

TSG-310  
Rev. C

Mechanical Registers  
157 Registers  
600 Series Registers  
800 Series Registers  
Mechanical Calibrator Adapters  
Pulser Systems



# neptune Universal Change Gear Selection System

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## UNIVERSAL CHANGE GEAR SELECTION SYSTEM

This system identifies the exact procedures required for the proper calibration of Actaris Refined Fuel and Industrial flowmeters.

All Refined Fuel and Industrial flowmeters have means for calibrating the registration, whether the registration is a presettable register (i.e., Model 800 Series register), a resettable register (i.e., Model 600 Series register), a totalizer register (i.e., Model 157 register) or some type of pulser and pulse receiving system. The primary way to calibrate the registration is by using change gears. Change gears are used at a strategic point in the gear train of the flowmeter or in the register. Changing the number of teeth on the driving gear (denoting "S" or "SB") or changing the number of teeth on the driven gear (denoted "R") will change the overall reduction ratio of the mechanism and **increase** or **decrease** the rate of registration of the flowmeter in whatever form it may take.

The ratio of numbers of "R" teeth divided by the number of "S" teeth, or the R/S ratio, will affect the rate of registration such that **increasing** the R/S ratio will **decrease** the rate of registration.

### SYSTEM ASSUMPTIONS & GENERAL INFORMATION

- All Actaris flowmeters have R and S change gears operating on either 0.625 or 0.716 center distances
- The Universal Change Gear Chart is arranged in R/S ratio order
- A low test registration (below 100%) indicates the flowmeter requires speeding up
- A high test registration (above 100%) indicates the flowmeter requires slowing down
- Three configurations are available. Refer to last column in Chart I to determine configuration required and Gear Type Chart II for illustrations, page 4

### USING THE SYSTEM

1. Locate the change gears by referring to the appropriate O&M Manual for the flowmeter to be calibrated.
2. Determine the R/S ratio by dividing the number stamped on the R gear by the number stamped on the S gear.
3. Refer to the Universal Change Gear Chart and locate the calculated R/S ratio (from step #2).
4. To **increase** registration, select a new ratio and gears farther **up** the chart from the actual ratio.
5. To **decrease** registration, select a new ratio and gears farther **down** the chart from the actual ratio.
6. When sizable changes are required, **add** the values in the % difference column to determine the **total % change** obtained. **The % difference values are the step-to-step percent changes.**
7. The diameters from the R & S gear pair indicated on the chart are dependent on the change gear spacing. Notice the column headings for change gear spacing on the chart. Refer to Chart I for change gear spacing and gear locations.

**NOTE: Make sure the correct gears are placed on the correct spindle.**

### EXAMPLE

**Situation:** A flowmeter tests at 99.0%. It uses a Model 157 Register with a change gear spacing of 0.625. This flowmeter has the change gear combination of R=36 and S=28, which is equal to the R/S ratio of 1.2857.

**Objective:** To speed up registration to 100%.

**Solution:** **Step 1:** Determine the % change required (speed up) in order to obtain 100%.  
 $100.0\% \text{ (desired performance)} - 99.0\% \text{ (actual performance)} = +1.0\% \text{ (required change)}$

**Step 2:** Refer to the Universal Change Gear and locate the R/S ratio of '1.286'. The chart will show R=36 and S=28 (or  $36/28 = 1.2857$ )

**Step 3:** Use '1.2857' (R=36 and S=28) as your starting point (because it is the **present** change gear combination). Moving up the chart from '1.2857', add the % difference values necessary to reach 1.00% (1%).

**Step 4:** In this case, it is only necessary to move up two steps to find that .45% + .57% = 1.02%

**Step 5:** The new gears are R=28 and S=22 (R/S ratio = 1.2727). The R diameter = .770 and the S diameter = .570 for the .625 center spacing.

Changing the gears to R=28 and S=22 will produce the following:  
99.00% (actual performance) + .45% (% difference) + .57% (% difference) = 100.02% (desired performance)

**Step 6:** Refer to "Use Table" column in Chart I to determine if Type A Gears are required. Refer to Type A Gear Listing (pages 4 & 5) to determine the part number of gears that are required.

### OPTIONAL METHOD FOR DETERMINING CALIBRATION GEARS NEEDED

Use the following formula:

$$R/S \times A/B = \text{new change gear ratio}$$

Where:

R = current "R" gear on the flowmeter

S = current "S" gear on the flowmeter

A = percent registration you now get

B = percent registration you desire

Example: You have a meter with an R gear with 27 teeth and an S gear with 25 teeth. You have tested the meter and it consistently registers only 97%. After referring to the meter's O&M Manual, you should now attempt to recalibrate the meter since the register is consistent but not accurate.

$$(27/25) \times (97\%/100\%) = 2619/2500 = 1.0476$$

Using the Universal Change Gear Chart, look in the 'R/S Ratio' column for '1.0476'. The pair of gears corresponding to '1.0476' ratio are R22 and S21. Thus, replacing the 27 and 25 tooth gears with the 22 and 21 tooth gears will change the registration from 97% to 100%.

**NOTE: The above formula is applicable on all Actaris flowmeters that are calibrated using change gears.**

### PERCENT REGISTRATION

$$\frac{\text{Amount of Liquid Indicated by the Register}}{\text{Amount of Liquid Actually Delivered}} \times 100 = \text{Percent Registration}$$

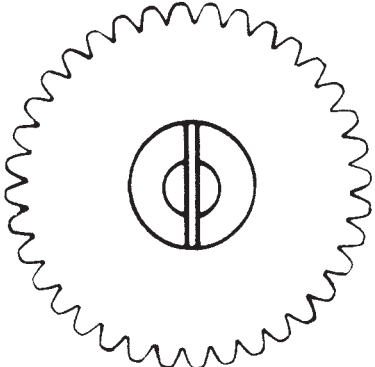
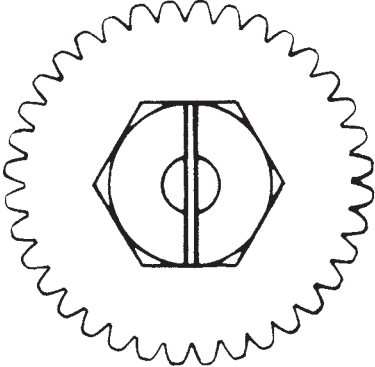
## CHART I CHANGE GEAR SELECTION

FLOWMETER TYPE	LOCATION OF CHANGE GEARS	*USE TABLE	**GEAR TYPE
All Flowmeters with Model 157 Registers	Below Register	I	A
Type MP Flowmeters with Non-Reset Registers	In Register	I	A
Type MP Flowmeters with Model 600 Series Registers	In Register	II	B
Type MP Flowmeters with Model 43 Pulser	In Gear Train	I	A
Trident Turbine with Non-Reset Totalizers	In Register	I	A
All flowmeters with Model 800 Series Registers	In Register	II	B
Non-Magnetic Drive Flowmeters w/ Model 600 Series Registers	In Register	II	B
Type S Magnetic Drive with Model 600 Series Registers	In Register	II	B

\* See the Universal Change Gear Chart for the Tables. Table I denotes .625 centers and Table II denotes .716 centers.

