## MAC-BMC 600-watt Motor

Motor: M4
Hall sensors tuned for CW rotation
Winding: Delta (stock)
Infineon controller (operating range: 20-60 Volts)

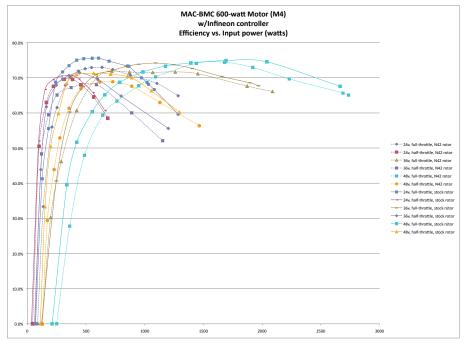
Stock rotor with composite magnet ring, 16-pole Rotor with N42 Neodymium magnets, 16-pole

Stock rotor with composit	e magnet ring, 16-po	ie	Kotor with N42 Neodyn	nium magnets, 16-poie	1
24-volt supply			24-volt supply		
Full Throttle			Full Throttle		
Power (CycleAnalyst) 69	Power (PowerTap) 0	Efficiency	Power (CycleAnalyst) 87	Power (PowerTap) 0	Efficiency 0.0%
126	52	0.0% 41.3%	135	45	33.3%
180	100	55.6%	209	117	56.0%
240	165	68.8%	252	155	61.5%
300	215	71.7%	324	220	67.9%
354	260	73.4%	368	258	70.1%
420	315	75.0%	434	312	71.9%
480	362	75.4%	492	357	72.6%
552	417	75.5%	546	398	72.9%
606	458	75.6%	636	464	73.0%
696	520	74.7%	726	525	72.3%
852	625	73.4%	876	620	70.8%
864 972	633 680	73.3% 70.0%	1104 1284	755 833	68.4% 64.9%
1020	700	68.6%	1284	833	64.9%
1020	703	68.1%	24-volt sunnly		
1080	720	66.7%	Half Throttle		
1284	766	59.7%	Power (CycleAnalyst)	Power (PowerTap)	Efficiency
			44	0	0.0%
24-volt supply			99	50	50.5%
Half Throttle			162	102	63.0%
Power (CycleAnalyst)	Power (PowerTap)	Efficiency	222	150	67.6%
35	0	0.0%	312	217	69.6%
96	50	52.1%	384	267	69.5%
150	100	66.7%	456	310	68.0%
216	150	69.4%	564	364 400	64.5%
288 378	203 267	70.5% 70.6%	684	400	58.5%
378 438	267 305	70.6% 69.6%	36-volt supply		
438 558	305 367	65.8%	Sb-voit supply		
558 660	400	60.6%	Power (CycleAnalyst)	Power (PowerTap)	Efficiency
000	400	00.0%	126	Power (Power Iap)	0.0%
36-volt supply			198	60	30.3%
Full Throttle			288	133	46.2%
Power (CycleAnalyst)	Power (PowerTap)	Efficiency	420	255	60.7%
120	0	0.0%	594	417	70.2%
246	100	40.7%	720	517	71.8%
360	217	60.3%	870	623	71.6%
474	320	67.5%	1068	764	71.5%
588 696	417	70.9%	1260 1452	903 1033	71.7%
840	500 615	71.8% 73.2%	1452	1033	71.1% 67.6%
948	700	73.2%	2088	1380	66.1%
1092	810	74.2%	2000	1300	00.170
1248	920	73.7%	36-volt supply		
1404	1020	72.6%	Half Throttle		
1656	1165	70.4%	Power (CycleAnalyst)	Power (PowerTap)	Efficiency
1896	1300	68.6%	66	0	0.0%
1968	1333	67.7%	120	58	48.3%
			180 252	107	59.4%
36-volt supply Half Throttle			252 372	164 250	65.1% 67.2%
Power (CycleAnalyst)	Power (PowerTap)	Efficiency	588	400	68.0%
60	Power (Power lap)	0.0%	888	533	60.0%
114	50	43.9%	1152	600	52.1%
162	100	61.7%	1132	000	32.170
246	167	67.9%	48-volt supply		
300	209	69.7%	Full Throttle		
354	250	70.6%	Power (CycleAnalyst)	Power (PowerTap)	Efficiency
444	317	71.4%	249	0	0.0%
600	417	69.5%	360	100	27.8%
798 1200	517	64.8%	486	233	47.9% 59.3%
1200	667	55.6%	642 762	381 483	
48-volt supply			762 948	483 642	63.4% 67.7%
Full Throttle			1092	767	70.2%
Power (CycleAnalyst)	Power (PowerTap)	Efficiency	1440	1067	74.1%
210	0	0.0%	1680	1250	74.4%
336	133	39.6%	1920	1400	72.9%
420	217	51.7%	2232	1555	69.7%
					65.7%
552	333	60.3%	2688	1765	03.770
552 660	333 430	60.3% 65.2%	2688 2736	1765 1780	65.1%
552 660 786	333 430 540	60.3% 65.2% 68.7%	2736	1765 1780	65.1%
552 660 786 984	333 430 540 705	60.3% 65.2% 68.7% 71.6%	2736 48-volt supply	1765 1780	65.1%
552 660 786 984 1176	333 430 540 705 862	60.3% 65.2% 68.7% 71.6% 73.3%	2736 48-volt supply Half Throttle	1780	65.1%
552 660 786 984 1176 1392	333 430 540 705 862 1033	60.3% 65.2% 68.7% 71.6% 73.3% 74.2%	2736 48-volt supply Half Throttle Power (CycleAnalyst)	1780 Power (PowerTap)	65.1% Efficiency
