



APEX DYNAMICS, INC.

Installation of Rack and Pinion



1. General Description




1.1 This instruction is written for the personnel that is related to the installation, transport, storage and maintenance of this transmission system. Please make sure to understand this instruction and work accordingly to the accident prevention regulations and safety laws in the local territory before any operation. Incorrect installation, maintenance or insufficient protection would lead to unpredictable damages.

The manufacturer of this transmission system will not assume any responsibility for any non-compliant or unsuitable operation which leads to personal injury or property damage.


1.2 For the maximal permissible driving force or torque of the rack please refer to the homepage of APEX DYNAMICS under: www.apexdyna.com
Any loading over the maximal permissible driving force or torque of the rack will be considered as incorrect application.

1.3 Safety Warnings


The following symbols show the warning and the precaution.

	Warning to potential danger which can lead to serious personal injury and/or system damage.
	Warning to possible environment pollution.
	Warning to potential danger and risk during transport or lifting work.

1.4 Make sure to switch off the power supply during installation, maintenance.

	<ul style="list-style-type: none">• Any non-compliant or unsuitable operation can lead to personal injury or property damage• Make sure the system can not be switch on during the maintenance.• Make sure to prevent any involving of any foreign objects.• Make sure all the safety equipments are effective before starting the operation again.
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1.5 Apply sufficient lubrication during the operation.

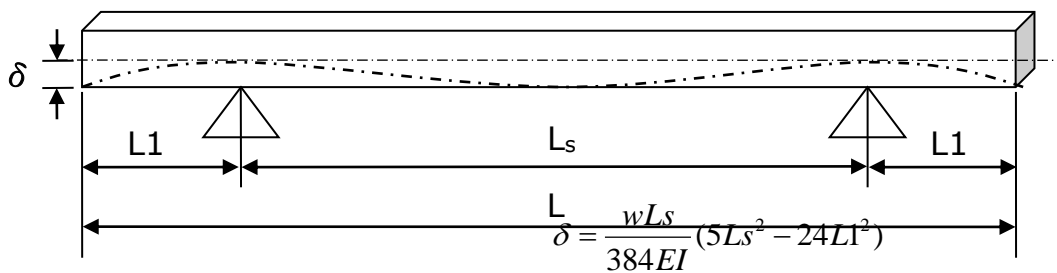
	The lubrication oil or grease will pollute the soil and water. The used lubricant should be collected and treated according to the regulations and laws in the local territory.
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- 1.6 The installation, disassembly, transport, storage and maintenance of this transmission system can be operated only by well trained personnel.
- 1.7 The weight of rack is given in the Table 1 below for the standard lengths. For more details please refer to the APEX catalog.

Rack Weight (Kg)														
Module No.	1	1.5	1.591 CP 5	2	2.5	3	3.183 CP 10	4	4.244 CP 13.33	5	6	8	10	12
Length mm														
200	-	-	-	0.7	-	-	-	-	-	-	-	-	-	-
250	0.4	0.5	-	1	-	1.4	-	2.5	-	-	-	-	-	-
500	0.8	1.2	-	2.1	2.5	2.8	-	5.2	-	6.1	9.2	20.1	-	-
1000	1.6	2.5	3.9	4.1	4.5	5.8	5.3	11	9.6	12.9	20	43.5	68.3	101
1500	3.9	-	-	6.1	7.2	8.8	-	16	-	19.3	29.8	-	102	-
2000	-	4.1	8.1	8.2	9	11.8	11.1	21.2	19.8	25.6	40	87.1	-	-

Table 1


- 1.8 For delivery, the racks are well coated with rust inhibitor and wrapped with PE film and cardboard as packaging. If the rack weigh is over 10 Kg, it needs 2 people to work coordinately with crane, in order to avoid personal injury or deformation of rack. Suitable personal protection during the transport or lifting work is necessary. It's prohibited to use crowbar. The suitable supporting points on a rack are given as below.



$$Ls = \frac{5}{9}L \quad L1 = \frac{2}{9}L \quad \delta = \frac{wLs}{384EI} (5Ls^2 - 24L1^2)$$

w = Weight of Rack

EI = Flexural rigidity (the best span for min. deformation in the center)

	<ul style="list-style-type: none"> • The lifting work should be carried out only by trained professional. • During the lifting work, it is strictly prohibited for persons to stay under the hanging objects in the working area. • Slowly and carefully to lift and lower the objects.
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1.9 Racks are to be stored horizontally in ambience with low humid under temperature 0~40°C. The APEX racks can be stored for max. 2 years in the original APEX packaging.

1.10 For a better fitting to the machine bed, a chamfer has been machined on the rack in the mounting position. Any interference on the contact surface should be avoided. The chamfer of different rack module no. is given in the Table 2.

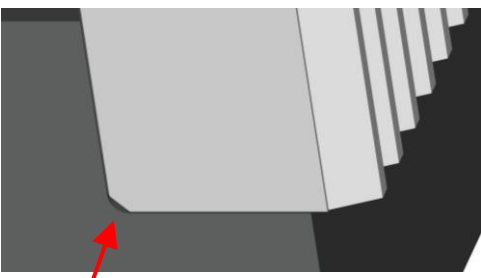
 <p>Attention</p>	Module No.	Chamfer
	≤ 3	2 x 45°
	≥ 4	3 x 45°

Table 2

1.11 For the installation of rack, a solid alignment as reference surface on the machine bed should be constructed. The screw bonding surface should have a flatness of about 0.02 mm.

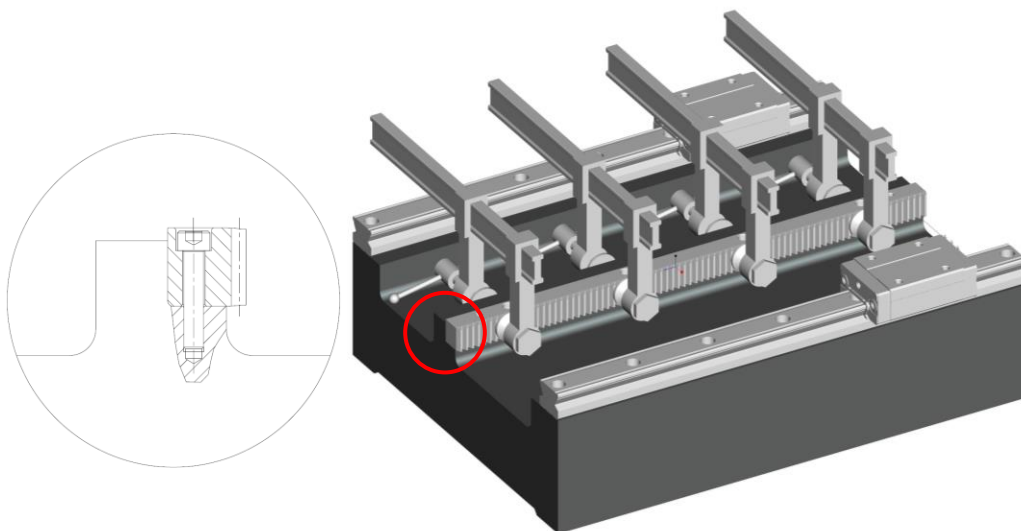


Fig. 1

- 1.12 If there is no solid alignment on the machine bed for the rack, a suitable reference surface (e.g. linear guide) could be chosen and apply fixtures to clamp the racks.

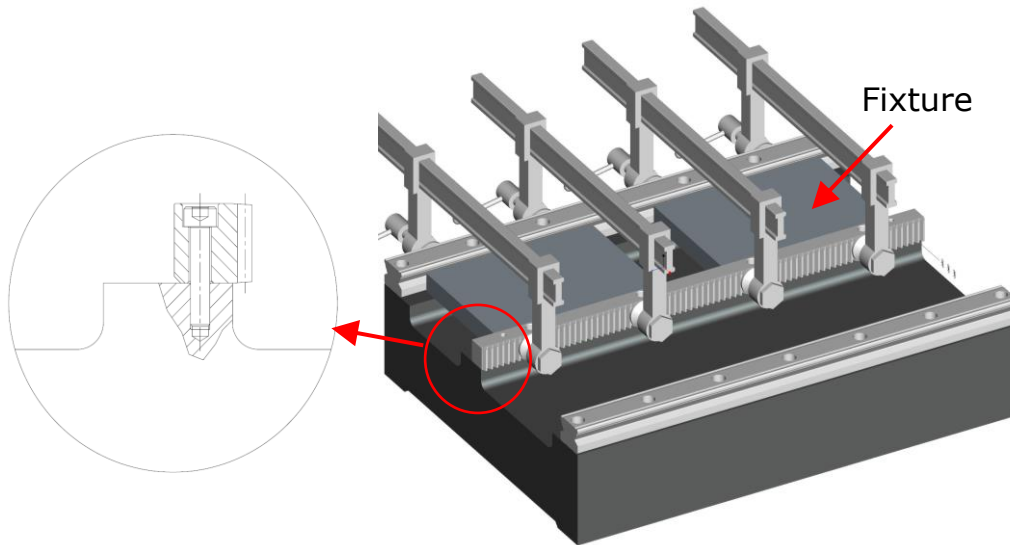


Fig. 2

- 1.13 For an installation as shown in the Fig. 2, or, to apply 2 pinions on the same rack like in Fig. 3, a rack of APEX Quality 5+ is strongly recommended, whereby the positioning pins should be applied.

