BSA Pre-Unit 4 Speed Transmission Ratios

Background & History

The 1st use of the transmission usually referred to generically as the "A10" is in the BB34 Goldstar with duplex cradle frame in 1953, with the remainder of the line following in 1954. These largest BSA machines ("A" Series 500 & 650cc twins and "B" Series 350 & 500cc single-cylinder) were originally offered with many different internal transmission ratio gear-sets to best equip the machines for different purposes such as normal road and moderate performance use, road race, and trials, sidecar and military & police, as shown below. Most of these parts are still available, and can be completely or partially retro-fit into transmission cases, both unit and pre-unit, back to . The exact gear tooth counts and ratios used in these gear-sets have varied slightly over time, and complete interchange may not be possible. Some of these parts were probably used in the older M20, M21, B31 &c. transmissions.

My purpose is to supply information about what choices are available based on combinations of factory parts, explain some of the differences between the various ratios, describe in a general way what needs to be done for a selection, and warn you of potential difficulties. I will limit my comments to methods that have either already been used successfully, or that I believe are sound concepts that are worthy of your time and effort.

Ratio Calculations

BSA 4 speed transmission's intermediate gears (1st through 3rd) are the result of power transmission through two pairs of mating gears, one of which is the mainshaft high gear being turned by the layshaft (countershaft) high gear. The gear ratio is determined by taking the product of multiplying the two pair's tooth count ratios together: the high gear ratio times the ratio of the individual gear pair selected (1st, 2nd or 3rd).

Please note that the total tooth count of each pair of mating gears (mainshaft and layshaft) is 43: 26/17, 25/18, etc. This is fixed by the tooth form's pitch diameter and the center-to-center distance of each pair (which is obviously the distance between the shafts) is a constant. This is a useful safety check to see if the assembly you have is really a useable gear set, or merely a random assortment of parts.

Under certain conditions, a mating pair (with the 43 total) may be substituted for another ratio: 2nd for 3rd, etc. but this must be researched on an empirical basis and may require minor modifications to the length, dog shape and size, etc.

The high gear ratio is the ratio of the tooth counts of the high gear pair for the transmission type selected (see "High Gear Pair" in Column 4 below). For example, the STD. transmission (the most common model) has 27 teeth on the mainshaft high gear and 16 teeth on the layshaft gear, so the high gear multiplier (Column 5) will be 1.68750 for this transmission.

The 2nd number is the ratio of the tooth counts of the pair of gears (mainshaft & layshaft) for that ratio: 1st, 2nd or 3rd.

The std. transmission has 27 teeth on the mainshaft 1st gear and 16 teeth on the layshaft 1st gear, so the gear ratio for the 1st gear pair (Column 8) is 1.6875 for 1st gear in the std. transmission. To get the actual effective ratio of 1st gear, multiply those two numbers together:

In 4th gear the mainshaft high gear is locked to the mainshaft, so the ratio is 1-1. No power is transmitted through the intermediate gears. Although they still turn, they're only idling.

This Table shows some common transmissions, their internal gear-sets, and how the individual ratios are generated.

For transmissions based on the Std (standard) high-gear pair, the high gear tooth counts are: 26 for the mainshaft gear and 17 for the layshaft gear, so the 1st number is always 1.54941 for transmission gear-sets based on the "std." high gear pair.

For transmissions based on the Close high-gear pair, the high gear tooth counts are: 25 for the mainshaft gear and 18 for the layshaft gear; the 1st number is always 1.38889 for transmission gear-sets based on the "close" high gear pair.

The overall governing component for all ratio selection is the high gear pair, which determines the range of ratio spread between 1st gear and 4th gear.

The two original factory gear-sets are shown in color for clarity: "Std." ratios in blue, and "Close" ratios in green.

Note that not all possible gear pair combinations were used in the original ratios shown in Table 8. I have inserted the other four theoretical choices, which may be possible (although I have no experience or information). Not all of them have any practical use.

Alternate 1st gear #1 (1.9319-1) creates an extremely close ratio, approximately the same ratio as the close ratio "RR., RR.T" (1.9290-1) and only suitable for road racing or LSR use. However, it allows this close ratio to be inserted in transmissions fitted with the std. ratio (26/17) high gear pair such as "DAY., DAY.T ".

