

## Handtorque™ Multipliers

### What is a Torque Multiplier?

A torque multiplier is a device that increases the torque that can be applied by an operator. Because the power output can not exceed the power input, the number of output revolutions will be lower than the number of input revolutions (Torque x rpm = Power).

### How Handtorque Torque Multipliers Work

Handtorque multipliers incorporate an 'epicyclic' or 'planetary' gear train having one or more stages. Each stage of gearing increases the torque applied by a factor of 5, allowing Norbar to offer multipliers typically in ratios of 5:1, 25:1 and 125:1.

In the planetary gear system, torque is applied to the input gear or 'sun' gear. Three or four planet gears whose teeth are engaged with the sun gear therefore rotate. The outside casing of the multiplier, or 'annulus' is also engaged with the planet gear teeth, and would normally rotate in the opposite direction to the sun gear. A reaction arm prevents the annulus from rotating, and this causes the planet gears to orbit around the sun. The planet gears are held in a 'planetary' carrier which also holds the output square drive. Therefore as the planet gears orbit around the sun gear, the carrier and so the square drive turns.

Without the reaction arm to keep the annulus stationary, the output square will not apply torque.

### Why use a Handtorque Torque Multiplier?

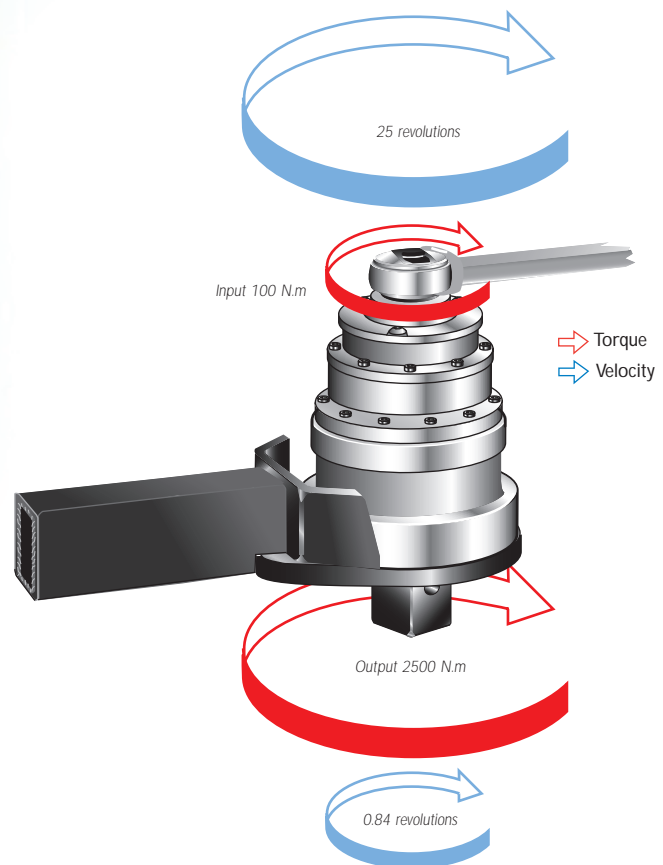
- **Safety** – use of long levers can be dangerous. Torque multipliers mean a reduction in the lever length or operator effort by a factor of 5, 25 or 125.
- **Space limitation** – the use of a long lever may be impossible due to the available space.
- **Accuracy** – torque will be applied most accurately when it is applied smoothly and slowly. Torque multipliers enable this by removing much of the physical effort from the tightening task.