\*\* See Chart II for Gear Type illustration and gear type listing specified for part number.

## CHART II GEAR TYPES

	
<p>TYPE A: ROUND HUB, NO SET SCREW (.270 THROUGH 1.256 DIA.)</p> <p>NON-RESET REGISTER</p>	<p>TYPE B: HEX HUB, NO SET SCREW (.670, .685, .770, .860 DIA.)</p> <p>600 &amp; 800 REGISTER</p>

**TYPE "A" GEARS (ROUND HUB, NO SET SCREW)**

<b>Number of Teeth</b>	<b>Diameter</b>	<b>Part Number</b>	<b>Number of Teeth</b>	<b>Diameter</b>	<b>Part Number</b>
10	0.270	01031-000	32	0.670	01066-000
11	0.270	01032-000	33	0.670	01069-000
12	0.270	01031-001	34	0.670	03319-000
12	0.312	03237-000	35	0.670	03325-000
13	0.312	01034-000	36	0.670	03331-000
14	0.312	01035-000	18	0.685	03259-000
15	0.312	01036-000	19	0.685	03267-000
11	0.354	03239-001	20	0.685	03273-000
12	0.354	03239-000	21	0.685	03279-000
13	0.354	03241-000	18	0.770	03261-000
14	0.354	03243-000	19	0.770	03269-000
15	0.354	03245-000	20	0.770	03275-000
15	0.375	03247-000	21	0.770	03281-000
16	0.375	01038-000	22	0.770	03287-000
17	0.375	03253-000	23	0.770	03295-000
18	0.375	03255-000	24	0.770	03299-000
19	0.375	03263-000	25	0.770	03301-000
15	0.426	03249-000	26	0.770	03305-000
16	0.426	03251-000	27	0.770	01060-000
17	0.426	01039-000	28	0.770	01062-000
18	0.426	01040-000	29	0.770	03309-000
19	0.426	01043-000	30	0.770	03311-000
15	0.460	81482-000	31	0.770	03313-000
16	0.460	87392-000	32	0.770	01067-000
17	0.460	81483-000	33	0.770	01068-000
18	0.460	01041-000	34	0.770	01070-000
19	0.460	01044-000	35	0.770	01071-000
20	0.460	01047-000	36	0.770	01072-000
21	0.460	01048-000	37	0.770	01073-000
22	0.460	01049-000	38	0.770	03343-000
23	0.460	03289-000	39	0.770	81489-000
24	0.460	03297-000	29	0.860	81491-000
12	0.480	49872-000	30	0.860	N/A
15	0.520	81484-000	31	0.860	81509-000
17	0.520	81485-000	32	0.860	03315-000
18	0.520	03257-000	33	0.860	03317-000
19	0.520	03265-000	34	0.860	03321-000
20	0.520	03271-000	35	0.860	03327-000
21	0.520	03277-000	36	0.860	03333-000
22	0.520	01050-000	37	0.860	01074-000
23	0.520	01051-000	38	0.860	01076-000
24	0.520	01052-000	39	0.860	01077-000
21	0.570	81487-000	40	0.860	01079-000
22	0.570	03283-000	41	0.860	01080-000
23	0.570	03291-000	42	0.860	01081-000
24	0.570	01053-000	43	0.860	01082-000
25	0.570	01055-000	44	0.860	01083-000
26	0.570	01057-000	25	0.925	49869-000
27	0.570	01058-000	34	0.958	03323-000
28	0.570	03307-000	35	0.958	03329-000
22	0.670	03285-000	36	0.958	03335-000
23	0.670	03293-000	37	0.958	03339-000
24	0.670	01054-000	38	0.958	03345-000
25	0.670	01056-000	39	0.958	03791-000
26	0.670	03303-000	40	0.958	03793-000
27	0.670	01059-000	41	0.958	03353-000
28	0.670	01061-000	42	0.958	03474-000
29	0.670	01063-000	43	0.958	03480-000
30	0.670	01064-000	44	0.958	01084-000
31	0.670	01065-000	45	0.958	01087-000

**TYPE "A" GEARS (ROUND HUB, NO SET SCREW)**

<b>Number of Teeth</b>	<b>Diameter</b>	<b>Part Number</b>	<b>Number of Teeth</b>	<b>Diameter</b>	<b>Part Number</b>
46	0.958	03496-000	55	1.056	03556-000
47	0.958	03506-000	56	1.056	01109-000
48	0.958	03516-000	34	1.080	N/A
49	0.958	03795-000	41	1.096	03472-000
50	0.958	03526-000	42	1.096	03478-000
51	0.958	03534-000	43	1.096	03484-000
29	1.007	81495-000	44	1.096	03486-000
32	1.007	81497-000	45	1.096	03490-000
35	1.007	81499-000	46	1.096	03500-000
36	1.007	03337-000	47	1.096	03510-000
37	1.007	03341-000	48	1.096	03518-000
38	1.007	03347-000	49	1.096	03799-000
39	1.007	03349-000	50	1.096	03528-000
40	1.007	03351-000	51	1.096	03538-000
41	1.007	03355-000	44	1.166	N/A
42	1.007	03476-000	45	1.166	03492-000
43	1.007	03482-000	46	1.166	03502-000
44	1.007	01085-000	47	1.166	03512-000
45	1.007	01088-000	48	1.166	03520-000
46	1.007	01089-000	49	1.166	03522-000
47	1.007	01090-000	50	1.166	03530-000
48	1.007	01091-000	51	1.166	03540-000
49	1.007	01094-000	52	1.166	03546-000
50	1.007	01096-000	53	1.166	01103-000
51	1.007	03536-000	45	1.256	03494-000
52	1.007	03544-000	46	1.256	03504-000
53	1.007	03550-000	47	1.256	03514-000
45	1.056	03488-000	48	1.256	N/A
46	1.056	03498-000	49	1.256	03524-000
47	1.056	03508-000	50	1.256	03532-000
48	1.056	03797-000	51	1.256	03542-000
49	1.056	01095-000	52	1.256	03548-000
50	1.056	01097-000	53	1.256	03552-000
51	1.056	01098-000	54	1.256	03554-000
52	1.056	N/A	55	1.256	03558-000
53	1.056	01101-000			
54	1.056	01105-000			

