

## Large (>3 Watts) Motor Comparison

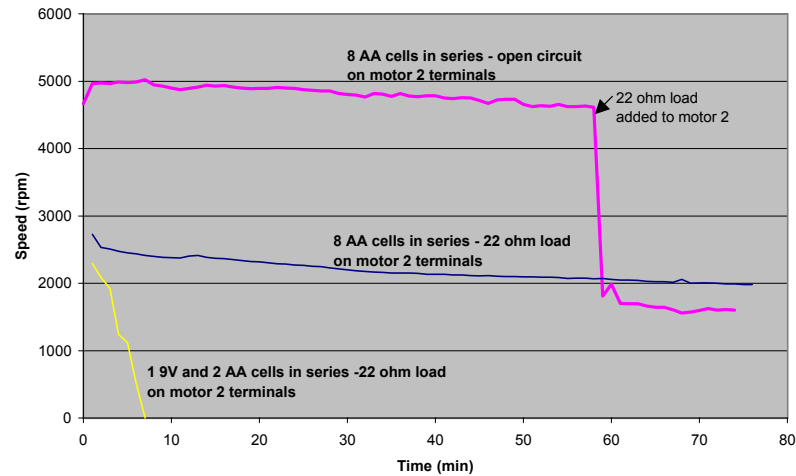
Year	Units	1985/86	1994	1995-97	1998	1999	2000**	2001-03
Manufacturer		Plymouth	HP/Buhler	HP/Mabuchi	HP/Mabuchi	HP/Mabuchi	HP/Mabuchi	HP/Mabuchi
Type		Rubberband	DC/PM Brush	DC/PM Brush	DC/PM Brush	DC/PM Brush	DC/PM Brush	DC/PM Brush
Model Number		#33	1645-60170		RS-555SB	RS-385SH	RS-385SH	RS-385PH
			1.13.043.230		-19160	-16120	-16120	-
HP Part Number				C2162-60006	C3604-6022	C6429-60004	C6429-60004	C6429-60004
				DN505728	TKS-71-0372	RD968Y10	RD968Y10	RD940Y13
Rating	Volts		19.10	19.00	15.00	24.00	24.00	18.00
Test	Volts		19.10	24.00	24.00	24.00	12.00	12.00
Source							8 AA	8 AA
Stall Current	Amps		2.00	2.50	1.60	2.52	1.63	1.35
Stall Torque	N-cm		18.40	28.70	9.40	4.75	2.61	2.30
Stall Torque	in-oz		26.08	40.68	13.32	6.73	3.70	3.26
No Load Speed	rpm		1,950	4,550	3,540	11,000	5,850	5,460
No Load Speed	rad/sec		204.20	476.47	370.71	1151.92	612.61	571.77
Max Power	Watts		9.40	34.20	8.72	13.70	4.00	3.29
Max Power	milli-HP		12.60	45.83	11.68	18.36	5.36	4.41
Duration	seconds		30	30	30	30	60	45
Energy	Joules	20.00	282.00	1026.00	262.00	411.00	239.84	147.95
Weight	grams	0.50	417	224	220	70	70	75
Weight	oz	0.02	14.68	7.88	7.74	2.46	2.46	2.64
Power/Weight	Watts/kg		22.54	152.68	39.64	195.71	57.10	43.84
Energy/Weight	Joules/kg	40,000.00	676.26	4,580.36	1,190.91	5,871.43	3,426.24	1,972.61
No Load Current	Amps		0.07	0.15	0.10	0.09	0.09	0.09
Start Up Voltage	Volts		1.50	2.00	3.00	1.50	1.50	1.50
Resistance	Ohms		9.60	8.20	11.60	6.30	6.50	6.50
Electrical Time Constant	milli-sec		1.20		0.90			
Mechanical Time Constant	milli-sec		7.10		16.00			
Motor Const	N-cm/watt <sup>1/2</sup>		3.00	1.80	1.78	0.75	0.75	0.75
Torque Constant	N-cm/Amp		9.30	4.80	6.08	1.90	1.90	1.90
Voltage Constant	Volts/Krpm		0.10		6.40	2.00	2.00	2.00
Inertia	g-cm <sup>2</sup>		67.80	45.00	50.00	8.00	8.00	8.00
Shaft Diameter	mm		3.96	3.10	3.32	2.30	2.30	2.30
Shaft Diameter	in		0.156	0.122	0.131	0.091	0.091	0.091
Shaft Length	mm			85.00	85.00	13.80	13.80	13.80
Motor Diameter	mm		40.00	37.00	37.50	27.70	27.70	27.70
Motor Length	mm		77.00	64.00	66.00	57.00	57.00	57.00

\*\* Motor for year 2000 is same as for 1999 but is driven by batteries.