While driving the system with 2 pinion-gearbox sets coordinately, note that the resulting force can exceed the permitted limit of the rack fixing screws.

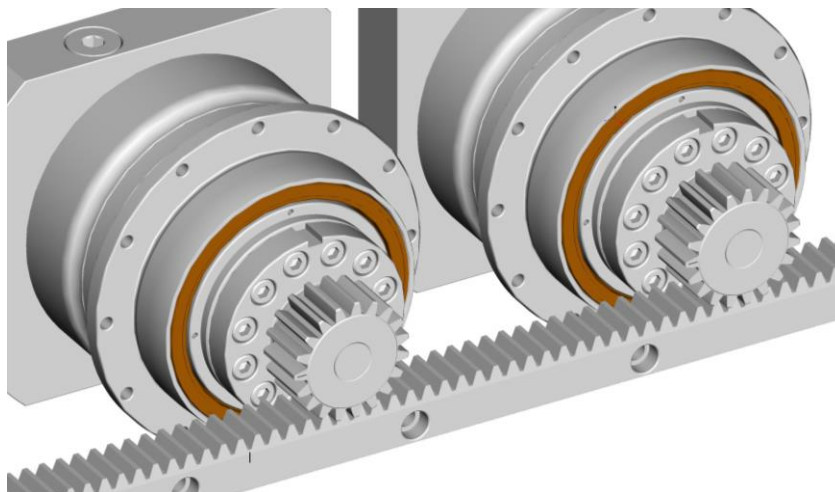

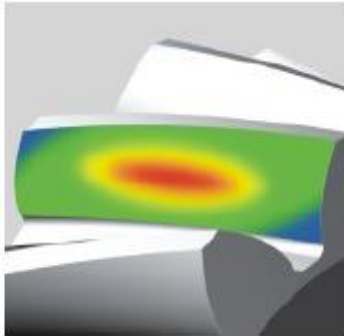


Fig. 3

- 1.14 The positioning pins of the rack serve for a repaid installation after demounting. The pins are not necessary if there is no repeated mounting and demounting. The positioning pins are however needed by installation without alignment surface like shown in the Fig. 2.

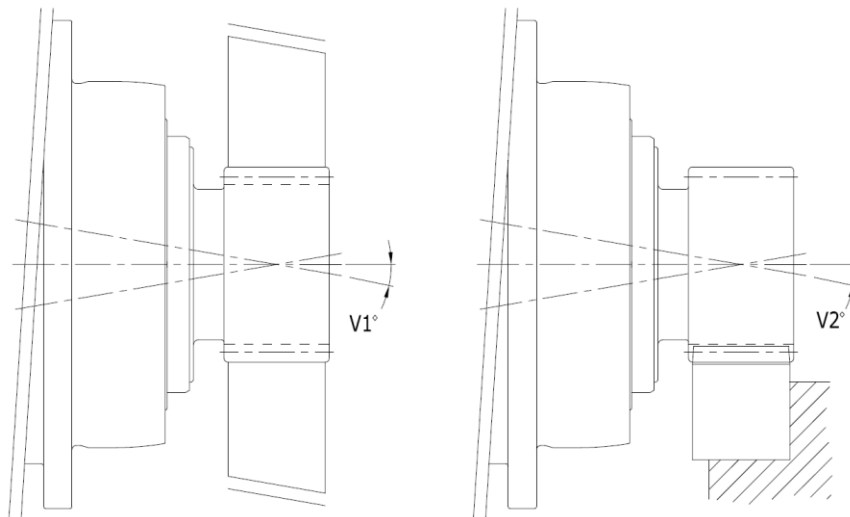
	<ul style="list-style-type: none"> • The disassembly of rack should be carried out only by trained professional. • The disassembled parts can fall and lead to serious personal injury and/or system damage.
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1.15 The unique design of pinions of APEX DYNAMICS reduces the interference between the rack and pinion, and hence reduces the noise level and wearing.



Unique design of the pinion with advanced 3D HeliTopo software, optimized profile and lead of the teeth reduce the interference of the pinion by coupling the teeth to the rack.

This unique design of APEX also helps to tolerate a larger inaccuracy of the machine bed, hence increase the installation efficiency of rack and pinion, and to reach a higher performance. The maximal tolerance of the perpendicularity (V1) and parallelism (V2) between APEX rack and pinion are given in Table 3.



Overview


Side view

Module No.	Tolerance (in arcmin)	
	V1	V2
1.5	4.5	13.2
2	5.1	13.2
3	3.3	13.2
4	4.8	13.2
5	4.5	13.2
6	4.8	13.5
8	4.5	13.2
10	4.8	13.2
1.591 (CP 5)	5.1	13.5
3.183 (CP 10)	3.8	13.2
4.244 (CP 13.33)	4.8	13.2

Table 3

2 Check and Preparation before Installation

2.1 Check if there is any damage on the surfaces of rack or machine bed

	<ul style="list-style-type: none">• Wear gloves by installation. Sharp edge can cut the hand.• Set the torque wrench in advance.
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2.2 Check if there is any rest magnet on the rack and pinion. Dust or fine metal chips in the environment can be attracted by the rest magnet and come into between the rack and pinion that influences the accuracy and life-time of the system.

Rack and pinion of APEX DYNAMICS has been demagnetized before delivery.

2.3 Clean up the contact surfaces of the rack and machine bed.

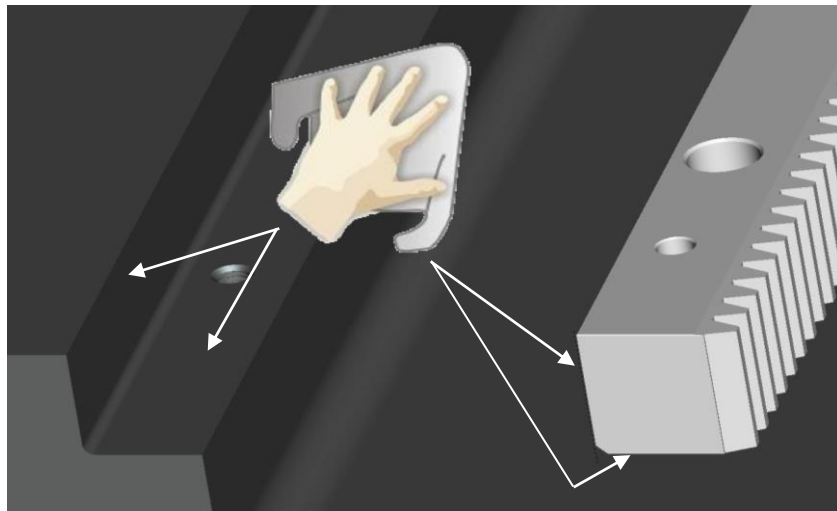




Fig. 4

	<ul style="list-style-type: none">• Wear gloves by cleaning to avoid corrosion by rust inhibitor.• Do not use damaged or un-cleaned rack.
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2.4 In order to achieve the best installation accuracy, the cleaned rack can be placed on the machine bed for some period of time for a temperature balance.

	<ul style="list-style-type: none">• Installation should be done under the room temperature, to avoid the heat transfer to the rack.
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2.5 For the connection of racks, the “Rack Gauge” is necessary for the calibration of rack connection. Micrometer and “Pin Gauges” are also necessary for the final check and adjustment of the racks. For the choice of the Pin Gauges, please refer to the Step 4.2. For more details and purchase of the Rack Gauge and the Pin Gauge please refer to the catalog or APEX DYNAMICS homepage.

3 Installation of Rack

- 3.1 Place the rack on the machine bed and align the mounting screw holes.
- 3.2 Use the fixture to clamp the rack onto the machine bed. The clamping positions should be close to the rack screw holes as much as possible.

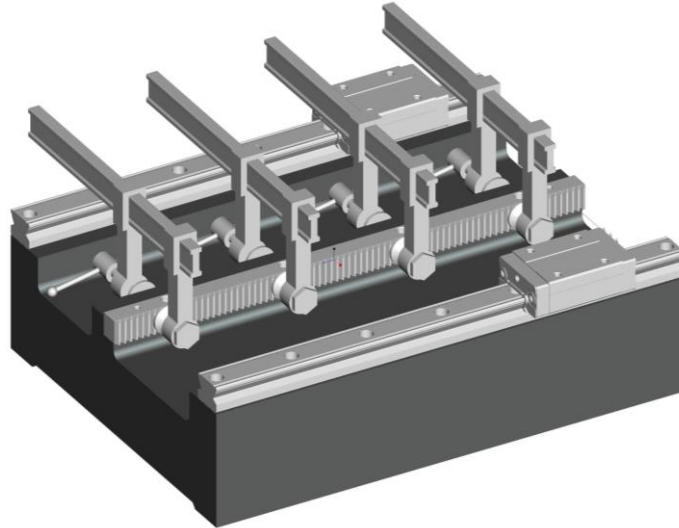



Fig. 5

	<ul style="list-style-type: none">• Fixture can damage rack or machine if not well applied.• Use plastic or copper spacer/washer if necessary.
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- 3.3 Insert the hexagon socket countersunk head bolts of class 12.9 to the mounting holes and tighten the screws with 10% of the rated torque as given in the Table 4. Do not lock screws completely yet!
- 3.4 Adjust the position of fixtures properly so that the rack can fully fit to the machine bed. According to the sequence shown in Fig. 6, tighten the screws with the rated torque as given in the Table 4, starting from the center to the both sides.