**TYPE "B" GEARS (HEX HUB, NO SET SCREW)**

<b>Number of Teeth</b>	<b>Diameter</b>	<b>Part Number</b>	<b>Number of Teeth</b>	<b>Diameter</b>	<b>Part Number</b>
22	0.670	82895-022	29	0.770	81230-029
23	0.670	82895-023	30	0.770	81230-030
24	0.670	82895-024	31	0.770	81230-031
25	0.670	82895-025	32	0.770	81230-032
26	0.670	82895-026	33	0.770	81230-033
27	0.670	82895-027	34	0.770	81230-034
28	0.670	82895-028	35	0.770	81230-035
21	0.685	82897-021	36	0.770	81230-036
18	0.770	81230-018	29	0.860	82899-029
19	0.770	81230-019	31	0.860	82899-031
20	0.770	81230-020	32	0.860	82899-032
21	0.770	81230-021	33	0.860	82899-033
22	0.770	81230-022	34	0.860	82899-034
23	0.770	81230-023	35	0.860	82899-035
24	0.770	81230-024	36	0.860	82899-036
25	0.770	81230-025	37	0.860	82899-037
26	0.770	81230-026	38	0.860	82899-038
27	0.770	81230-027	39	0.860	82899-039
28	0.770	81230-028			

## UNIVERSAL CHANGE GEAR CHART

R/S Ratio	R	S	% Dif	TABLE I		TABLE II	
				R Dia	S Dia	R Dia	S Dia
.1818	10	55	1.87	.270	1.056	.270	1.256
.1852	10	54	1.89	.270	1.056	.270	1.256
.1887	10	53	1.91	.270	1.056	.270	1.256
.1923	10	52	1.98	.270	1.056	.270	1.256
.1961	10	51	1.99	.270	1.056	.270	1.256
.2000	10	50	1.85	.270	1.056	.270	1.256
.2037	11	54	.20	.270	1.056	.270	1.256
.2041	10	49	1.67	.270	1.056	.270	1.256
.2075	11	53	.39	.270	1.056	.270	1.256
.2083	10	48	1.54	.270	1.056	.270	1.256
.2115	11	52	.61	.270	1.056	.270	1.256
.2128	10	47	1.36	.270	1.056	.270	1.256
.2157	11	51	.79	.270	1.056	.270	1.256
.2174	10	46	1.20	.270	1.056	.270	1.256
.2200	11	50	1.00	.270	1.056	.270	1.256
.2222	10	45	1.04	.270	1.056	.270	1.256
.2245	11	49	.85	.270	1.056	.270	1.256
.2264	12	53	1.24	.270	1.056	.270	1.256
.2292	11	48	.70	.270	1.056	.270	1.256
.2308	12	52	1.39	.270	1.056	.270	1.256
.2340	11	47	.56	.270	1.056	.270	1.256
.2353	12	51	1.61	.270	1.056	.354	1.166
.2391	11	46	.38	.270	1.056	.354	1.166
.2400	12	50	1.83	.270	1.056	.354	1.166
.2444	11	45	.20	.270	1.056	.354	1.166
.2449	12	49	.16	.312	1.007	.354	1.166
.2453	13	53	1.92	.312	1.007	.354	1.166
.2500	13	52	1.96	.312	1.007	.354	1.166
.2549	13	51	.16	.312	1.007	.354	1.166
.2553	12	47	1.84	.312	1.007	.354	1.166
.2600	13	50	.35	.312	1.007	.354	1.166
.2609	12	46	1.69	.312	1.007	.354	1.166
.2653	13	49	.53	.312	1.007	.354	1.166
.2667	12	45	.94	.312	1.007	.354	1.166
.2692	14	52	.60	.312	1.007	.354	1.166
.2708	13	48	.70	.312	1.007	.354	1.166
.2727	12	44	.66	.312	1.007	.354	1.166
.2745	14	51	.77	.312	1.007	.354	1.166
.2766	13	47	1.23	.312	1.007	.354	1.166
.2800	14	50	.93	.312	1.007	.354	1.166
.2826	13	46	1.10	.312	1.007	.354	1.166
.2857	14	49	.98	.312	1.007	.354	1.166
.2885	15	52	.14	.312	1.007	.354	1.166
.2889	13	45	.97	.312	1.007	.354	1.166
.2917	14	48	.82	.312	1.007	.354	1.166
.2941	15	51	1.29	.312	1.007	.354	1.166
.2979	14	47	.70	.312	1.007	.354	1.166
.3000	15	50	1.43	.312	1.007	.354	1.166
.3043	14	46	.59	.312	1.007	.354	1.166
.3061	15	49	1.63	.312	1.007	.354	1.166
.3111	14	45	.45	.312	1.007	.354	1.166
.3125	15	48	.38	.312	1.007	.354	1.166
.3137	16	51	1.72	.375	.958	.426	1.096
.3191	15	47	.28	.375	.958	.426	1.096
.3200	16	50	1.91	.375	.958	.426	1.096
.3261	15	46	2.21	.375	.958	.426	1.096
.3333	15	45	2.13	.375	.958	.426	1.096
.3404	16	47	.15	.375	.958	.426	1.096
.3409	15	44	1.76	.375	.958	.426	1.096
.3469	17	49	.26	.375	.958	.426	1.096