Without a torque multiplier



With a torque multiplier



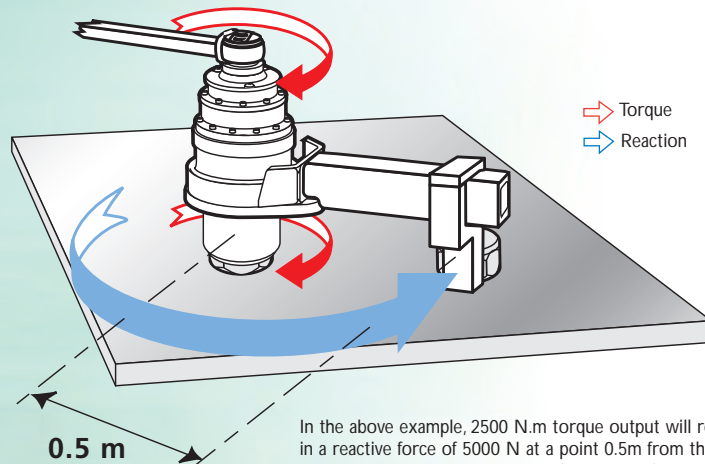
## Torque Reaction

### Principles of Torque Reaction

Newton's law dictates that for every applied force there is an equal and opposite reactive force. For applications requiring relatively low torques that can be applied with a torque wrench this does not present a problem as the reactive force is absorbed by the operator. However, if the desired torque necessitates the use of a multiplier, the resultant reactive force can only be absorbed using an appropriate reaction device.

For this reason all Norbar multipliers are supplied with a reaction plate or reaction foot fitted as standard.

All of the standard reaction plates and feet illustrated have been designed to enable the multiplier's use in a variety of environments but, due to an infinite number of bolting arrangements, it is impossible to have one reaction device that will satisfy every customer's requirement.



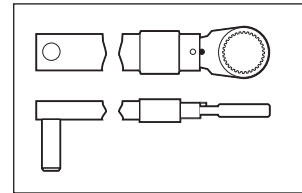
In the above example, 2500 N.m torque output will result in a reactive force of 5000 N at a point 0.5m from the axis of rotation or 2500 N at 1m (see page 63).

### What to do if the standard reaction device is not suitable

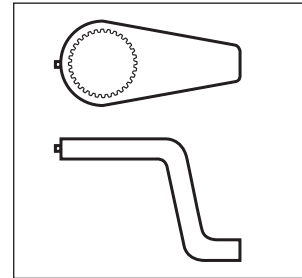
For those applications that do not permit the use of a standard reaction plate the customer has three options.

- Norbar or an authorised Norbar distributor will design and manufacture a special purpose reaction plate to the customer's requirements.
- The customer can modify the standard reaction plate to suit his requirements.
- The customer can fabricate his own reaction device after liaison with Norbar's technical department or a Norbar distributor.

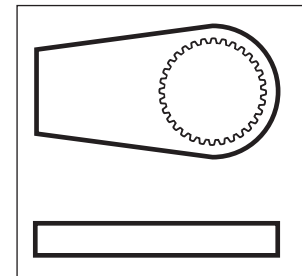
Customers wishing to either modify the original reaction plate or fabricate their own device should read the information on page 63 to avoid common torque reaction problems.



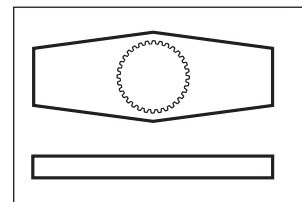
Optional on PTM-52 and PTM-72,  
Standard on PT72mm Series



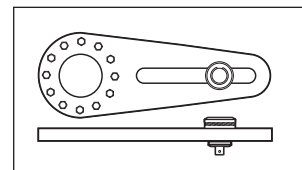
HT-52, HT-72, HT30/HT60,  
PT2700/PT5500, PTM-52, PTM-72



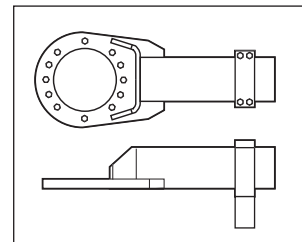
Optional Reaction Plate, 72mm  
Series



Optional Double Ended Reaction  
Plate, 72mm Series



Typical Reaction with sliding 'slave  
square', PT/HT1 to PT/HT5



Typical Reaction with adjustable  
reaction foot, PT/HT7 and PT/HT9

## Torque Reaction Avoiding Torque Reaction Problems

It has already been mentioned that the reaction force is equal to the force being applied. However, the magnitude of the reaction force is dependent upon the perpendicular distance between the point of reaction and the centre line of the multiplier, i.e. the greater the distance the lower the force.