Alternate 2nd gear #2 (1.9319-1) creates a std. ratio in between the fairly wide "STD., STD.T" (1.7588-1) and the extremely wide "TRI., TRI.T " (2.3391-1) ratios in these std. ratio transmissions.

Alternate 2nd gear #3 (1.5972-1) creates a close ratio in between the fairly wide "SC., SC.T" and "ARRT., ASC., ACS.T, STD.2" (1.7545-1) and "RR.T2" and "RR., RR.T " (1.3257-1) ratios in these close ratio transmissions.

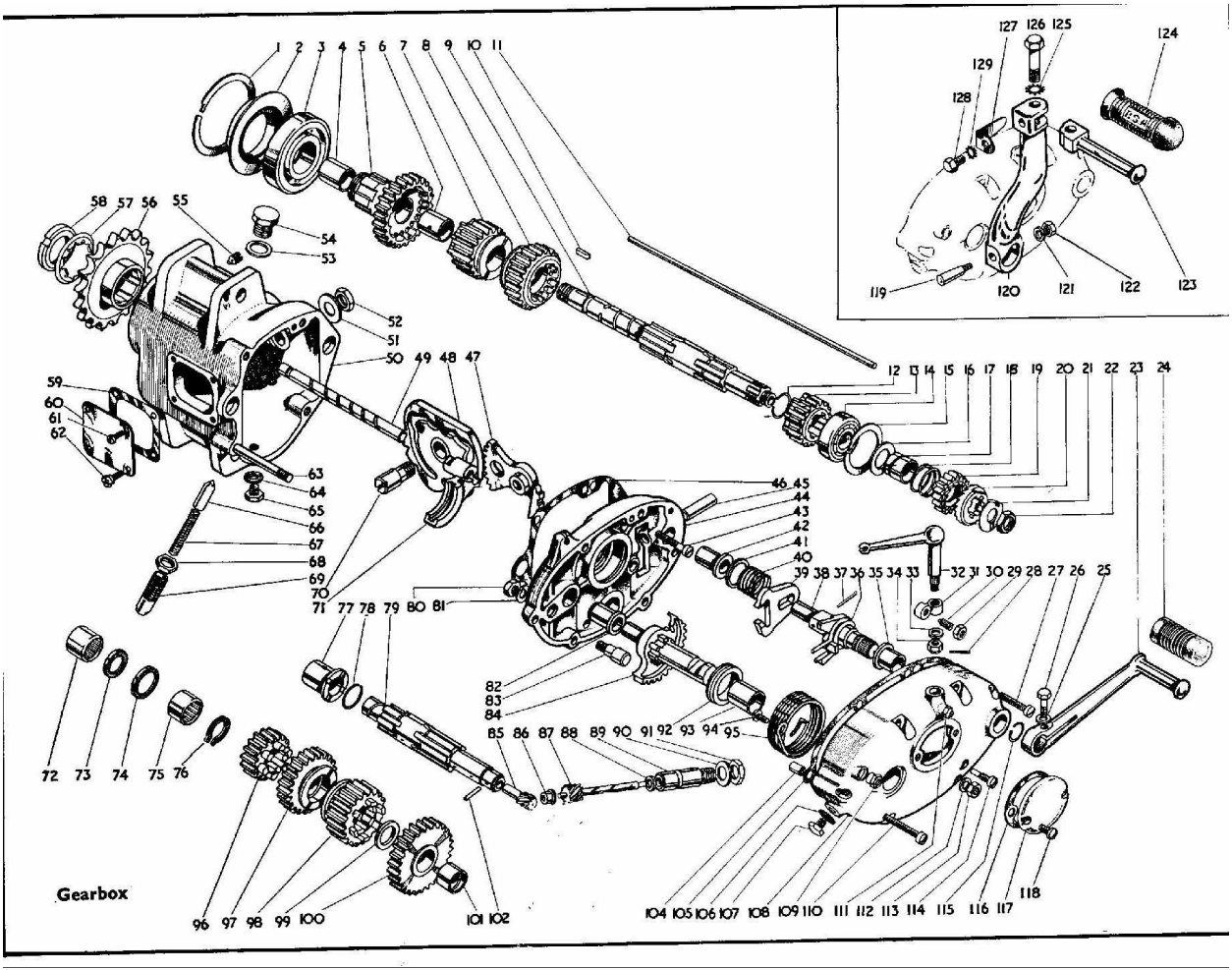
Alternate 3rd gear #4 (1.0000-1) has no practical purpose.