R/S Ratio	R	S	% Dif	TABLE I		TABLE II	
				R Dia	S Dia	R Dia	S Dia
.3478	16	46	.29	.375	.958	.426	1.096
.3488	15	43	.34	.375	.9581	.426	1.096
.3500	14	40	.40	.312	1.007		
.3514	13	37	.43	.312	1.007		
.3529	18	51	.37	.375	.958	.426	1.096
.3542	17	48	.40	.375	.958	.426	1.096
.3556	16	45	.42	.375	.958	.426	1.096
.3571	15	42	.53	.375	.958	.426	1.096
.3590	14	39	.28	.312	1.007		
.3600	18	50	.47	.375	.958	.426	1.096
.3617	17	47	.53	.375	.958	.426	1.096
.3636	16	44	.63	.375	.958	.426	1.096
.3659	15	41	.38	.375	.958	.426	1.096
.3673	18	49	.63	.375	.958	.426	1.096
.3696	17	46	.68	.375	.958	.426	1.096
.3721	16	43	.78	.375	.958	.426	1.096
.3750	18	48	.75	.375	.958	.426	1.096
.3778	17	45	.58	.375	.958	.426	1.096
.3800	19	50	.26	.375	.958	.426	1.096
.3810	16	42	.52	.375	.958	.426	1.096
.3830	18	47	.42	.375	.958	.426	1.096
.3846	15	39	.47	.375	.958		
.3864	7	44	.36	.375	.958	.426	1.096
.3878	19	49	.62	.375	.958	.426	1.096
.3902	16	41	.28	.375	.958	.426	1.096
.3913	18	46	.87	.375	.958	.426	1.096
.3947	15	38	.28	.375	.958		
.3958	19	48	1.06	.375	.958	.426	1.096
.4000	18	45	1.08	.375	.958	.426	1.096
.4043	19	47	.27	.375	.958	.426	1.096
.4054	15	37	.91	.375	.958		
.4091	18	44	.29	.375	.958	.426	1.096
.4103	16	39	.66	.375	.958		
.4130	19	46	.39	.375	.958	.426	1.096
.4146	17	41	.51	.375	.958	.426	1.096
.4167	15	36	.46	.375	.958		
.4186	18	43	.60	.375	.958	.426	1.096
.4211	16	38	.26	.375	.958		
.4222	19	45	.66	.375	.958	.426	1.096
.4250	17	40	.85	.375	.958		
.4286	18	42	.75	.375	.958	.426	1.096
.4318	19	44	.14	.375	.958	.426	1.096
.4324	16	37	.81	.375	.958		
.4359	17	39	.71	.375	.958		
.4390	18	41	.50	.375	.958	.426	1.096
.4412	15	34	.16	.460	.860		
.4419	19	43	.57	.460	.860	.426	1.096
.4444	16	36	.68	.460	.860		
.4474	17	38	.58	.460	.860	.520	1.007
.4500	18	40	.53	.460	.860	.520	1.007
.4524	19	42	.46	.460	.860	.520	1.007
.4545	20	44	.00	.460	.860	.520	1.007
.4545	15	33	.57	.460	.860		
.4571	16	35	.53	.460	.860		
.4595	17	37	.44	.460	.860		
.4615	18	39	.41	.460	.860	.520	1.007
.4634	19	41	.37	.460	.860	.520	1.007
.4651	20	43	.80	.460	.860	.520	1.007
.4688	15	32	.38	.460	.860	.520	1.007
.4706	16	34	.34	.460	.860		

## UNIVERSAL CHANGE GEAR CHART

R/S Ratio	R	S	% Dif	TABLE I		TABLE II	
				R Dia	S Dia	R Dia	S Dia
.4722	17	36	.32	.460	.860		
.4737	18	38	.27	.460	.860	.520	1.007
.4750	19	40	.25	.460	.860	.520	1.007
.4762	20	42	.23	.460	.860	.520	1.007
.4773	21	44	.57	.460	.860	.520	1.007
.4800	12	25	.00	.480	.925		
.4800	24	50	.81			.520	1.007
.4839	15	31	.37	.460	.860		
.4857	17	35	.16	.460	.860		
.4865	18	37	.14	.460	.860	.520	1.007
.4872	19	39	.25	.460	.860	.520	1.007
.4884	21	43	2.38	.460	.860	.520	1.007
.5000	22	44	2.32	.460	.860	.520	1.007
.5116	22	43	.12	.460	.860	.520	1.007
.5122	21	41	.25	.460	.860	.520	1.007
.5135	19	37	.33	.460	.860	.520	1.007
.5152	17	33	.39	.460	.860		
.5172	15	29	1.06	.460	.860	.520	1.007
.5227	23	44	.21	.460	.860	.520	1.007
.5238	22	42	.23	.460	.860	.520	1.007
.5250	21	40	.25	.460	.860		
.5263	20	38	.29	.460	.860	.520	1.007
.5278	19	36	.30	.460	.860		
.5294	18	34	.36	.460	.860		
.5313	17	32	.38	.460	.860	.520	1.007
.5333	16	30	.30	.460	.860	.520	1.007
.5349	23	43	.32	.460	.860	.520	1.007
.5366	22	41	.35	.460	.860	.520	1.007
.5385	21	39	.37	.460	.860	.520	1.007
.5405	20	37	.44	.460	.860	.520	1.007
.5429	19	35	.48	.460	.860	.520	1.007
.5455	24	44	.38	.460	.860	.520	1.007
.5476	23	42	.44	.460	.860		
.5500	22	40	.47	.460	.860	.520	1.007
.5526	21	38	.54	.460	.860	.520	1.007
.5556	20	36	.45	.460	.860	.520	1.007
.5581	24	43	.52	.460	.860		
.5610	23	41	.55	.460	.860	.520	1.007
.5641	22	39	.62	.460	.860	.520	1.007
.5676	21	37	.67	.460	.860	.520	1.007
.5714	20	35	.63	.460	.860		
.5750	23	40	.68	.460	.860	.520	1.007
.5789	22	38	.29	.460	.860	.520	1.007
.5806	18	31	.47	.460	.860		
.5833	21	36	.36	.460	.860	.520	1.007
.5854	24	41	.48	.460	.860		
.5882	20	34	.26	.460	.860		
.5897	23	39	.70	.460	.860	.570	.958
.5938	19	32	.13	.460	.860		
.5946	22	37	.91	.460	.860	.570	.958
.6000	24	40	.88	.460	.860	.570	.958
.6053	23	38	.13	.460	.860	.570	.958
.6061	20	33	.82	.460	.860		
.6111	22	36	.29	.460	.860	.570	.958
.6129	19	31	.77	.460	.860		
.6176	21	34	.50	.460	.860		
.6207	18	29	.14	.460	.860		
.6216	23	37	.00	.460	.860		
.6216	23	37	.55	.570	.770	.570	.958
.6250	20	32	.58	.460	.860		