For this reason the point of reaction should be kept as far away from the centre line of the gearbox as is practical.

Customers using or modifying reaction plates for Standard Series multipliers up to a capacity of 3400 N.m should note that if the reaction is taken on the radiused part, the reaction force is perpendicular to the tangent of the curve. Consequently, the further around the radius the reaction is taken, the smaller the perpendicular distance and therefore the greater the force.

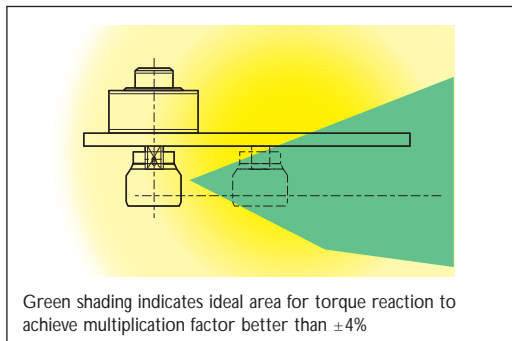
Although a longer reaction plate may mean lower forces, the bending moment close to the multiplier will increase.

Customers extending the length of Norbar's standard reaction plates should be aware that an increase in overall length will result in a larger induced bending stress and should not assume that because the reaction plate is strong enough at one length it will remain so when extended.

Excessive side loading, resulting from poor reaction, increases frictional forces inside the multiplier. This can lead to lower multiplication ratios (outside  $\pm 4\%$ ).

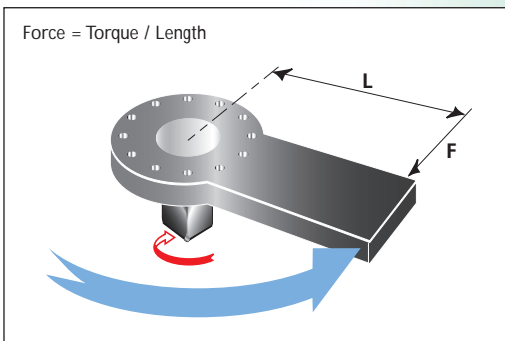
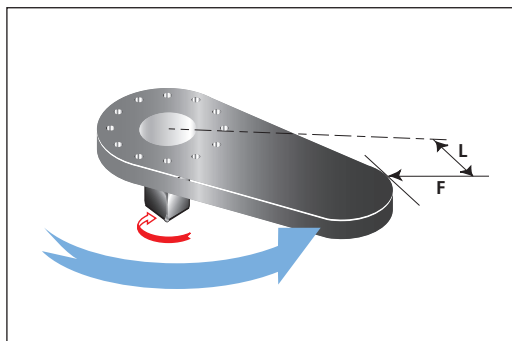


Signs of poor reaction are evident on this damaged foot. Reaction was taken at the wrong point on the foot and burring indicates that the foot was slipping off the reaction point.



### Points to remember

- Take the reaction as far away from the multiplier as practical.
- Ensure that the reaction point remains square to the multiplier wherever possible as this will minimise any additional stress in the output square, which could result in premature failure. If the multiplier tilts under load, the reaction may not be square.
- For applications that do not allow the reaction to be taken securely it is advisable to use a double ended or balanced reaction plate.



## Reaction Force

When using Multipliers and Pneutorques the reaction point must be capable of withstanding reaction force. Therefore, great care must be exercised where reaction is taken when applying high torques to studs and bolts.

By using the following formula you can calculate the force at the point of reaction. The greater the distance the lower the force.

$$\text{Formula to calculate Area of Stud} = \frac{\pi \times D^2}{4}$$

$$\text{Formula to calculate Shear Force: Shear Force} = \frac{\text{Reaction Force}}{\text{Area of Stud}}$$

## Advantages of the Norbar Handtorque System

Norbar gearboxes are built to an extremely high standard of precision. All gears rotate on needle roller bearings about hardened and ground journal pins. As a result, Norbar Handtorques can be relied upon to have a torque multiplication accuracy of  $\pm 4\%$ , throughout the operating range, taking the uncertainty out of high torque tightening.