High Gear Multiplier	×	1st Pair Ratio	=	1st Gear Ratio
1.54941	×	1.68750	=	2.58088-1

Table 1: Internal Gearbox Ratios & Gear Tooth Counts

Gear	Ratio Type & Case Marking	Actual Ratio	High Gear Pair	Multiply By	L/S Gear	M/S Gear	Pair Ratio
1st	RR.T2	1.7545-1	25/18	1.38889	24	19	1.2632
	RR., RR.T	1.9290-1	25/18	1.38889	25	18	1.3889
	DAY., DAY.T	2.1242-1	26/17	1.54941	25	18	1.3889
	SC., SC.T	2.3438-1	25/18	1.38889	27	16	1.6875

	STD., STD.T	2.5809-1	26/17	1.54941	27	16	1.6875
	ARRT., ASC., ACS.T, STD.2	2.8770-1	25/18	1.38889	29	14	2.0714
	TRI., TRI.T	3.1680-1	26/17	1.54941	29	14	2.0714
	Alternate 1st #1	1.9319-1	26/17	1.54941	24	19	1.2632
2nd	RR.T2	1.3257-1	25/18	1.38889	21	22	0.9545
	RR., RR.T	1.3257-1	25/18	1.38889	21	22	0.9545
	DAY., DAY.T	1.4598-1	26/17	1.54941	21	22	0.9545
	SC., SC.T	1.7545-1	25/18	1.38889	24	19	1.2632
	STD., STD.T	1.7588-1	26/17	1.54941	23	20	1.1500
	ARRT., ASC., ACS.T, STD.2	1.7545-1	25/18	1.38889	24	19	1.2632
	TRI., TRI.T	2.3391-1	26/17	1.54941	26	17	1.5494
	Alternate 2nd #2	1.9319-1	26/17	1.54941	24	19	1.2632
	Alternate 2nd #3	1.5972-1	25/18	1.38889	23	20	1.1500
3rd	RR.T2	1.0996-1	25/18	1.38889	19	24	0.7917
	RR., RR.T	1.0996-1	25/18	1.38889	19	24	0.7917
	DAY., DAY.T	1.1012-1	26/17	1.54941	18	25	0.7200
	SC., SC.T	1.3257-1	25/18	1.38889	21	22	0.9545
	STD., STD.T	1.2108-1	26/17	1.54941	19	24	0.7917
	ARRT., ASC., ACS.T, STD.2	1.3257-1	25/18	1.38889	21	22	0.9545
	TRI., TRI.T	1.4598-1	26/17	1.54941	21	22	0.9545
	Alternate 3rd #4	1.0000-1	25/18	1.38889	18	25	0.7200
4th	RR.T2	1.0000-1	25/18	1.38889	NA		
	RR., RR.T	1.0000-1	25/18	1.38889			
	DAY., DAY.T	1.0000-1	26/17	1.54941			
	SC., SC.T	1.0000-1	25/18	1.38889			
	STD., STD.T	1.0000-1	26/17	1.54941			
	ARRT., ASC., ACS.T, STD.2	1.0000-1	25/18	1.38889			
	TRI., TRI.T	1.0000-1	26/17	1.54941			


1 2 3 4 5 6 7 8 9 10 11
12 13 14 15 16 17 18 19 20 21 22 23 24
25 26 27 28 29 30 31 32 33 34 35 36 37 38 39
40 41 42 43 44 45 46
47 48 49 50 51 52
53 54 55 56 57 58
59 60 61 62
63 64 65 66 67 68 69 70 71
72 73 74 75 76
77 78 79 80 81
82 83 84
85 86 87 88 89 90 91 92 93 94 95
96 97 98 99 100
101 102
104 105 106 107 108 109 110 111 112 113 114 115 116 117 118
119 120 121 122 123 124 125 126 127 128 129
Gearbox

INTERNAL GEARBOX RATIOS FOR A AND B GROUP S/A MODELS

PART NUMBERS OF GEAR PINIONS & SHAFTS

NUMBER OF TEETH ON GEAR PINIONS.