R/S Ratio	R	S	% Dif	TABLE I		TABLE II	
				R Dia	S Dia	R Dia	S Dia
.6286	22	35	.48	.570	.770	.570	.958
.6316	24	38	.27	.570	.770	.570	.958
.6333	19	30	.88	.460	.860		
.6389	23	36	.99	.570	.770	.570	.958
.6452	20	31	.29	.460	.860		
.6471	22	34	.23	.570	.770	.570	.958
.6486	24	37	1.19	.570	.770	.570	.958
.6563	21	32	.12	.570	.770		
.6571	23	35	.12	.570	.770	.570	.958
.6579	25	38	1.34	.570	.770	.570	.958
.6667	24	36	1.35	.570	.770	.570	.958
.6757	25	37	.12	.570	.770	.670	.860
.6765	23	34	.13	.570	.770	.670	.860
.6774	21	31	1.00	.570	.770	.685	.860
.6842	26	38	.22	.570	.770	.670	.860
.6857	24	35	.26	.570	.770	.670	.860
.6875	22	32	.70	.570	.770	.670	.860
.6923	27	39	.30	.570	.770		
.6944	25	36	.37	.570	.770	.670	.860
.6970	23	33	.43	.570	.770	.670	.860
.7000	21	30	.39	.570	.770		
.7027	26	37	.46	.570	.770	.670	.860
.7059	24	34	.65	.570	.770	.670	.860
.7105	27	38	.53	.570	.770	.670	.860
.7143	25	35	.50	.570	.770	.670	.860
.7179	28	39	.13	.570	.770	.670	.860
.7188	23	32	.47	.570	.770	.670	.860
.7222	26	36	.26	.570	.770	.670	.860
.7241	21	29	.44	.570	.770	.685	.860
.7273	24	33	.33	.570	.770	.670	.860
.7297	27	37	.77	.570	.770	.670	.860
.7353	25	34	.20	.570	.770	.670	.860
.7368	28	38	.83	.570	.770	.670	.860
.7429	26	35	.96	.570	.770	.670	.860
.7500	24	32	.91	.570	.770	.670	.860
.7568	28	37	.11	.570	.770	.670	.860
.7576	25	33	.13	.570	.770	.670	.860
.7586	22	29	.80	.570	.770		
.7647	26	34	.26	.570	.770	.670	.860
.7667	23	30	.61	.570	.770		
.7714	27	35	.36	.570	.770	.670	.860
.7742	24	31	.46	.570	.770		
.7778	28	36	.45	.570	.770	.670	.860
.7813	25	32	.56	.570	.770	.670	.860
.7857	22	28	.28	.570	.770		
.7879	26	33	.79	.570	.770	.670	.860
.7941	27	34	.74	.570	.770	.670	.860
.8000	28	35	.81	.570	.770	.670	.860
.8065	25	31	.15	.570	.770		
.8077	21	26	.59	.570	.770		
.8125	26	32	.28	.570	.770	.670	.860
.8148	22	27	.42	.570	.770		
.8182	27	33	.39	.570	.770	.670	.860
.8214	23	28	.26	.570	.770		
.8235	28	34	.50	.570	.770	.670	.860
.8276	24	29	1.34	.570	.770		
.8387	26	31	.61	.570	.770	.770	.770
.8438	27	32	.28	.570	.770	.670	.860
.8462	22	26	.27	.570	.770	.770	.770
.8485	28	33	.00	.570	.770		

## UNIVERSAL CHANGE GEAR CHART

R/S Ratio	R	S	% Dif	TABLE I		TABLE II	
				R Dia	S Dia	R Dia	S Dia
.8485	28	33	.52	.670	.670	—	—
.8529	29	34	1.08	.670	.670	.770	.770
.8621	25	29	.53	.670	.670	.770	.770
.8667	26	30	.50	.670	.670	.770	.770
.8710	27	31	.46	.670	.670	.770	.770
.8750	28	32	.43	.670	.670	.770	.770
.8788	29	33	.41	.670	.670	.770	.770
.8824	30	34	.37	.670	.670	.770	.770
.8857	31	35	.36	.670	.670	.770	.770
.8889	24	27	.45	.670	.670	.770	.770
.8929	25	28	.41	.670	.670	.770	.770
.8966	26	29	.38	.670	.670	.770	.770
.9000	27	30	.36	.670	.670	.770	.770
.9032	28	31	.34	.670	.670	.770	.770
.9063	29	32	.31	.670	.670	.770	.770
.9091	30	33	.30	.670	.670	.770	.770
.9118	31	34	.27	.670	.670		
.9143	32	35	.26	.670	.670	.770	.770
.9167	22	24	.36	.670	.670		
.9200	23	25	.34	.670	.670	.770	.770
.9231	24	26	.30	.670	.670	.770	.770
.9259	25	27	.29	.670	.670	.770	.770
.9286	26	28	.26	.670	.670	.770	.770
.9310	27	29	.25	.670	.670	.770	.770
.9333	28	30	.24	.670	.670	.770	.770
.9355	29	31	.21	.670	.670	.770	.770
.9375	30	32	.20	.670	.670	.770	.770
.9394	31	33	.18	.670	.670	.770	.770
.9411	32	34	.19	.670	.670	.770	.770
.9429	33	35	.16	.670	.670	.770	.770
.9444	34	36	.32	.670	.670	.770	.770
.9474	18	19	.27	.685	.685	.770	.770
.9500	19	20	.25	.685	.685	.770	.770
.9524	20	21	.22	.685	.685	.770	.770
.9545	21	22	.21	.685	.670	.770	.770
.9565	22	23	.19	.670	.670	.770	.770
.9583	23	24	.18	.670	.670	.770	.770
.9600	24	25	.16	.670	.670	.770	.770
.9615	25	26	.16	.670	.670	.770	.770
.9630	26	27	.13	.670	.670	.770	.770
.9643	27	28	.12	.670	.670	.770	.770
.9655	28	29	.12	.670	.670	.770	.770
.9667	29	30	.10	.670	.670	.770	.770
.9677	30	31	.21	.670	.670	.770	.770
.9697	32	33	.26	.670	.670	.770	.770
.9722	35	36	2.86	.670	.670	.770	.770
1.0000	33	33	2.86	.670	.670	.770	.770
1.0286	36	35	.26	.670	.670	.770	.770
1.0313	33	32	.19	.670	.670	.770	.770
1.0333	31	30	.12	.670	.670	.770	.770
1.0345	30	29	.12	.670	.670	.770	.770
1.0357	29	28	.13	.670	.670	.770	.770
1.0370	28	27	.14	.670	.670	.770	.770
1.0385	27	26	.14	.670	.670	.770	.770
1.0400	26	25	.16	.670	.670	.770	.770
1.0417	25	24	.17	.670	.670	.770	.770
1.0435	24	23	.19	.670	.670	.770	.770
1.0455	23	22	.20	.670	.670	.770	.770
1.0476	22	21	.23	.670	.685	.770	.770
1.0500	21	20	.25	.685	.685	.770	.770