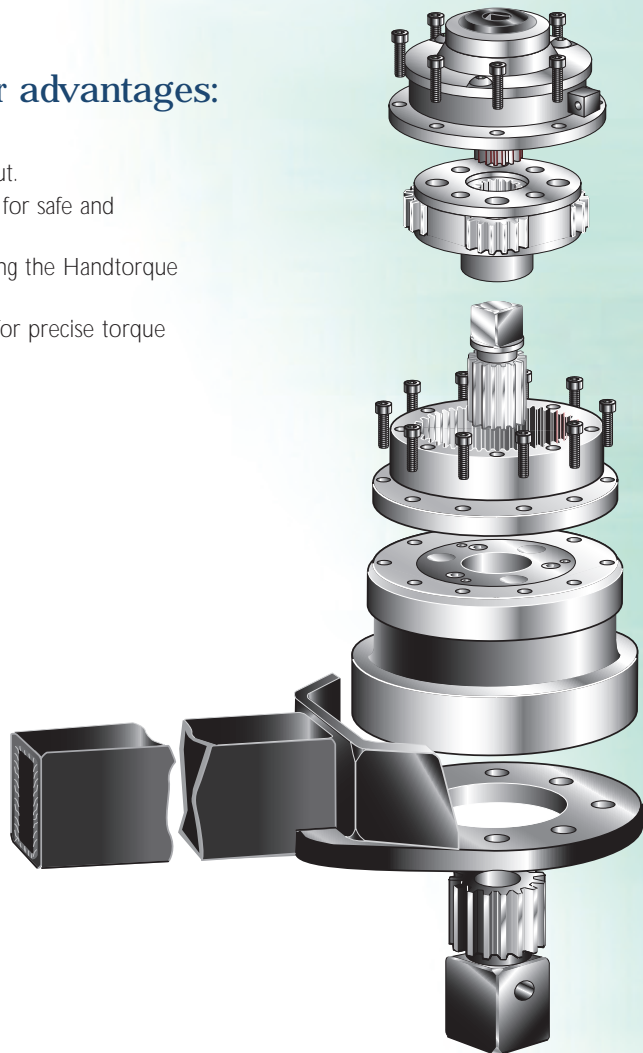
No gearbox is 100% efficient and so the velocity ratio (the number of turns that the input has to make to achieve one revolution of the output) is not the same as the torque multiplication ratio. Norbar multipliers are engineered such that each gear stage has a velocity ratio of typically 5.45:1 which results in a true torque multiplication factor of 5:1.

Torque output calculations are therefore a matter of simple arithmetic with little risk of incorrect bolt loading due to conversion errors. Other manufacturer's multipliers often require graphs or formulae to calculate the input torque to achieve a particular output.

The Norbar Handtorque is the most comprehensive multiplier range available. Standard products are available up to 47,500 N.m (35,000 lbf.ft) and 'specials' to 100,000 N.m (73,000 lbf.ft). A range of 'nose extensions' for reaching difficult to access bolts and a full range of torque transducers for highly accurate torque monitoring are available.

## Summary of Norbar torque multiplier advantages:

- The ratio stated is the true torque multiplication factor.
- No correction charts are needed to determine torque output.
- Strong, safe Anti Wind-Up Ratchet available on most models for safe and comfortable operation.
- A wide range of alternative reaction styles are available making the Handtorque adaptable to many applications.
- Electronic torque transducers are available on most models for precise torque control.



## HT3 Torque Multiplier

- 5:1 torque multiplication, accuracy guaranteed better than  $\pm 4\%$ .
- Supplied with two reaction bar styles for maximum versatility.
- Robust construction means minimal maintenance and long life.
- Supplied in a carrying case, the Highwayman is ideal for inclusion in the heavy vehicle tool kit.
- 1300 N.m version has a spare 3/4" output square included in the kit.
- Multiplier head only (no reaction bars or plastic box) also available. 1300 N.m version, part no. 17218. 2700 N.m version, part no. 17219.