DESCRIPTION	GEARBOX MARKING	A	B	C	D	E	F	G	H	MAIN SHAFT	LAY SHAFT	SPEEDO GEARS	
												DRIVING	DRIVEN
EXTRA CLOSE ROAD RACING	RR.	67-3184 [25]	42-3022 [18]	67-3361 [22]	42-3026 [21]	67-3187 [24]	67-3198 [19]	67-3221 [18]	67-3216 [25]	67-3330	42-3019	42-3033	42-3032
EXTRA CLOSE ROAD RACING	RR.T	67-3184 [25]	42-3086 [18]	67-3361 [22]	42-3026 [21]	67-3187 [24]	67-3198 [19]	67-3221 [18]	42-3087 [25]	67-3330	42-3094	42-3033	42-3032
EXTRA CLOSE ROAD RACING	RR.T2	42-3133 [25]	42-3086 [18]	67-3361 [22]	42-3026 [21]	42-3136 [24]	67-3198 [19]	42-3137 [19]	42-3138 [24]	42-3131	42-3094	42-3033	42-3032
DAYTONA	DAY.	67-3207 [26]	42-3020 [17]	67-3361 [22]	42-3026 [21]	67-3223 [25]	67-3226 [18]	67-3221 [18]	67-3216 [25]	67-3330	42-3019	67-3088	67-3175
DAYTONA	DAY.T	67-3207 [26]	42-3081 [17]	67-3361 [22]	42-3026 [21]	67-3223 [25]	67-3226 [18	67-3221 [18]	42-3087 [25]	67-3330	42-3094	67-3088	67-3175
SCRAMBLES	SC.	67-3311 [25]	42-3022 [18]	67-3302 [19]	42-3024 [24]	67-3305 [22]	67-3212 [21]	67-3191 [16]	42-3097 [27]	67-3315	42-3019	42-3033	42-3032
SCRAMBLES	SC.T	42-3088 [25]	42-3086 [18]	67-3302 [19]	42-3024 [24]	67-3305 [22]	67-3212 [21]	67-3191 [16]	42-3210 [27]	67-3315	42-3094	42-3033	42-3032
A10 SPITFIRE 1957 ONLY	SC.T2	42-3157 [25]	42-3086 [18]	67-3302 [19]	42-3024 [24]	67-3305 [22]	67-3212 [21]	67-3191 [16]	42-3210 [27]	42-3156	42-3094	42-3033	42-3032
STANDARD	STD.	67-3192 [26]	42-3020 [17]	67-3201 [20]	42-3023 [23]	67-3202 [24]	67-3198 [19]	67-3191 [16]	42-3097 [27]	67-3330	42-3019	67-3088	67-3175
STANDARD	STD.T	42-3076 [26]	42-3081 [17]	67-3201 [20]	42-3023 [23]	67-3202 [24]	67-3198 [19]	67-3191 [16]	42-3210 [27]	67-3330	42-3094	67-3088	67-3175
TRIALS	TRI.	67-3309 [26]	42-3020 [17]	67-3301 [17]	42-3025 [26]	67-3210 [22]	67-3212 [21]	67-3313 [14]	67-3213 [29]	67-3313	42-3019	67-3089	67-3175
TRIALS	TRI.T	42-3091 [26]	42-3081 [17]	67-3301 [17]	42-3025 [26]	67-3210 [22]	67-3212 [21]	67-3313 [14]	42-3093 [29]	67-3313	42-3094	67-3088	67-3175
B34 GOLD STAR CLUBMAN 1962	ARRT.	42-3088 [25]	42-3086 [18]	67-3302 [19]	42-3024 [24]	67-3210 [22]	67-3212 [21]	67-3313 [14]	42-3093 [29]	67-3313	42-3094	42-3033	42-3032
B34 GOLD STAR CATALINA 1962	ASC.T	42-3088 [25]	42-3086 [18]	67-3302 [19]	42-3024 [24]	67-3210 [22]	67-3212 [21]	67-3313 [14]	42-3093 [29]	67-3313	42-3094	42-3033	42-3032
A10 SUPER ROCKET 1962	STD.2	42-3088 [25]	42-3022 [18]	67-3302 [19]	42-3024 [24]	67-3210 [22]	67-3212 [21]	67-3313 [14]	67-3213 [29]	67-3313	42-3019	42-3033	42-3032
650cc G/STAR TWIN 1963	ARRT.	42-3088 [25]	42-3086 [18]	67-3302 [19]	42-3024 [24]	67-3210 [22]	67-3212 [21]	67-3313 [14]	42-3093 [29]	67-3313	42-3094	42-3033	42-3032
650cc G/STAR SPITFIRE 1963	ASC.	42-3088 [25]	42-3022 [18]	67-3302 [19]	42-3024 [24]	67-3210 [22]	67-3212 [21]	67-3313 [14]	67-3213 [29]	67-3313	42-3019	42-3033	42-3032