R/S Ratio	R	S	% Dif	TABLE I		TABLE II	
				R Dia	S Dia	R Dia	S Dia
1.0526	20	19	.29	.685	.685	.770	.770
1.0556	19	18	.30	.685	.685	.770	.770
1.0588	36	34	.17	.670	.670	.770	.770
1.0606	35	33	.18	.670	.670	.770	.770
1.0625	34	32	.19	.670	.670	.770	.770
1.0645	33	31	.21	.670	.670	.770	.770
1.0667	32	30	.22	.670	.670	.770	.770
1.0690	31	29	.22	.670	.670	.770	.770
1.0714	30	28	.25	.670	.670	.770	.770
1.0741	29	27	.26	.670	.670	.770	.770
1.0769	28	26	.29	.670	.670	.770	.770
1.0800	27	25	.31	.670	.670	.770	.770
1.0833	26	24	.34	.670	.670	.770	.770
1.0870	25	23	.36	.670	.670	.770	.770
1.0909	24	22	.27	.670	.670		
1.0938	35	32	.27	.670	.670	.770	.770
1.0968	34	31	.29	.670	.670		
1.1000	33	30	.31	.670	.670	.770	.770
1.1034	32	29	.34	.670	.670	.770	.770
1.1071	31	28	.36	.670	.670	.770	.770
1.1111	30	27	.39	.670	.670	.770	.770
1.1154	39	26	.41	.670	.670	.770	.770
1.1200	28	25	.45	.670	.670	.770	.770
1.1250	27	24	.36	.670	.670	.770	.770
1.1290	35	31	.38	.670	.670	.770	.770
1.1333	34	30	.41	.670	.670	.770	.770
1.1379	33	29	.44	.670	.670	.770	.770
1.1429	32	28	.45	.670	.670	.770	.770
1.1481	31	27	.50	.670	.670	.770	.770
1.1538	30	26	.54	.670	.670	.770	.770
1.1600	29	25	1.07	.670	.670	.770	.770
1.1724	34	29	.53	.670	.670	.770	.770
1.1786	33	28	0	.770	.570	.770	.770
1.1786	33	28	.27	.770	.570		
1.1818	26	22	.29	.770	.570	.770	.770
1.1852	32	27	.60	.770	.570		
1.1923	31	26	1.34	.770	.570	.770	.770
1.2083	29	24	.50	.770	.570		
1.2143	34	28	.26	.770	.570	.860	.670
1.2174	28	23	.39	.770	.570		
1.2222	33	27	.42	.770	.570	.860	.670
1.2273	27	22	.29	.770	.570		
1.2308	32	26	.59	.770	.570	.860	.670
1.2381	26	21	.15	.770	.570		
1.2400	31	25	.81	.770	.570		
1.2500	35	28	.74	.770	.570	.860	.670
1.2593	34	27	.79	.770	.570	.860	.670
1.2692	33	26	.28	.770	.570	.860	.670
1.2727	28	22	.57	.770	.570		
1.2800	32	25	.45	.770	.570	.860	.670
1.2857	36	28	.47	.770	.570	.860	.670
1.2917	31	24	.36	.770	.570		
1.2963	35	27	.62	.770	.570	.860	.670
1.3043	30	23	.26	.770	.570		
1.3077	34	26	.80	.770	.570	.860	.670
1.3182	29	22	.14	.770	.570		
1.3200	33	25	.11	.770	.570	.860	.670
1.3214	37	28	.90	.770	.570	.860	.670
1.3333	32	24	.97	.770	.570	.860	.670