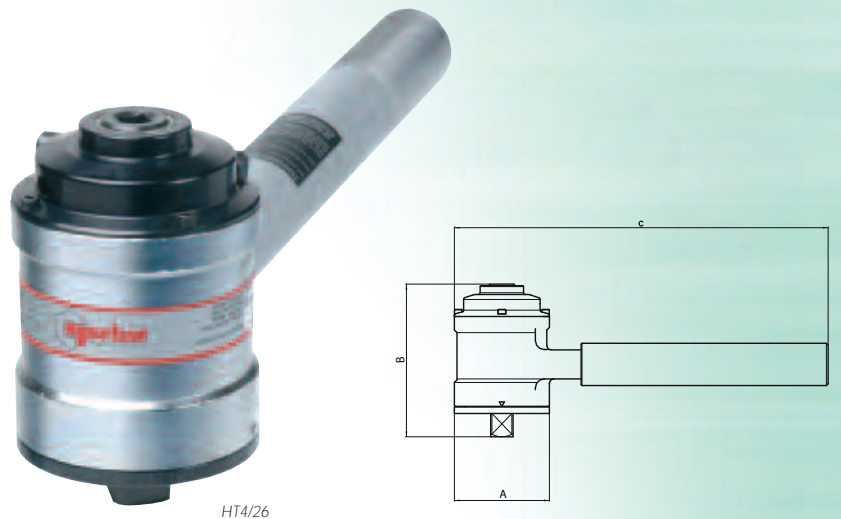
## HT3 Torque Multiplier

Model	Part No.	Range		Ratio	Input Square	Output Square	A	B	C	D	Tool Weight	Reaction Weight
		N.m	lbf.ft				in	mm	mm	mm		
HT3 1300 N.m Version Kit	17220	1300	960	5:1	½	¾	108	126	210	180	3.8	1.3
HT3 2700 N.m Version Kit	17221	2700	2000	5:1	¾	1	108	128	210	186	3.8	1.3

Weight of entire kit, 7.1kg.

## HT4 Torque Multiplier

- True 15.5:1 or 26:1 torque multiplication, accuracy guaranteed better than  $\pm 4\%$ .
- High ratios allow the use of a small torque wrench.
- Robust construction means minimal maintenance and long life.
- Supplied in carrying case with replacement square drive.
- Anti Wind-Up Ratchet (Anti Backlash) fitted to allow safer and more practical operation.
- Angle protractor for easy torque and angle tightening.



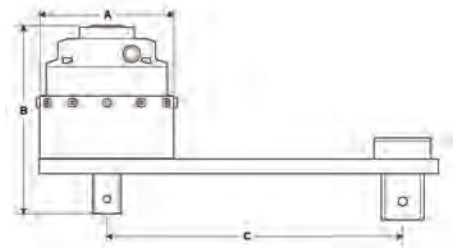
## HT4 Torque Multiplier

Model	Part No.	Range		Ratio	Input Square	Output Square	A	B	C	Tool Weight	Reaction Weight
		N.m	lbf.ft				in	in	mm		
HT4/15.5	17022	3000	2200	15.5:1	½	1	108	156	450	6.1	1.9
HT4/26	17021	4500	3300	26:1	½	1	108	173	450	7.0	1.9



## Handtorque™ Standard Series Models to 3400 N.m

- True torque multiplication guaranteed better than  $\pm 4\%$ .
- High ratios allow the use of a small torque wrench, multipliers can be used where access is limited.
- Anti Wind-Up Ratchet available on models of 25:1 ratio.
- Other reaction styles can be designed to suit specific applications.
- Electronic torque transducers can be fitted for precise torque monitoring. See page 83.