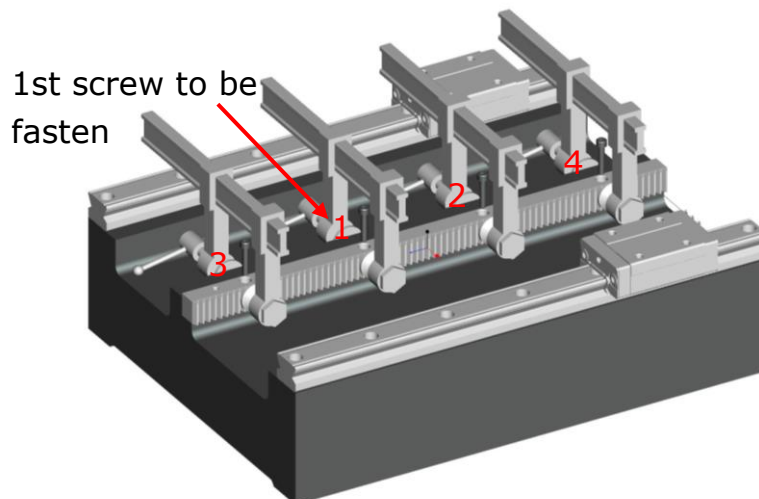



Fig. 6

Screw Size	Dimension Hexagon Head	Rated Torque Class 12.9	
	[mm]	[Nm]	[Lbf-ft]
M4 x 0.7P	3	4.9	3.6
M5 x 0.8P	4	9.8	7
M6 x 1P	5	17	13
M8 x 1.25P	6	41	30
M10 x 1.5P	8	80	60
M12 x 1.75P	10	139	105
M14 x 2P	12	223	165
M16 x 2P	14	343	255
M20 x 2.5P	17	660	485
M24 x 3P	19	1140	840
M30 x 3.5P	22	2300	1695
M36 x 4P	27	4100	3025

Table 4

	Incorrect tightening torque on the screws can cause the screw to loose or overloaded resulting in damage to the system.
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3.5 Remove the fixtures.

4 Identify the Highest Position on the Rack

- 4.1 Check the straightness of rack after the rack is installed.
- 4.2 Choose a suitable magnetic Pin Gauge according to Table 5.


	Module No.	Diameter [mm]
	1	2
	1.5	3
	2	4.2
	3	5
	4	7
	5	9
	6	10
	8	14
	10	18
	12	20

Table 5

- 4.3 Place Pin Gauge to positions on both of the end and in the center of rack.
- 4.4 To measure the height-difference of the 3 Pin Gauges with micrometer on a movable platform.
- 4.5 The tolerance of the height-difference is shown in Table 6.

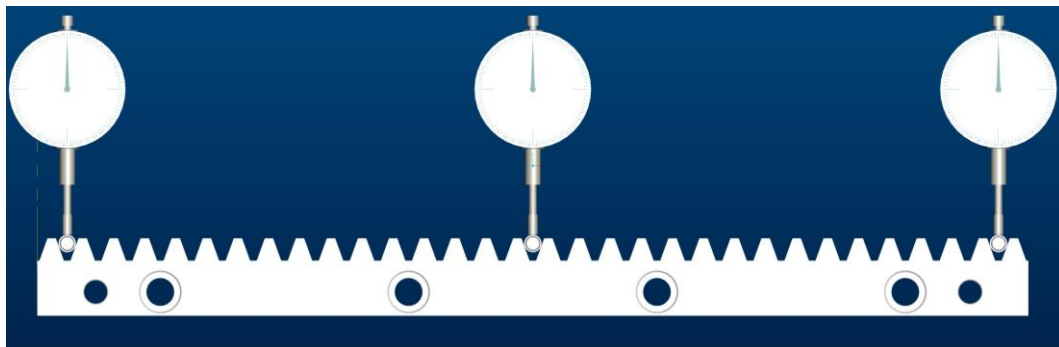


Fig. 7

Rack Quality	Q3	Q5	Q6	Q7	Q8	Q10
Tolerance	0.018	0.02	0.03	0.044	0.066	0.123

Table 6

- 4.6 Find out the highest position on the rack and give mark. This marked position will be the reference point while installing the gearbox and pinion.

5 Connecting Racks in Sequence

5.1 To connect racks in sequence must start with the rack close to the center of machine bed.

5.1.1 Refer to Step 3.1 to 3.4 to install the 1st rack.

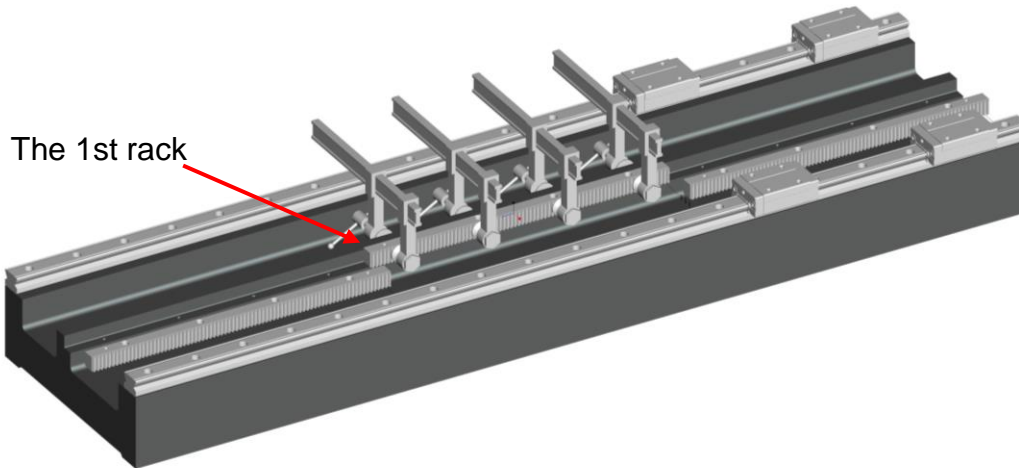


Fig. 8

5.2 Remove the fixtures.

5.3 Install Other Racks in Sequence

5.3.1 Place the 2nd rack in the engagement direction and align the screw holes.

5.3.2 Insert the hexagon socket countersunk head bolts of class 12.9 to the mounting holes and fasten the screws with 10% of the rated torque as given in the Table 4. Do not lock screws completely yet!

5.3.3 Apply the Rack Gauge to the junction position of 2 neighbor racks and make sure the teeth are well coupled. The rack Gauge serves only for the connection of racks.

5.3.4 Adjust the Rack Gauge and the fixtures properly so that the rack can fully fit to the machine bed. Note that large pressure will be induced by pressing the Rack Gauge to racks and this influences the gap between the 2 neighbor racks.

5.3.5 According to the sequence shown in Fig. 9 starting from the 1st screw next to the junction position, tighten the screws with the 50% rated torque. To tighten all screws with the rated torque when the adjustment of rack gap has been done, s. Step 5.