NOTE—T. IN MARKING INDICATES NEEDLE ROLLERS ON LAYSHAFT.
T.2 IN MARKING INDICATES NEEDLE ROLLERS ON LAYSHAFT AND MAINSHAFT.

THE FORWARD FOOTCHANGE CAM PLATE IS PART No. 67-3332.

THE REVERSE FOOTCHANGE CAM PLATE IS PART No. 42-3011.

TO FIND THE GEAR RATIOS OF A MACHINE CALCULATE THE TOP GEAR AS FOLLOWS:

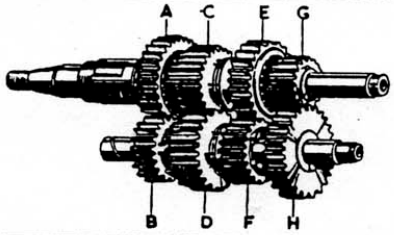
DIVIDE THE NUMBER OF TEETH ON THE CLUTCH SPROCKET BY THE NUMBER OF TEETH ON THE ENGINE SPROCKET AND MULTIPLY BY THE NUMBER OF TEETH ON THE REAR WHEEL SPROCKET DIVIDED BY THE NUMBER OF TEETH ON THE GEARBOX SPROCKET AS EXAMPLE:

$$\frac{\text{CLUTCH SPROCKET (43)}}{\text{ENGINE SPROCKET (17)}} \times \frac{\text{R/W SPROCKET (42)}}{\text{G/B SPROCKET /19)}} = \frac{1806}{323} = 5.591$$

TO FIND THE INTERMEDIATE GEAR RATIO MULTIPLY THE OVERALL TOP GEAR BY THE INTERNAL GEAR RATIO CONCERNED, AS EXAMPLE:

TOP GEAR 5.591 OR 5.6 X BOTTOM GEAR INTERNAL RATIO 2.58=14.4 BOTTOM GEAR OVERALL RATIO.

$$\text{GEARBOX INTERNAL RATIO} = \frac{\text{LAYSHAFT GEAR}}{\text{MAINSHAFT GEAR}} \times \frac{\text{PINION SLEEVE}}{\text{LAYSHAFT FIXED GEAR}}$$



GEARBOX INTERNAL RATIOS

MARKING	TOP	THIRD	SECOND	BOTTOM
RR. or RR.T	1	1.099	1.326	1.929
RR.T2	1	1.099	1.326	1.754
DAY. or DAY.T	1	1.101	1.460	2.124
SC. or SC.T	1	1.325	1.754	2.343
STD. or STD.T	1	1.210	1.758	2.580
TRI. or TRI.T	1	1.459	2.339	3.167
ARRT., ASC ASC.T or STD.2	1	1.325	1.754	2.877

A DEALER CONVENIENCE CHART FROM BSA Incorporated 639 PASSAIC AVENUE NUTLEY 10, NEW JERSEY JULY 1963