims S1* and S2* installed



- Install torque gauge, 0-600 Ncm (53 in. lb)-A- onto differential.
- Read value of dial indicator.

Friction torque specifications:

New bearings	Used bearings1)
150-300 Ncm (13-27 in. lb)	30-60 Ncm (3-5 in. lb)
1) Must have run at least 50 km (30 miles)	

Notes:

- *Differential tapered roller bearings are low friction bearings. Therefore the friction torque only has a limited use as a check. Correct adjustment is only possible by determining the total shim thickness Stotal.*
- *Do not additionally oil new tapered roller bearings for the friction torque measurement. The bearings have already been treated with a special oil by the manufacturer.*
- *If the final drive gear set (pinion shaft and ring gear) is being re-adjusted, the adjustment of the pinion shaft should be checked* ⇒ *Page 39-153* *.*

39-168

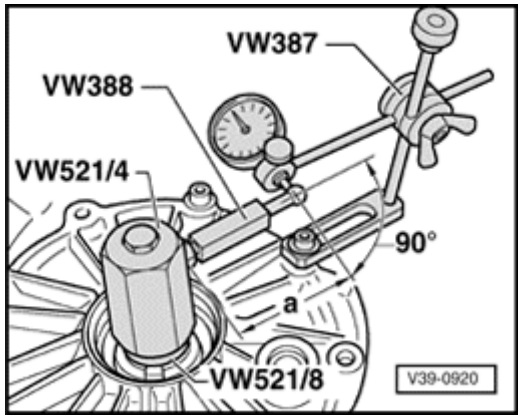
Adjusting backlash

Position of ring gear in final drive housing

- Pinion shaft with shim S3 installed
- Differential with shims S1* + S2* installed

- Insert differential into final drive housing, install final drive cover and tighten all bolts to 25 Nm (18 ft lb).

- Turn differential 5 turns in both directions to settle tapered roller bearings.



- Assemble measuring equipment.
- Use VW382/10 dial indicator extension (6 mm flat).
- Set VW388 measuring lever to dimension -a-

  Dimension -a-: 60 mm.
- Determine play between teeth flanks as follows:
  - Turn ring gear until it makes contact with tooth flank (end of backlash travel).
  - Set dial indicator to "0"with 1 mm preload.

- Turn ring gear back until contact is made against opposite tooth flank (backlash).

- Read value of dial indicator and note.

- Turn ring gear 1/2-turn (90 °) each time and repeat measurements 3 times.

CAUTION!

If the individual measurements differ by more than 0.06 mm from each other, the installation of the ring gear or the final drive set itself is not correct. Check installation, replace final drive set if necessary.

Determining average backlash

Example:

	1st measurement	0.28 mm
+	2nd measurement	0.30 mm
+	3rd measurement	0.30 mm
+	4th measurement	0.28 mm
=	Sum of measured values	1.16 mm

- Result: the average backlash is 1.16 mm ÷ 4 = 0.29 mm

Determining thickness of shim "S2"

Formula:

S2 = S2* - backlash + lift

Example:

	Inserted shim S2*	1.00 mm
-	Average backlash	0.29 mm
+	Lift (constant)	0.15 mm
=	Thickness of shim S2	0.86 mm

- Determine shim(s) according to table. Part numbers ⇒ parts catalog

The following shims are available for "S2"

Shim thickness (mm)1)		
0.15	0.50	1.50
0.20	0.80	
0.25	1.00	

1) Using the shim tolerance variations it is possible to find the exact shim thickness required, insert two shims if necessary.

Determining thickness of shim "S1"

Formula:

-S1- = Stotal - S2

Example:

	Total shim thickness Stotal for S1 + S2	1.80 mm
-	Thickness of shim S2	0.86 mm
=	Thickness of shim S1	0.94 mm

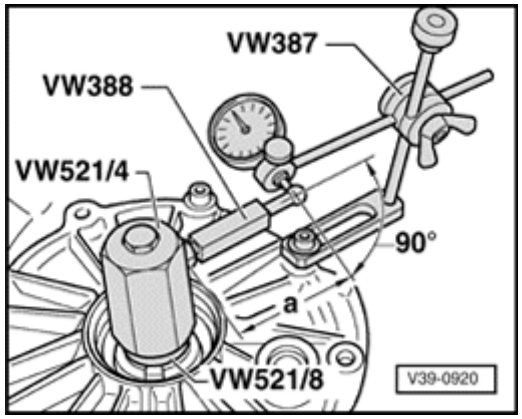
- Determine shim(s) according to table. Part numbers ⇒ parts catalog.

The following shims are available for "S1"

Shim thickness (mm)1)		
0.15	0.50	0.90
0.20	0.60	1.00
0.30	0.70	1.20
0.40	0.80	

1) Using the shim tolerance variations it is possible to find the exact shim thickness required,

insert two shims if necessary.



Checking measurements

- Pinion shaft with shim S3 installed
- Differential with shims S1 + S2 installed

- Turn differential 5 turns in both directions to settle tapered roller bearings.
- Measure backlash four times on circumference.

  Specifications: 0.12-0.22 mm

Notes:

- *If the backlash lies outside the tolerance, the adjustment must be repeated, but the total shim thickness Stotal must remain unchanged.*
- *The individual measurements must not differ by more than 0.06 mm from each other.*