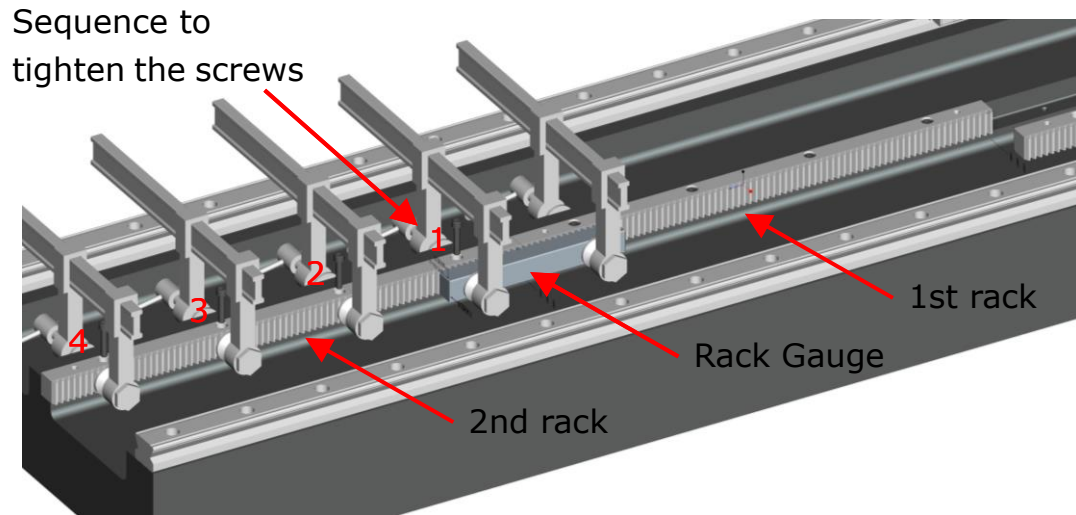


Fig. 9

5.3.6 Repeat the Steps 5.3.1 to 5.3.5 to install the next rack or the rack on the other side ◦

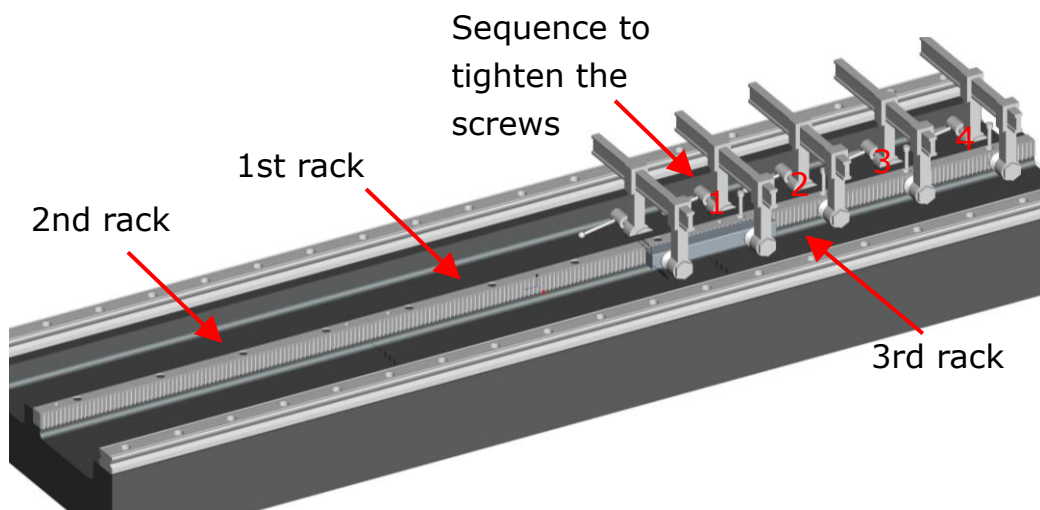


Fig. 10

5.3.7 Remove the fixtures.

6 Connecting the Racks

- 6.1 By connecting the racks, the teeth pitch in the junction position must be measured and adjusted.
- 6.2 Choose a suitable magnetic "Pin Gauge" according to Table 5.
- 6.3 Place the Pin Gauges in the junction position B and in the symmetrical positions in each of the rack, A and C.
- 6.4 Fix the micrometer on a suitable reference surface and measure the heights at the 3 Pin Gauge positions.
- 6.5 The height in the junction position B should be the average of the heights of positions A and C. The tolerance of the height on B to the average height is shown in Table 7.

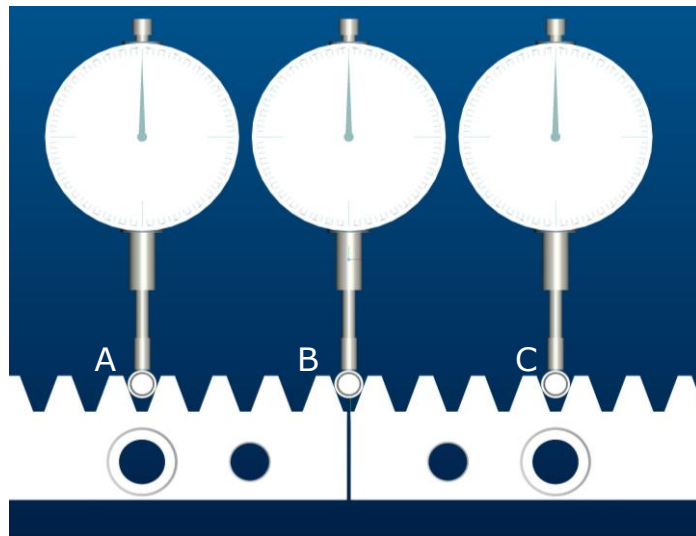


Fig. 11

Rack Quality	Q3	Q5	Q6	Q7	Q8	Q10
Tolerance	± 0.005	± 0.007	± 0.011	± 0.016	± 0.024	± 0.045

Table 7

- 6.6 If the height-difference is lying out of the tolerance, try to tap the rack on the pin hole with suitable tool to adjust the rack to the left or right to change the gap between the racks, until the tolerance matches the values in Table 7.
Note, not to damage the rack by adjustment!
- 6.7 Apply the fixtures to re-clamp the rack onto the machine bed.
- 6.8 Starting from the 1st screw next to the junction position, tighten with the rated torque.
- 6.9 Remove the fixtures.
- 6.10 Confirm the height-difference. If the height-difference does not match the values in Table 7, repeat the Step 6.3 to 6.8.

7 Identify the Highest Position in the Operation Range of Racks

- 7.1 Check the straightness of each rack, as shown in Step 4, in the operation range after the racks are connected.
- 7.2 Choose a suitable Pin Gauge according to Table 5.
- 7.3 Find out the highest position of each rack according to Step 4.2 ~ 4.5.
- 7.4 Find out the highest position on the racks in the whole operation range and give mark. This marked position will be the reference point while installing the gearbox and pinion.

8 Install the Positioning Pins

- 8.1 Positioning pins according to DIN 7979 / DIN EN, Type ISO 8735 A should be used.
- 8.2 Apply fixtures to the rack in positions close to the pin holes.
- 8.3 On the rack, holes are pre-bored for the pin hole reamer. The pin hole tolerance for the positioning pin is H7. Drill the pin hole according to the Pin Hole Diameter given in Table 8 for different module numbers. For special pin hole sizes please refer to catalog.

(mm)

Module Number	Drill Hole Diameter on Rack	Pin Hole Diameter (H7)*
1	5.7	6
1.5	5.7	6
2	7.7	8
3	7.7	8
4	7.7	8
5	11.7 *	12
6	15.7 *	16
8	19.7 *	20
10	19.7 *	20
12	19.7 *	20

(*) A suitable magnetic drill holder can be applied as guide.

Table 8

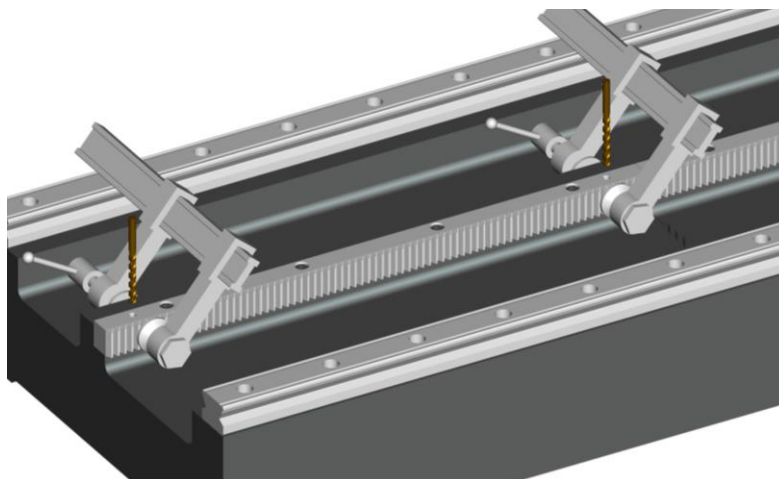
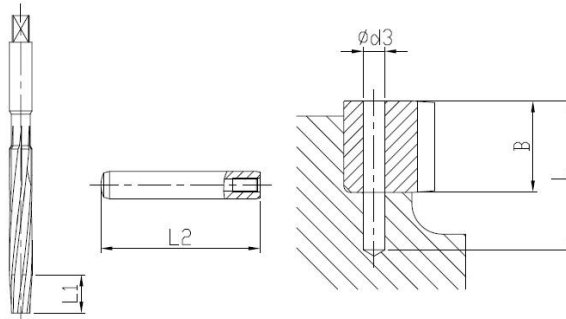


Fig. 12

8.4 For the drilling depth, the chamfer length of the reamer cutting edge should be considered. Please also refer to the specification of the reamer manufacturer. For the calculation of the drilling depth please refer to the Table 9. For the drilling depth of rack with special width, please refer to catalog.



(mm)

Module No.	Rack Width B	Pin Length L2	Drilling Depth L
3	29	40	$L = L2 + L1 + 1$
4	39	50	
5	49	70	
6	59	80	
8	79	100	
10	99	120	
12	120	140	

Table 9

8.4.1 A magnetic drill holder helps to work on a larger pin holes (≥ 11.7 mm) in any direction. Drilling without drill holder please refer to Step 8.4.

8.4.2 Choose a suitable drill holder and align it onto the pin hole.

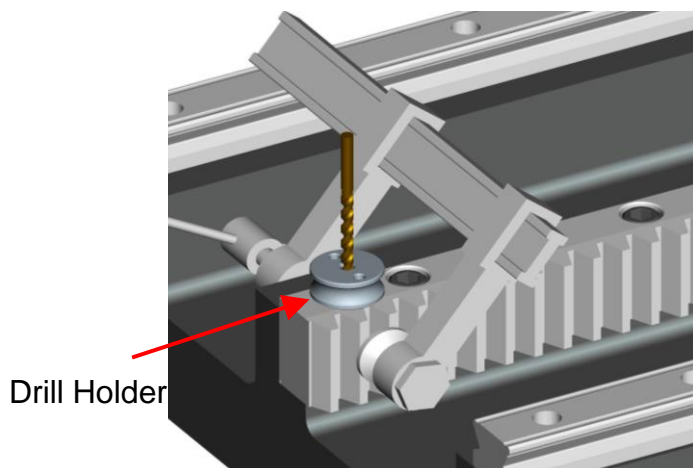


Fig. 13

- 8.4.3 Apply $\phi 5.7$ drill to drill a 5 mm deep hole on the machine bed, Fig. 14.
- 8.4.4 Remove the drill holder and drill the hole further to the depth L, as given in Table 9.
- 8.4.5 Enlarge the hole to the Drill Hole Diameter according to Table 8 to finish the drilling.