HT5/25



HT2/5

### Standard Series to 3400 N.m

Model	Part No.	Range		Ratio	Input Square	Output Square	A	B	C min	C max	Tool Weight	Reaction Weight
		N.m	lbf.ft									
1	16010	1700	1250	5:1	½	¾	108	106	83	217	3	2.2
2/5	16012	1700	1250	5:1	¾	1	108	126	83	217	3	2.2
2/25 Fitted with AWUR	16089	1700	1250	25:1	½	1	108	141.5	83	217	5.6	2.2
5/5	16014	3400	2500	5:1	¾	1	119	142.1	86	264	4.7	2.5
5/25 Fitted with AWUR	16090	3400	2500	25:1	½	1	119	167.6	86	264	7.5	2.5
6/5	16016	3400	2500	5:1	¾	1½	119	144.7	86	264	4.7	2.5
6/25 Fitted with AWUR	16092	3400	2500	25:1	½	1½	119	172	86	264	7.5	2.5

## Handtorque™ Standard Series Models to 47500 N.m

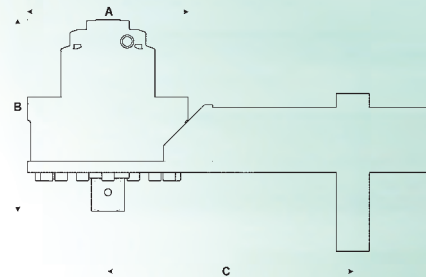
- True torque multiplication guaranteed better than  $\pm 4\%$ .
- High ratios allow the use of a small torque wrench, multipliers can be used where access is limited.
- Anti Wind-Up Ratchet available on models of 25:1 ratio and above.
- Electronic torque transducers can be fitted for precise torque monitoring. See page 83.
- Other models available up to 300,000 N.m.



HT13/125



HT9/125



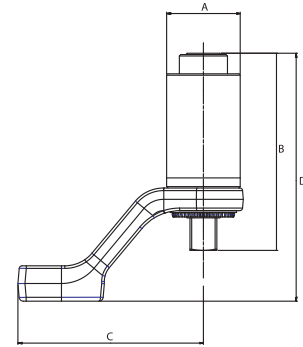
### Standard Series to 47500 N.m

Model	Part No.	Range		Ratio	Input Square		Output Square		A	B	C		Tool Weight	Reaction Weight
		N.m	lbf.ft		in	in	mm	mm			mm	mm		
7/5	16067	6000	4500	5:1	$\frac{3}{4}$	1 ½	144	174.8	146	333	8.1	6.3		
7/25 Fitted with AWUR	16065	6000	4500	25:1	$\frac{1}{2}$	1 ½	144	201.1	146	333	10.7	6.3		
7/25 Sm. Dia Fitted with AWUR	16095	6000	4500	25:1	$\frac{1}{2}$	1 ½	130	201.1	163.4	337	10.6	4.9		
7/125 Fitted with AWUR	16068	6000	4500	125:1	$\frac{1}{2}$	1 ½	144	226	146	333	12.2	6.3		
7/125 Sm. Dia Fitted with AWUR	16096	6000	4500	125:1	$\frac{1}{2}$	1 ½	130	226	163.4	337	12.1	4.9		
9/25 Fitted with AWUR	16070	9500	7000	25:1	$\frac{3}{4}$	1 ½	184	200.1	171	351	17.4	8.3		
9/125 Fitted with AWUR	16071	9500	7000	125:1	$\frac{1}{2}$	1 ½	184	220.1	171	351	18.9	8.3		
11/25	16082	20000	14700	25:1	$\frac{3}{4}$	2 ½	212	265.6	-	500	30.1	13.3		
11/125 Fitted with AWUR	16049	20000	14700	125:1	$\frac{1}{2}$	2 ½	212	293.4	-	500	32.1	13.3		
12/87.5 Fitted with AWUR	18085	34,000	25000	87.5:1	$\frac{3}{4}$	2 ½	240	337	-	-	41.5	6.5		
13/125 Fitted with AWUR	16053	47500	35000	125:1	$\frac{3}{4}$	2 ½	315	379	-	-	95.2	6.9		



## Handtorque™ HT-52 and HT-72 Series

- Compact dimensions allow excellent access and easy, safe handling.
- Guaranteed accuracy of better than  $\pm 4\%$ .
- Anti Wind-Up Ratchet available, for easier and safer operation.
- HT-72 features a light weight aluminium reaction arm.
- A variety of alternative reaction styles are available for maximum versatility.
- Electronic torque transducers can be fitted to the HT-72 for precise torque monitoring. See page 81.
- Available in a variety of ratios and output square drive sizes.