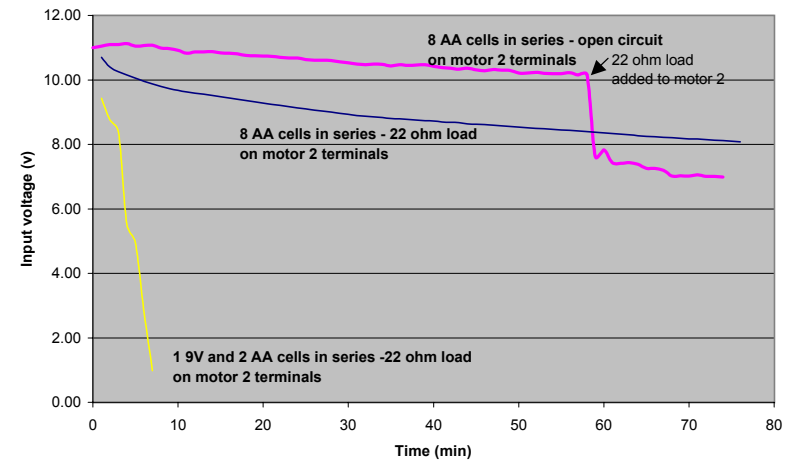
Power shown is obtained when motor is tested with 8 fresh AA batteries in series and loaded to run at an initial speed of 2726 rpm. Initial battery input voltage at this load is 10.7V, and initial current is 1.63 amps. Motor torque and power decrease as batteries discharge.

## Mabuchi RS-385SH-16120 (2000) Motor/Battery Tests

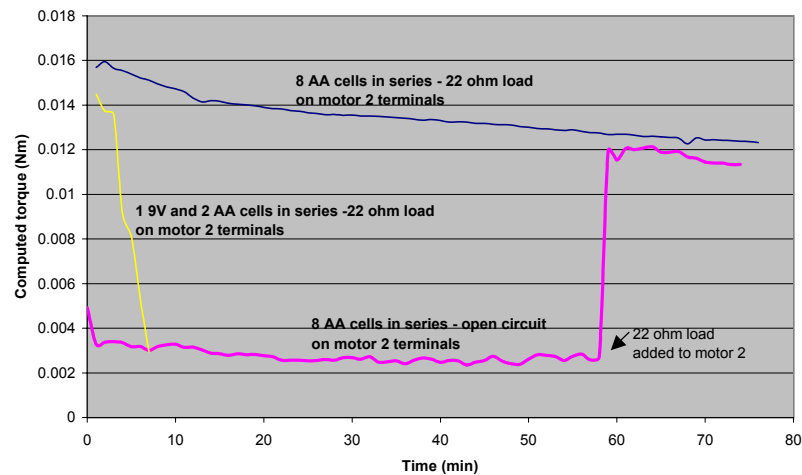
Motor Speed  
Motor 1 driving Motor 2



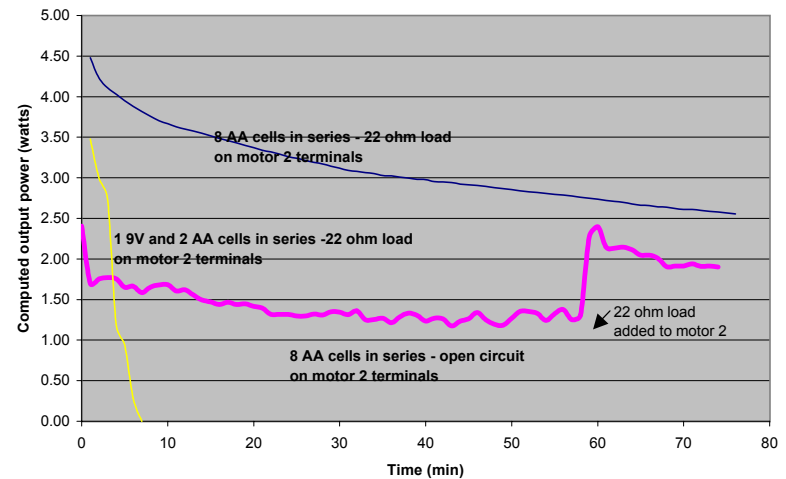
Battery Input Voltage  
Motor 1 driving Motor 2



Computed Torque  
Motor 1 driving Motor 2



Computed Output Power  
Motor 1 driving Motor 2



## Small (~1 Watt) Motor Comparison

<b>Year</b>	<b>1994-95, 98-01</b>	<b>1994-03</b>
<b>Manufacturer</b>	GM/ITT/Valeo	GM/ITT/Vale
	Clutch	No Clutch
<b>Type</b>	DC/PM/Brush	DC/PM/Brush
<b>Model Number</b>		
<b>Rating (volts)</b>	12.00	12.00
<b>Stall Current (amps)</b>		
<b>Stall Torque (N-cm)</b>	1.20	1.23
<b>Stall Torque (in-oz)</b>	1.70	1.73
<b>Max Speed (rpm)</b>	4,250	4,050
<b>Max Speed (rad/sec)</b>	445.06	424.12
<b>Max Power (Watts)</b>	1.33	1.30
<b>Max Power (milli-HP)</b>	1.78	1.74
<b>Duration (sec)</b>	45.00	45.00
<b>Energy (Joules)</b>	59.85	58.50
<b>Weight (grams)</b>	45.40	41.00
<b>Weight (oz)</b>	1.60	1.44
<b>Power/Weight (Watts/kg)</b>	29.30	31.71
<b>Energy/Weight (Joules/kg)</b>	1,318.28	1,426.83