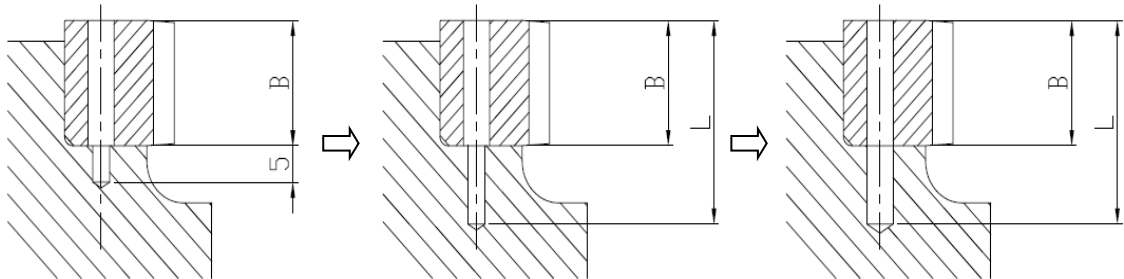


Fig. 14

- 8.5 Clean the scraps after drilling and apply reamer to enlarge the drill hole to the corresponding Pin Hole Diameter and depth.
- 8.6 Clean the scraps after reaming and apply pin to fix the rack on the machine bed. For an easy disassembly it is recommend using the pins with internal thread hole. The special tool as shown in Fig. 15 can be used to release the pin and without damage the rack.

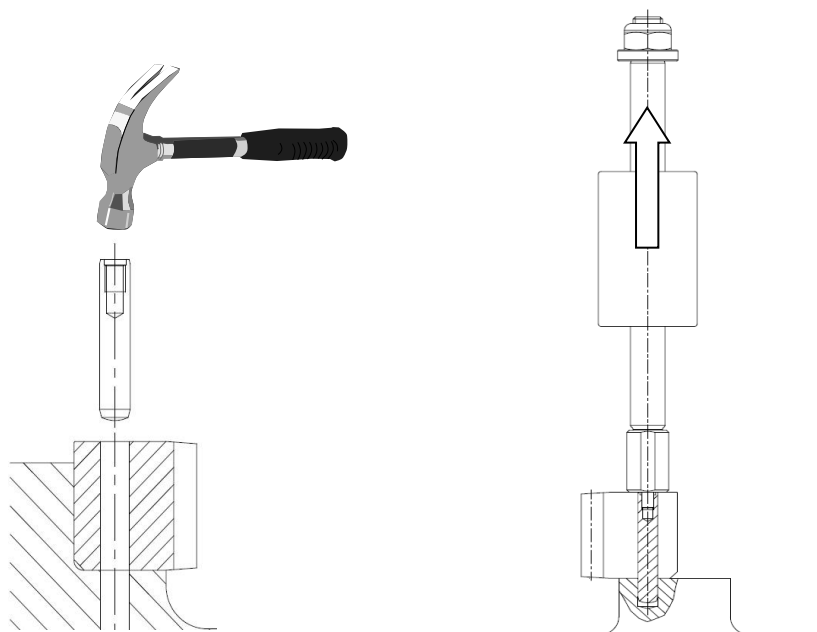



Fig. 15

	<ul style="list-style-type: none"> • By disassembly the pins and the rack, be careful not to damage the neighboring parts or components.
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9 Install the Gearbox onto the Rack

9.1 The APEX pinion is well installed on the APEX gearbox as a set. The highest position of the circular run-out is marked.

If the pinion and gearbox are purchased separately, the user should check the circular run-out first after the pinion has been set on the gearbox.

For the mounting of different pinions onto the gearbox please refer to Step 12.

9.2 By installing the gearbox with pinion onto the rack, be sure to match the mark of the highest circular run-out on the pinion to the mark of the highest position on the racks (Step 4.6). The measurement and adjustment of the backlash between the rack and pinion will be done in this position.

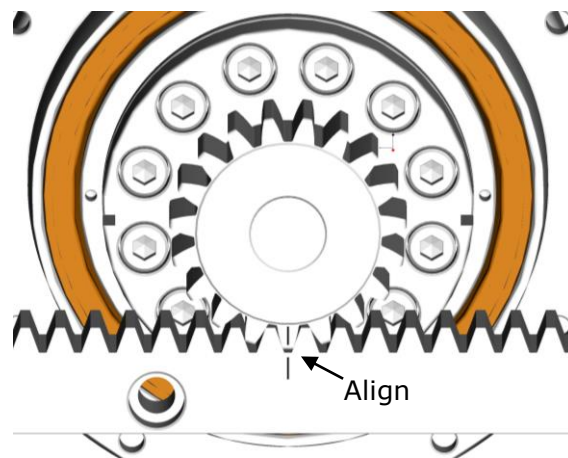


Fig. 16

9.3 The backlash of the rack and pinion system can be adjusted via the Center Height "A". The design backlash can be best achieved by the Standard Center Height. For the standard center height of different products please refer to APEX catalog.

By setting the Center Height, the pitch lines of the rack and pinion should be possibly parallel to each other. For the permitted tilting and parallelism of the pitch lines or the tolerance for Center Height, please refer to the standard DIN 3964 according to different quality levels. The ideal backlash under different application conditions please refer to the standard DIN 3967.

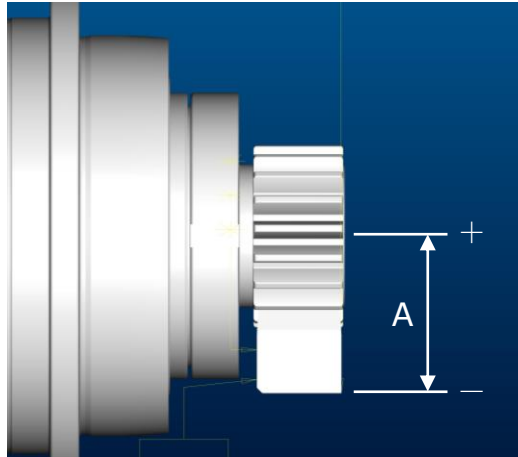


Fig. 17

9.4 Measurement of the Backlash (j_t)

- 9.4.1 Fix the gearbox and fix the output-shaft with suitable tool (e.g. hook wrench) while measuring the backlash. Be sure to match the mark of the highest circular run-out on the pinion to the mark of the highest position on the racks, Step 9.2.
- 9.4.2 Place the micrometer on tooth profile in the pitch circle of the pinion.
- 9.4.3 Use the hexagonal wrench to turn the pinion to touch the left and right profile of the contacting rack teeth. While doing this, the difference “b” (in mm) between the minimal and maximal values can be read from the micrometer. The maximal angle measured is the backlash j_t (in arcmin) which can be calculated with the formula given below.

$$j_t = b / (0.000145 \times \text{Pitch Circle Diameter})$$

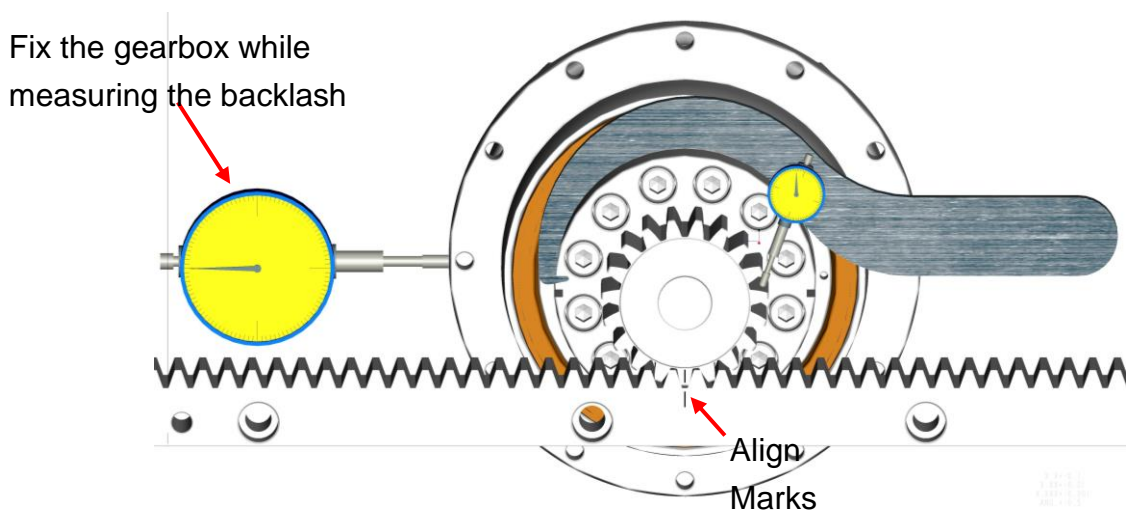


Fig. 18

9.4.4 The minimal backlash can be influenced by the temperature change of the system, the elastical deformation by loads or other possible factors leading to expansion or contraction.