HT-52/22

HT-72/25

### HT-52 and HT-72 Series

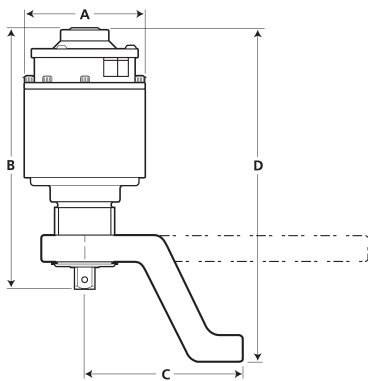
Model	Part No.	Range		Ratio	Input Square		A	B	C	D	Tool Weight	Reaction Weight
		N.m	lbf.ft		in	in						
HT-52/22	18051	1000	740	22:1	$\frac{3}{8}$	$\frac{3}{8}$	52	139	131	175	1.4	0.85
HT-52/22	18052	1000	740	22:1	$\frac{1}{2}$	$\frac{3}{8}$	52	139	131	175	1.4	0.85
HT-52/22 Fitted with AWUR	18083	1000	740	22:1	$\frac{3}{8}$	$\frac{3}{8}$	52	150.1	131	186.3	1.6	0.85
HT-52/22 Fitted with AWUR	18084	1000	740	22:1	$\frac{1}{2}$	$\frac{3}{8}$	52	150.1	131	186.3	1.6	0.85
HT-72/5	18014	1000	740	5:1	$\frac{1}{2}$	$\frac{3}{8}$	72	144	165	188	2.4	0.66
HT-72/5	18015	1500	1100	5:1	$\frac{1}{2}$	1	72	144	165	188	2.4	0.66
HT-72/5	18017	2000	1450	5:1	$\frac{3}{8}$	1	72	144	165	188	2.4	0.66
HT-72/25	18018	1000	740	25:1	$\frac{1}{2}$	$\frac{3}{8}$	72	165	165	188	2.7	0.66
HT-72/25	18019	2000	1450	25:1	$\frac{1}{2}$	1	72	165	165	188	2.7	0.66
HT-72/25 Fitted with AWUR	18081	1000	740	25:1	$\frac{1}{2}$	$\frac{3}{8}$	72	174	165	218	3.0	0.66
HT-72/25 Fitted with AWUR	18082	2000	1450	25:1	$\frac{1}{2}$	1	72	174	165	218	3.0	0.66



## Handtorque™ Small Diameter Series

Handtorque models HT30, 45 and 60 have all the features of the Standard Series, but have a higher torque output for a given gearbox diameter.

- Reduced diameter allows better access, particularly on pipe flanges.
- Reaction taken from high strength spline.
- Reaction foot can slide on the spline to allow for sockets of various lengths (except HT45).
- Anti Wind-Up Ratchet available on all models (except 5:1 ratios), allowing safer and more practical operation.
- HT45 has integral angle protractor for easy torque and angle tightening.



Alternative 350mm long, straight reaction plate; may be modified by customer to suit their applications.  
HT30 Part No. 16686  
HT45 and HT60 Part No. 16687



### Small Diameter Series

Model	Part No.	Range		Ratio	Input Square		A	B	C	D min	D max	Tool Weight	Reaction Weight
		N.m	lbf.ft		in	in							
30/5	18003	3000	2200	5:1	¾	1	108	190.4	141	223	251.4	5.0	2
30/15 Fitted with AWUR	18004	3000	2200	15:1	½	1	108	224	141	256	285	7.0	2
30/25 Fitted with AWUR	18006	3000	2200	25:1	½	1	108	224	141	256	285	7.0	2
45/26 Fitted with AWUR	18037	4500	3300	26:1	½	1	108*	224	175	-	318	8.7	4
60/25 Fitted with AWUR	18008	6000	4400	25:1	½	1½	119	271	154	320	351	10.6	4
60/125 Fitted with AWUR	18012	6000	4400	125:1	½	1½	119	301	172	350	381	12.1	4

\*Maximum width 140mm.