## UNIVERSAL CHANGE GEAR CHART

R/S Ratio	R	S	% Dif	TABLE I		TABLE II	
				R Dia	S Dia	R Dia	S Dia
1.3462	35	26	.81	.770	.570	.860	.670
1.3571	38	28	.21	.770	.570	.860	.670
1.3600	34	25	.76	.770	.570	.860	.670
1.3704	37	27	.34	.770	.570	.860	.670
1.3750	33	24	.44	.770	.570	.860	.670
1.3810	29	21	.26	.770	.570	.860	.685
1.3846	36	26	.48	.770	.570	.860	.670
1.3913	32	23	.12	.770	.570	.860	.670
1.3929	39	28	.51	.770	.570	.860	.670
1.4000	35	25	.53	.770	.570	.860	.670
1.4074	38	27	.66	.770	.570	.860	.670
1.4167	34	24	.45	.770	.570	.860	.670
1.4231	37	26	.39	.770	.570	.860	.670
1.4286	30	21	.43	.770	.570		
1.4348	33	23	.36	.770	.570	.860	.670
1.4400	36	25	.31	.770	.570	.860	.670
1.4444	39	27	.70	.770	.570		
1.4545	32	22	.26	.770	.570	.860	.670
1.4583	35	24	.22	.770	.570	.860	.670
1.4615	38	26	1.01	.770	.570	.860	.670
1.4762	31	21	.14	.770	.570		
1.4783	34	23	.11	.770	.570	.860	.670
1.4800	37	25	1.35	.770	.570	.860	.670
1.5000	36	24	1.33	.770	.570	.958	.570
1.5200	38	25	.11	.770	.570	.958	.570
1.5217	35	23	.14	.770	.570	.958	.570
1.5238	32	21	1.17	.770	.570		
1.5417	37	24	.25	.770	.570	.958	.570
1.5455	34	22	.29	.770	.570	.958	.570
1.5500	31	20	.98	.860	.460		
1.5652	36	23	0	.770	.570	.958	.570
1.5652	36	23	.88	.860	.460		
1.5789	30	19	.28	.860	.460		
1.5833	38	24	.48	.770	.570	.958	.570
1.5909	35	22	.57	.770	.570	.958	.570
1.6000	32	20	.54	.860	.460		
1.6087	37	23	0	.770	.570	.958	.570
1.6087	37	23	.15	.860	.460		
1.6111	29	18	.49	.860	.460		
1.6190	34	21	.78	.860	.460		
1.6316	31	19	.29	.860	.460		
1.6364	36	22	.83	.860	.460	.958	.570
1.6500	33	20	.13	.860	.460		
1.6522	38	23	.88	.860	.460	.958	.570
1.6667	40	24	.91	.860	.460	.958	.570
1.6818	37	22	.14	.860	.460	.958	.570
1.6842	32	19	.68	.860	.460		
1.6957	39	23	.25	.860	.460	.958	.570
1.7000	34	20	.49	.860	.460		
1.7083	41	24	.35	.860	.460		
1.7143	36	21	.46	.860	.460	1.007	.520
1.7222	31	18	.30	.860	.460		
1.7273	38	22	.68	.860	.460	1.007	.520
1.7391	40	23	.63	.860	.460	1.007	.520
1.7500	42	24	.68	.860	.460		
1.7619	37	21	.61	.860	.460	1.007	.520
1.7727	39	22	.56	.860	.460	1.007	.520
1.7826	41	23	.51	.860	.460	1.007	.520
1.7917	43	24	.46	.860	.460		
1.8000	36	20	.53	.860	.460	1.007	.520

R/S Ratio	R	S	% Dif	TABLE I		TABLE II	
				R Dia	S Dia	R Dia	S Dia
1.8095	38	21	.48	.860	.460	1.007	.520
1.8182	40	22	.43	.860	.460	1.007	.520
1.8261	42	23	.39	.860	.460		
1.8333	44	24	.48	.860	.460	1.007	.520
1.8421	35	19	.43	.860	.460	1.007	.520
1.8500	37	20	.38	.860	.460	1.007	.520
1.8571	39	21	.35	.860	.460	1.007	.520
1.8636	41	22	.32	.860	.460	1.007	.520
1.8696	43	23	.29	.860	.460	1.007	.520
1.8750	30	16	.39	.860	.460		
1.8824	32	17	.35	.860	.460	1.007	.520
1.8889	34	18	.31	.860	.460		
1.8947	36	19	.28	.860	.460		
1.9000	38	20	.25	.860	.460	1.007	.520
1.9048	40	21	.23	.860	.460		
1.9091	42	22	.20	.860	.460	1.007	.520
1.9130	44	23	1.06	.860	.460	1.007	.520
1.9333	29	15	.41	.860	.460	1.007	.520
1.9412	33	17	.32	.860	.460		
1.9474	37	19	.26	.860	.460	1.007	.520
1.9524	41	21	.11	.860	.460	1.007	.520
1.9545	43	22	2.33	.860	.460	1.007	.520
2.0000	44	22	2.38	.860	.460	1.007	.520
2.0476	43	21	.15	.860	.460	1.007	.520
2.0526	39	19	.24	.860	.460	1.007	.520
2.0556	37	18	.16	.860	.460	1.007	.520
2.0588	35	17	.38	.860	.460		
2.0667	31	15	.80	.860	.460		
2.0833	25	12	0	.925	.480		
2.0833	50	24	.57			1.007	.520
2.0952	44	21	.23	.860	.460	1.007	.520
2.1000	42	20	.25	.860	.460	1.007	.520
2.1053	40	19	.28	.860	.460	1.007	.520
2.1111	38	18	.31	.860	.460	1.007	.520
2.1176	36	17	.35	.860	.460		
2.1250	34	16	.39	.860	.460		
2.1333	32	15	.78	.860	.460	1.007	.520
2.1500	43	20	.37	.860	.460	1.007	.520
2.1579	41	19	.41	.860	.460	1.007	.520
2.1667	39	18	.45	.860	.460	1.007	.520
2.1765	37	17	.51	.860	.460		
2.1875	35	16	.57	.860	.460		
2.2000	44	20	0	.860	.460	1.007	.520
2.2000	33	15	.48	.860	.460		
2.2105	42	19	.53	.860	.460	1.007	.520
2.2222	40	18	.59	.860	.460	1.007	.520
2.2353	38	17	.66	.860	.460	1.007	.520
2.2500	36	16	.59	.860	.460		
2.2632	43	19	.15	.860	.460	1.096	.426
2.2667	34	15	.49	.860	.460		
2.2778	41	18	.72	.958	.375	1.096	.426
2.2941	39	17	.80	.958	.375		
2.3125	37	16	.14	.958	.375		
2.3158	44	19	.76	.958	.375	1.096	.426
2.3333	42	18	.84	.958	.375	1.096	.426
2.3529	40	17	.66	.958	.375		
2.3684	45	19	.28	.958	.375	1.096	.426
2.3750	38	16	.59	.958	.375		
2.3889	43	18	.46	.958	.375	1.096	.426
2.4000	36	15	.49	.958	.375		