The minimal backlash of racks of different qualities is shown in Table 10.

9.4.5 For the information about the backlash changing by the center height tolerance, please refer to APEX Homepage.

Rack Quality	Q3	Q5	Q6	Q7	Q8	Q10
min. Backlash (mm)	0.013	0.015	0.022	0.032	0.06	0.1

Table 10

10 Check after Installation

10.1 Clean up the grease, oil or fat on the rack.

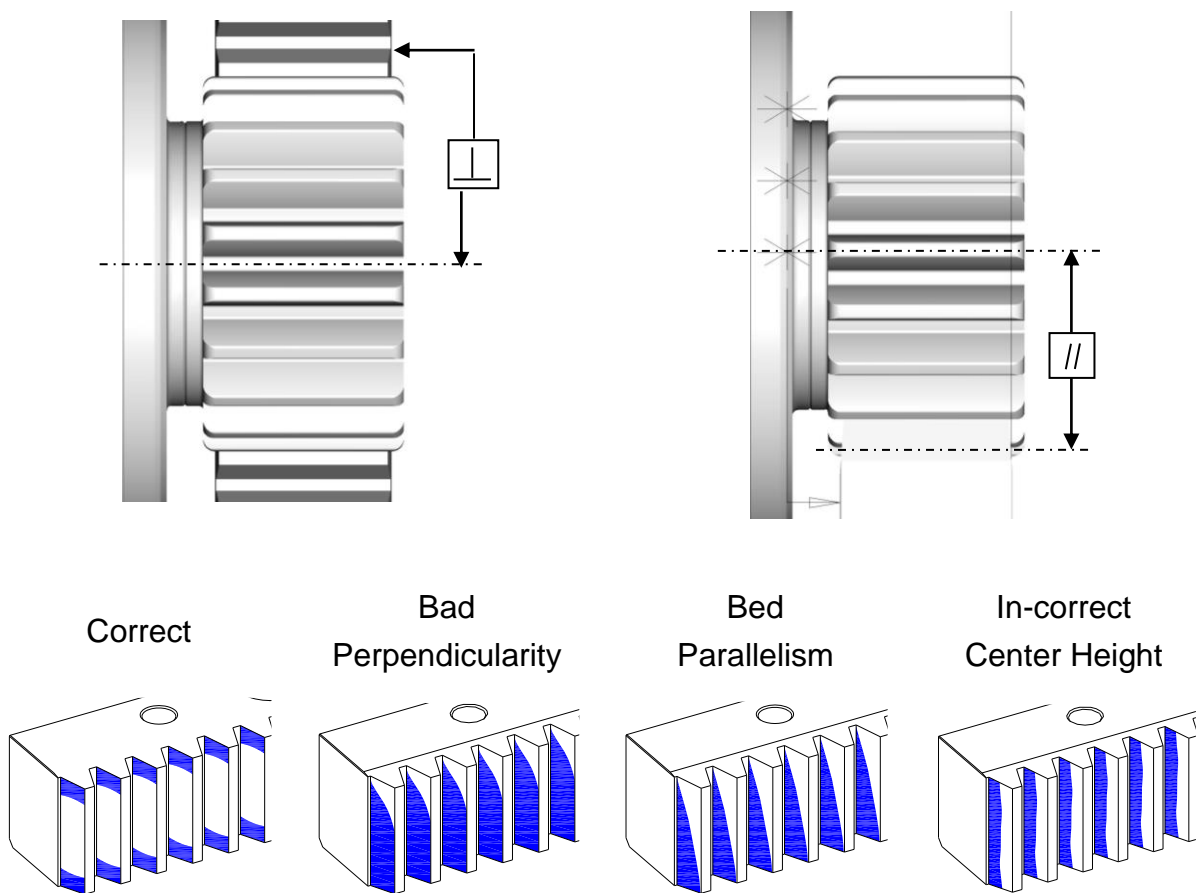
10.2 Apply color to the rack teeth.

10.3 Move the gearbox forwards and backwards on the rack in the whole operation range, to have the color well coated on the rack.

During this movement, it can also be checked if the operation is smooth.

10.4 Further move the gearbox forwards and backwards on the rack and check how the color is shedding on the rack teeth.

10.5 Basing on the color pattern below to judge if the rack and pinion system is coupling well.



10.6 Clean up the color on the teeth and apply rust protection to all the open parts.

10.7 Fix the gearbox permanently.

11 Confirm the function and performance before operation

11.1 Install the motor to the gearbox.

11.2 Run the gearbox repeatedly in the operation range with low speed first.

11.3 The motor driving force and the noise of the system should be possibly constant in every different position.



- Insufficient lubrication will cause damage of rack and pinion.

11.4 If anything abnormal shows up, check immediately the relative positions between the rack and pinion with the help of micrometer and Pin Gauge.

11.5 For more information of the pinion by different application please refer to APEX catalog.

12 Installation of Pinion with Curvic Coupling (Pinion Quality: Q4)

- 12.1 The pinion with curvic coupling is a patented design of APEX DYNAMICS to align the pinion center automatically and to reduce the round-out error on the gearbox out-put. By switching the curvic position, the best round-out of the pinion-gearbox set can be reached and enhanced the overall accuracy of the system.
- 12.2 If the pinion with curvic coupling is purchased separately to the gearbox, the user needs to assemble it as the instruction below.
- 12.3 To screw the flange to the gearbox with the rated torque as given in Table 4. If necessary, to apply hook wrench to fix the gearbox.

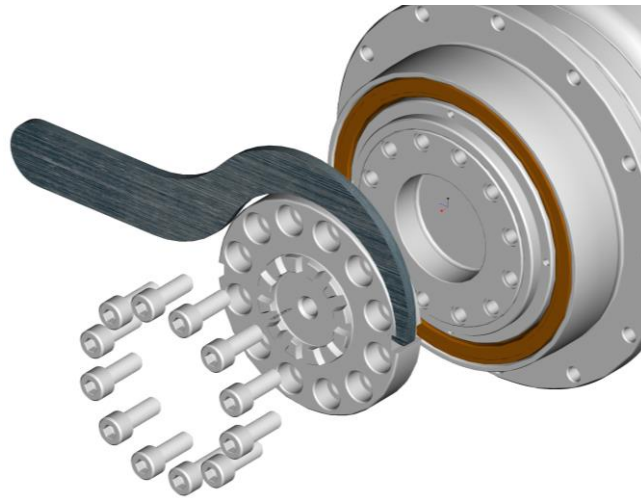


Fig. 19

- 12.4 To align and combine the pinion and flange according to the convex/concave teeth of the curvic coupling. To apply the rated torque in Table 4 to tighten the screw.

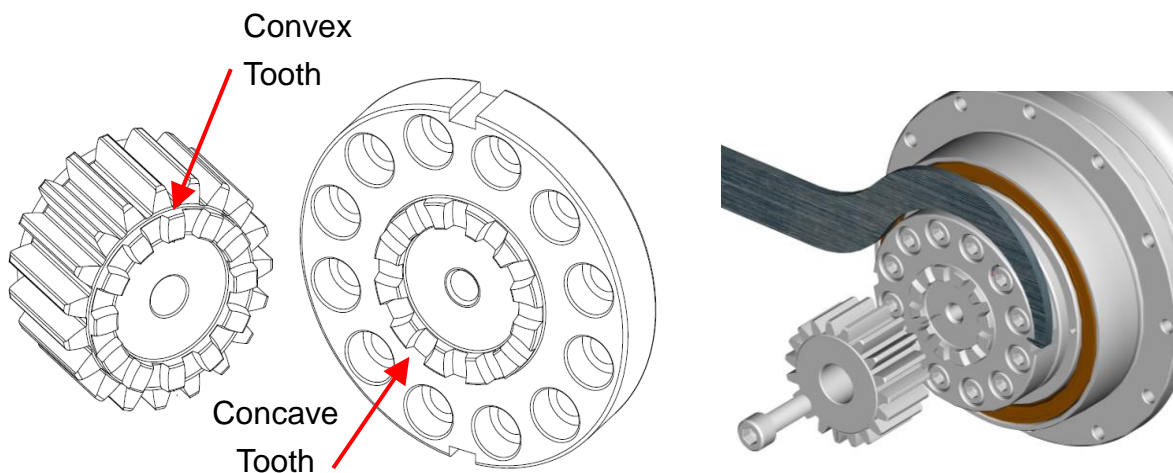


Fig. 20

12.5 The tooth-tip of the APEX pinion is ground simultaneously with the tooth-profiles. Hence, the round-out of the pinion can be check with micrometer on the tooth-tips, tooth to tooth. While doing this, the micrometer needs to be fixed in the same suitable position.

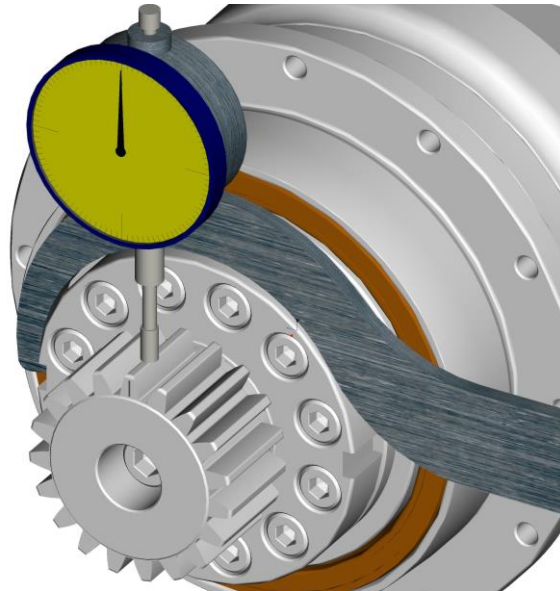


Fig. 21

12.6 Repeat the Step 12.4 ~ 12.5 to confirm the best overall round-out of the system. For the round-out tolerance, please refer to Table 11.

12.7 The screw hole in the center helps to remove the flange.

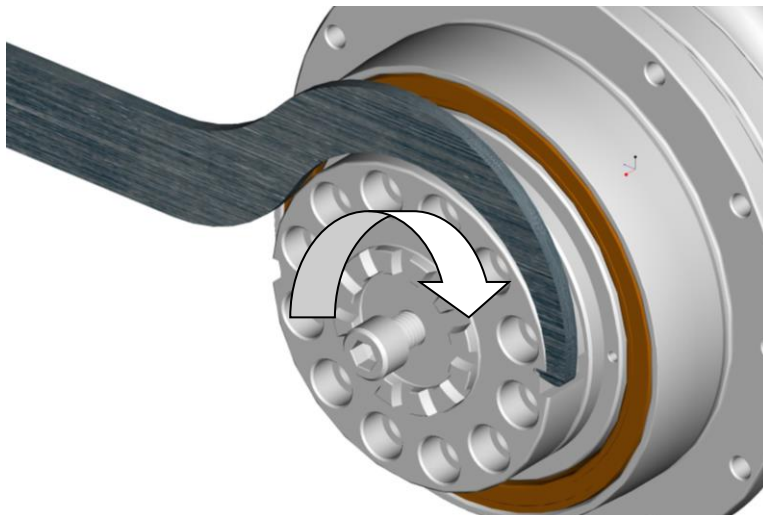


Fig. 22

12.8 Find out the position of maximal overall round-out and mark on it. Tighten the screw with the rated torque in Table 4 and apply the cover plug.

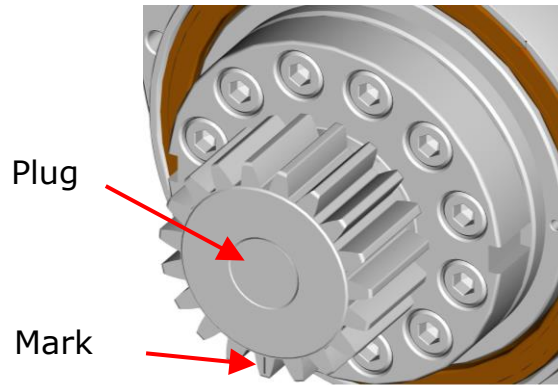


Fig. 23

12.9 The Round-Out Tolerance of Pinion (based on ISO 1328)

Pitch Circle Diameter D (mm)	Module Number Mn	Quality (DIN)				
		4	5	6	7	8
		μm				
$5 \leq d \leq 20$	$0.5 \leq M_n \leq 2.0$	6.5	9.0	13	18	25
	$2.0 < M_n \leq 3.5$	6.5	9.0	13	19	27
$20 < d \leq 50$	$0.5 \leq M_n \leq 2.0$	8.0	11	16	23	32
	$2.0 < M_n \leq 3.5$	8.5	12	17	24	34
	$3.5 < M_n \leq 6.0$	8.5	12	17	25	35
	$6.0 < M_n \leq 10$	9.5	13	19	26	37
$50 < d \leq 125$	$0.5 \leq M_n \leq 2.0$	10	15	21	29	42
	$2.0 < M_n \leq 3.5$	11	15	21	30	43
	$3.5 < M_n \leq 6.0$	11	16	22	31	44
	$6.0 < M_n \leq 10$	12	16	23	33	46
	$10 < M_n \leq 16$	12	18	25	35	50
$125 < d \leq 280$	$0.5 \leq M_n \leq 2.0$	14	20	28	39	55
	$2.0 < M_n \leq 3.5$	14	20	28	40	56
	$3.5 < M_n \leq 6.0$	14	20	29	41	58
	$6.0 < M_n \leq 10$	15	21	30	42	60
	$10 < M_n \leq 16$	16	22	32	45	63
$280 < d \leq 560$	$0.5 \leq M_n \leq 2.0$	18	26	36	51	73
	$2.0 < M_n \leq 3.5$	18	26	37	52	74
	$3.5 < M_n \leq 6.0$	19	27	38	53	75
	$6.0 < M_n \leq 10$	19	27	39	55	77
	$10 < M_n \leq 16$	20	29	40	57	81

Table 11

13 Installation of Pinion with DIN 5480 Interface (Pinion Quality: Q5)

- 13.1 If the pinion with DIN 5480 Interface is purchased alone, the user needs to assemble it according to the instruction below.
- 13.2 Place the pinion onto the output-shaft with DIN 5480 interface and tighten the screw with the rated torque as given in Table 12. Use this tightening torque to press the pinion onto the end-position on the gearbox output-shaft. Do not tap the pinion onto the shaft.

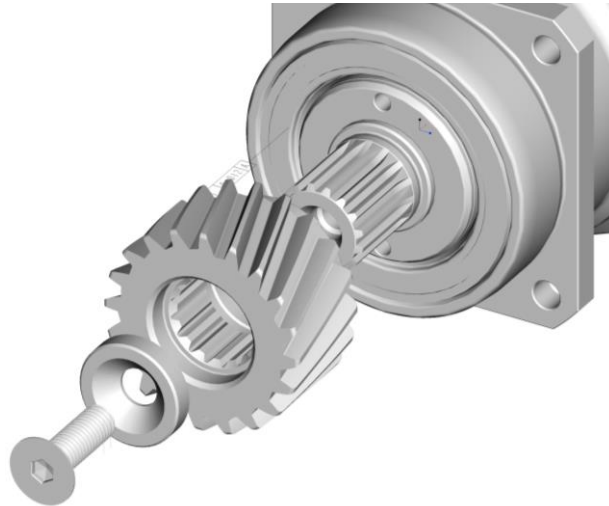


Fig. 24

Screw Size	Hexagon Dimension	Tightening Torque Screw of Class 10.9	
	[mm]	[Nm]	[Lbf-ft]
M5 x 0.8P	3	5.4	4
M8 x 1.25P	5	22	16
M12 x 1.75P	8	77	57
M16 x 2P	10	190	140
M20 x 2.5P	12	370	275

Table 12

- 13.3 Refer to Step 12.5 to measure the overall round-out of the pinion-gearbox set. For the round-out tolerance, please refer to Table 11.
- 13.4 Find out the position of maximal overall round-out of and mark on it.

14 Installation of Pinion with Key-Way (Pinion Quality: Q5)

- 14.1 If the pinion with Key-Way is purchased alone, the user needs to assemble it according to the instruction below.
- 14.2 Place the Pinion onto the output-shaft with key-way and tighten the screw with the rated torque as given in Table 12. Use this tightening torque to press the pinion onto the end-position on the gearbox output-shaft. Do not tap the pinion onto the shaft.

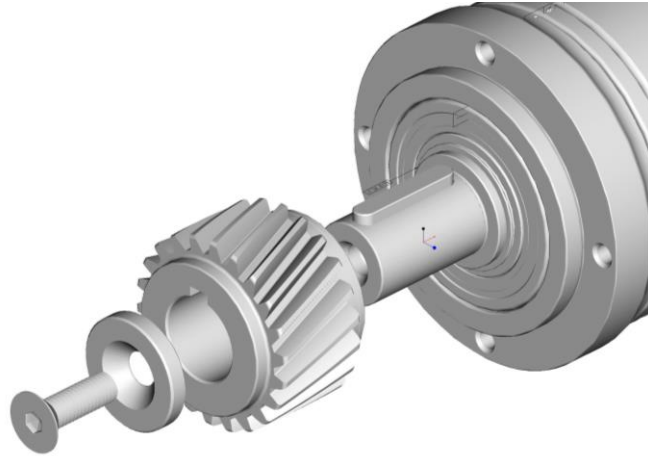


Fig. 25

- 14.3 Refer to Step 12.5 to measure the overall round-out of the pinion-gearbox set. For the round-out tolerance, please refer to Table 11.
- 14.4 Find out the position of maximal overall round-out of and mark on it.

15 Installation of Pinion with ISO 9409 Flange (Pinion Quality: Q4)

15.1 Align the screw hole on the pinion to the output flange of gearbox and tighten the screws with the rated torque given in Table 4.