## UNIVERSAL CHANGE GEAR CHART

R/S Ratio	R	S	% Dif	TABLE I		TABLE II	
				R Dia	S Dia	R Dia	S Dia
2.4118	41	17	.39	.958	.375	1.096	.426
2.4211	46	19	.68	.958	.375	1.096	.426
2.4375	39	16	.28	.958	.375		
2.4444	44	18	.91	.958	.375	1.096	.426
2.4667	37	15	.28	.958	.375		
2.4737	47	19	1.06	.958	.375	1.096	.426
2.5000	45	18	1.05	.958	.375	1.096	.426
2.5263	48	19	.28	.958	.375	1.096	.426
2.5333	38	15	.88	.958	.375		
2.5556	46	18	.27	.958	.375	1.096	.426
2.5625	41	16	.64	.958	.375	1.096	.426
2.5789	49	19	.36	.958	.375	1.096	.426
2.5882	44	17	.46	.958	.375	1.096	.426
2.6000	39	15	.43	.958	.375		
2.6111	47	18	.53	.958	.375	1.096	.426
2.6250	42	16	.25	.958	.375	1.096	.426
2.6316	50	19	.59	.958	.375	1.096	.426
2.6471	45	17	.74	.958	.375	1.096	.426
2.6667	48	18	.78	.958	.375	1.096	.426
2.6875	43	16	.68	.958	.375	1.096	.426
2.7059	46	17	.60	.958	.375	1.096	.426
2.7222	49	18	.41	.958	.375	1.096	.426
2.7333	41	15	.61	.958	.375	1.096	.426
2.7500	44	16	.53	.958	.375	1.096	.426
2.7647	47	17	.47	.958	.375	1.096	.426
2.7777	50	18	.29	.958	.375	1.096	.426
2.7857	39	14	.51	1.007	.312		
2.8000	42	15	.45	.958	.375	1.096	.426
2.8125	45	16	.39	.958	.375	1.096	.426
2.8235	48	17	.35	.958	.375	1.096	.426
2.8333	51	18	.46	.958	.375		
2.8462	37	13	.38	1.007	.312		
2.8571	40	14	.34	1.007	.312		
2.8667	43	15	.29	.958	.375	1.096	.426
2.8750	46	16	.26	.958	.375	1.096	.426
2.8824	49	17	1.19	.958	.375	1.096	.426
2.9167	35	12	.57	1.007	.312		
2.9333	44	15	.14	.958	.375	1.096	.426
2.9375	47	16	.13	.958	.375	1.096	.426
2.9412	50	17	2.00	.958	.375		
3.0000	45	15	2.08	.958	.375	1.096	.426
3.0625	49	16	.14	.958	.375		
3.0667	46	15	.15	.958	.375	1.096	.426
3.0714	43	14	.39	1.007	.312		
3.0833	37	12	1.35	1.007	.312		
3.1250	50	16	.27	.958	.375	1.096	.426
3.1333	47	15	.31	.958	.375	1.096	.426
3.1429	44	14	.35	1.007	.312		
3.1538	41	13	.41	1.007	.312		
3.1667	38	12	.66	1.007	.312		
3.1875	51	16	.39	.958	.375	1.096	.426
3.2000	48	15	.45	1.007	.312	1.166	.354
3.2143	45	14	.51	1.007	.312	1.166	.354
3.2308	42	13	.59	1.007	.312		
3.2500	39	12	.51	1.007	.312		
3.2667	49	15	.58	1.007	.312	1.166	.354
3.2857	46	14	.67	1.007	.312	1.166	.354
3.3077	43	13	.77	1.007	.312		
3.3333	50	15	.71	1.007	.312	1.166	.354
3.3571	47	14	.82	1.007	.312	1.166	.354

R/S Ratio	R	S	% Dif	TABLE I		TABLE II	
				R Dia	S Dia	R Dia	S Dia
3.3846	44	13	.46	1.007	.312		
3.4000	51	15	.49	1.007	.312	1.166	.354
3.4167	41	12	.35	1.007	.312		
3.4286	48	14	.96	1.007	.312	1.166	.354
3.4615	45	13	.15	1.007	.312	1.166	.354
3.4667	52	15	.96	1.007	.312	1.166	.354
3.5000	49	14	0	1.007	.312	1.166	.354
3.5000	42	12	.95	1.007	.312		
3.5333	53	15	.15	1.007	.312		
3.5385	46	13	.93	1.007	.312	1.166	.354
3.5714	50	14	.33	1.007	.312	1.166	.354
3.5833	43	12	.90	1.007	.312		
3.6154	47	13	.76	1.007	.312	1.166	.354
3.6429	51	14	.65	1.007	.312	1.166	.354
3.6667	44	12	.70	1.007	.312	1.166	.354
3.6923	48	13	.60	1.007	.312	1.166	.354
3.7143	52	14	.96	1.007	.312	1.166	.354
3.7500	45	12	.51	1.007	.312	1.166	.354
3.7692	49	13	.44	1.007	.312	1.166	.354
3.7857	53	14	1.26	1.007	.312		
3.8333	46	12	.34	1.007	.312	1.166	.354
3.8462	50	13	1.83	1.007	.312	1.166	.354
3.9167	57	12	.16	1.007	.312	1.166	.354
3.9231	51	13	1.96	1.007	.312	1.166	.354
4.0000	52	13	0	1.007	.312	1.166	.354
4.0000	48	12	1.92	1.007	.312		
4.0769	53	13	.16	1.007	.312	1.166	.354
4.0833	49	12	.19	1.007	.312	1.166	.354
4.0909	45	11	1.85	1.056	.270	1.166	.354
4.1667	50	12	.36	1.056	.270	1.166	.354
4.1818	46	11	1.63	1.056	.270	1.166	.354
4.2500	51	12	.53	1.056	.270	1.166	.354
4.2727	47	11	1.42	1.056	.270	1.256	.270
4.3333	52	12	.70	1.056	.270	1.256	.270
4.3636	48	11	1.22	1.056	.270	1.256	.270
4.4167	53	12	.86	1.056	.270	1.256	.270
4.4545	49	11	1.02	1.056	.270	1.256	.270
4.5000	45	10	1.01	1.056	.270	1.256	.270
4.5455	50	11	.83	1.056	.270	1.256	.270
4.5833	55	12	.36	1.056	.270		
4.6000	46	10	.79	1.056	.270	1.256	.270
4.6364	51	11	.65	1.056	.270	1.256	.270
4.6667	56	12	.71	1.056	.270		
4.7000	47	10	.58	1.056	.270	1.256	.270
4.7273	52	11	1.54	1.056	.270	1.256	.270
4.8000	48	10	.38	1.056	.270	1.256	.270
4.8182	53	11	1.70	1.056	.270	1.256	.270
4.9000	49	10	.19	1.056	.270	1.256	.270
4.9091	54	11	1.85	1.056	.270	1.256	.270
5.0000	50	10	2.00	1.056	.270	1.256	.270
5.1000	51	10	1.96	1.056	.270	1.256	.270
5.2000	52	10	1.92	1.056	.270	1.256	.270
5.3000	53	10	1.89	1.056	.270	1.256	.270
5.4000	54	10	1.85	1.056	.270	1.256	.270
5.5000	55	10		1.056	.270	1.256	.270