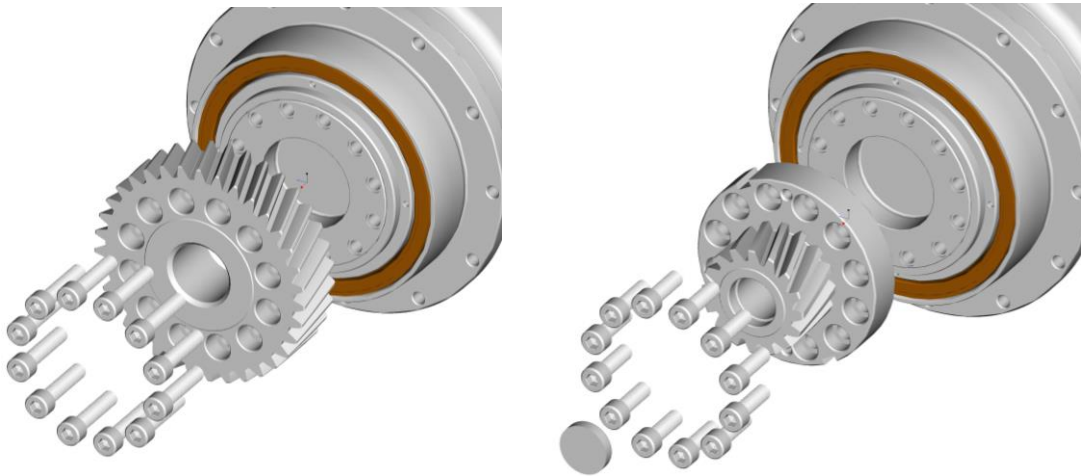


Fig. 26


15.2 Refer to Step 12.5 to measure the overall round-out of the pinion-gearbox set.

For the round-out tolerance, please refer to Table 11.

15.3 Find out the position of maximal overall round-out of and mark on it.

16 Re-Installation of Rack after Demounting


16.1 Switch off all electric power before demounting

	<ul style="list-style-type: none">• In-correct operation can lead to serious personal injury and/or system damage.• The demounting of rack can be carried out only by well trained personal.
---	---

16.2 Make sure the demounting work will not damage the whole machine or system.

16.3 Loosen all the screws and use the tool shown in Fig. 15 to remove the positioning pins according to Step 8.5.

16.4 Remove the racks carefully and give sequence number on racks and all the other parts.

	<ul style="list-style-type: none">• By removing the rack, be careful not to damage the neighboring parts or components.• Consider the center of gravity of the rack by placing the rack. Avoid rack sliding, even system dumping.
---	--

16.5 Place the same rack to the same position in machine by re-installation.

16.6 Align the pin positions

16.7 Apply the 1st pin to fix the rack to the machine bed.

16.8 Use the fixture to clamp the rack to fit the machine bed. The clamp positions should be close to the rack screw holes as much as possible.

16.9 Insert the hexagon socket countersunk head screws of class 12.9 to the mounting holes and fasten the screws with the rated torque as given in the Table 4. To begin with the first screw close to the positioning pin and in the sequence as shown in Fig. 27.

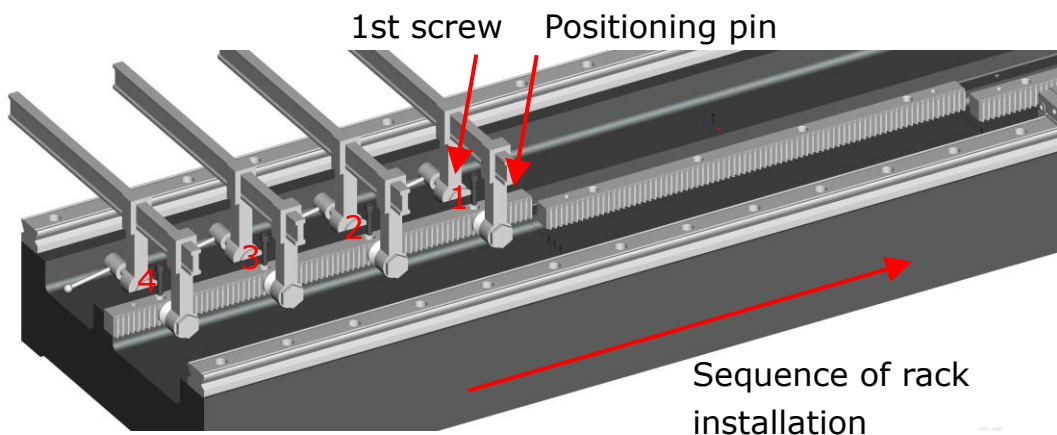


Fig. 27

- 16.10 Install the 2nd positioning pin and remove the fixtures.
- 16.11 Repeat the Step 16.6 ~ 16.10 to install the 2nd rack.

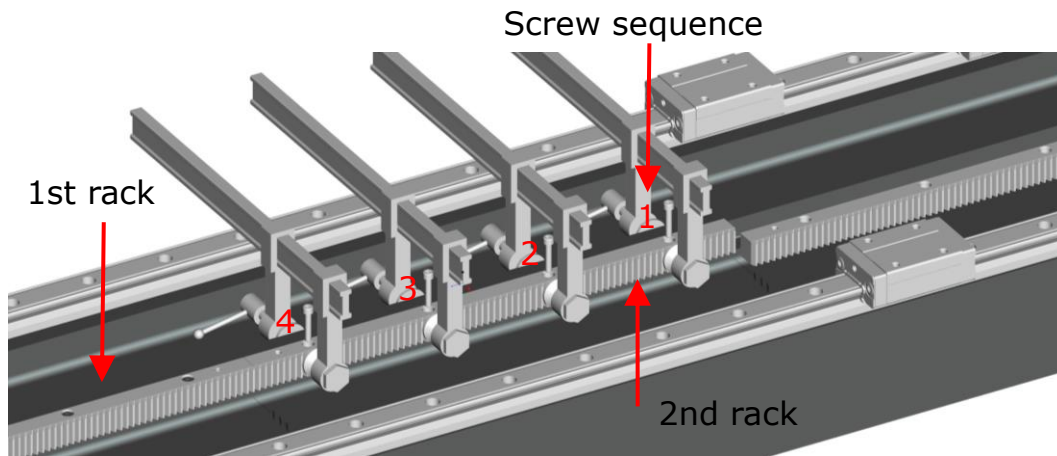



Fig. 28

- 16.12 Install the other racks in sequence.
- 16.13 Confirm the rack pitch after re-installation referring to Step 6.1 ~ 6.5.
- 16.14 Confirm the highest position on the racks in the operation range, referring to Step 7.

17 Maintenance

17.1 A maintenance plane should be set according to the usage of system.

17.2 Do make sure to switch off the power supply during any operation of installation, maintenance and transport.

	<ul style="list-style-type: none">• In-correct operation can lead to serious personal injury and/or system damage.• Do make sure no one can switch on the power supply of the system during maintenance.
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17.3 Check the entire system if there is any external damage or oil (grease) leakage.

17.4 Replace or repair all damaged parts.

17.5 Check the Lubrication System

17.5.1 Check the lubrication system if there is any external damage, loosing or broken tube, dirty or worn-out lubrication wheel.


The life-time of the lubrication wheel depends on the application. If wear fast, need to adjust the maintenance interval.

17.5.2 Replace damaged or dirty parts immediately.

17.5.3 Check the volume of lubricant, add or change the lubricant if necessary.

17.6 Replace the Rack

17.6.1 Loosen all the screws and use the tool shown in Fig. 15 to remove the positioning pins according to Step 8.5.

	The demounting of rack can be carried out only by well trained personal.
---	--

17.6.2 By removing the rack, be careful not to damage the neighboring parts or components.

17.6.3 Re-install the rack according to Step 3 ~ 5.

17.6.4 If the positioning pin was applied, please refer to the Table 8 in Step 8.2 and choose a pin one size larger.

17.6.5 Re-install the positioning pins according to Step 8.

17.7 Clean up and lubricate the rack and pinion, and make sure all the safety equipment has been well set.

17.8 Check before operation according to Step 11.

18 Function Failure

If any abnormal phenomenon during the operation shows up, stop the operation immediately and take correction measures. Some examples are given as below.

Function Failure	Possible Reason	Correction Measure to do
Increasing Noise	Transmission device (gearbox) defect	Check the transmission device
	In-correct installation of rack and pinion	Refer to Step 10
	Insufficient lubrication	Check lubrication system
High Temperature	Unsuitable design	Check design data
	Over-heat on Transmission device	Check the transmission device. Apply cooling device if necessary.
	Environment temperature too high	Apply sufficient air-condition
Leakage of lubricant	Too much lubricant	Remove excess lubricant and correct the lubrication rate and volume.
	Leakage	Check the lubrication system and pinion transmission device.
Rubbing marks or crack on the rack teeth	Insufficient lubrication	Adjust the lubrication rate and volume. It is suggested to use automatic lubrication system.
	Incorrect lubricant	Change to suitable lubricant
	Bad environment	The operation environment should be clean and dry.
	Effected by magnet	Make sure the rack and pinion are both well demagnetized.
Rack teeth broken	Overloaded	Check the design data.
	Collision of system	Make sure there is no obstacle in the operation range, the emergency stop is well set and the operation is correct.
	Pitting on tooth profile	Improve the lubrication for the operation
	Insufficient lubrication	Check lubrication system
	Bad perpendicularity or parallelism between rack and pinion	Check the alignment of the pinion on the rack. Check the round-out of pinion on the gearbox.
Increasing Backlash or Position Error	Misalignment of the rack, pinion or the transmission device	Check the alignment of the pinion on the rack. Check the round-out of pinion on the gearbox.

Table 13



APEX DYNAMICS, INC.

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