552 660 786 984 1176 1392 1692	333 430 540 705 862 1033 1267	60.3% 65.2% 68.7% 71.6% 73.3% 74.2% 74.9%	2736 48-volt supply Half Throttle Power (CycleAnalyst) 126	1780 Power (PowerTap) 0	65.1% Efficiency 0.0%
552 660 786 984 1176 1392 1692 2040	333 430 540 705 862 1033 1267 1520	60.3% 65.2% 68.7% 71.6% 73.3% 74.2% 74.9% 74.5%	2736 48-volt supply Half Throttle Power (CycleAnalyst) 126 170	Power (PowerTap) 0 50	65.1% Efficiency 0.0% 29.4%
552 660 786 984 1176 1392 1692	333 430 540 705 862 1033 1267	60.3% 65.2% 68.7% 71.6% 73.3% 74.2% 74.9%	48-volt supply Half Throttle Power (CycleAnalyst) 126 170 228	Power (PowerTap) 0 50 100	65.1% Efficiency 0.0% 29.4% 43.9%
552 660 786 984 1176 1392 1692 2040 2664	333 430 540 705 862 1033 1267 1520	60.3% 65.2% 68.7% 71.6% 73.3% 74.2% 74.9% 74.5%	2736 48-volt supply Half Throttle Power (CycleAnalyst) 126 170 228 276	Power (PowerTap) 0 50 100 146	65.1% Efficiency 0.0% 29.4% 43.9% 52.9%
552 660 786 984 1176 1392 1692 2040 2664 48-volt supply Half Throttle	333 430 540 705 862 1033 1267 1520	60.3% 65.2% 68.7% 71.6% 73.3% 74.2% 74.9% 74.5%	48-volt supply Half Throttle Power (CycleAnalyst) 126 170 228	Power (PowerTap) 0 50 100	65.1% Efficiency 0.0% 29.4% 43.9% 52.9% 61.3% 66.9%
552 660 786 984 1176 1392 1692 2040 2664 48-volt supply Half Throttle Power (CycleAnalyst)	333 430 540 705 862 1033 1267 1520 1800	60.3% 65.2% 68.7% 71.6% 73.3% 74.2% 74.5% 67.6%	2736 48-volt supply Half Throttle Power (CycleAnalyst) 126 170 228 276 354 456 618	Power (PowerTap) 0 50 100 146 217 305 425	65.1% Efficiency 0.0% 29.4% 43.9% 52.9% 61.3% 66.9% 68.8%
552 6600 786 984 1176 1392 1692 2040 2664 48-volt supply Half Throttle Power (CycleAnalyst)	333 430 540 705 862 1033 1267 1520 1800	60.3% 65.2% 68.7% 71.6% 73.3% 74.2% 67.6%	2736 48-volt supply Half Throttle Power (CycleAnalyst). 126 170 228 276 354 456 618 726	Power (PowerTap) 0 50 100 146 217 305 425 500	65.1% Efficiency 0.0% 29.4% 43.9% 61.3% 66.9% 68.8% 68.8%
552 660 786 984 1176 1392 1692 2040 2664 48-volt supply Half Throttle Power (CycleAnalyst) 150	333 430 540 705 862 1033 1267 1520 1800 Power (PowerTap) 0 5	60.3% 65.2% 68.7% 71.6% 73.3% 74.2% 67.6% Efficiency 0.0% 33.3%	2736 48-volt supply Half Throttle Power (CycleAnalyst) 126 170 228 276 354 456 618 726 888	Power (PowerTap) 0 0 100 146 217 305 425 500 600	65.1% Efficiency 0.0% 29.4% 43.9% 51.3% 66.9% 68.8% 67.6%
552 660 786 984 1176 984 1176 1392 1692 2040 2664 48-volt supply Half Throttle Power (CycleAnalyst) 110 150 198	333 430 540 705 862 1033 1267 1520 1800 Power (PowerTap) 0 50	60.3% 65.2% 68.7% 71.6% 73.3% 74.2% 74.5% 67.6% Efficiency 0.0% 33.3% 50.5%	2736 48-volt supply Half Throttle Power (CycleAnalyst) 126 170 228 276 354 456 618 726 888 1128	Power (PowerTap)  0 50 100 146 217 305 425 500 600 710	65.1% Efficiency 0.0% 29.4% 43.9% 52.9% 61.3% 66.9% 68.8% 68.9% 67.6% 62.9%
552 660 786 984 1176 984 1176 1392 1692 2040 2664 48-volt supply Half Throttle Power (CycleAnalyst) 150 198 264	333 430 540 705 862 1033 1267 1520 1800 Power (PowerTap) 50 100	60.3% 65.2% 68.7% 71.6% 73.3% 74.2% 74.5% 67.6%	2736 48-volt supply Half Throttle Power (CycleAnalyst) 126 170 228 276 354 456 618 726 888	Power (PowerTap) 0 0 100 146 217 305 425 500 600	65.1% Efficiency 0.0% 29.4% 43.9% 52.9% 61.3% 66.9% 68.8% 67.6%
552 660 786 984 1176 984 1176 1392 1692 2040 2664 48-volt supply Half Throttle Power (CycleAnalyst) 110 150 198 264 336	333 430 540 705 862 1033 1267 1520 1800  Power (PowerTap) 0 50 100 158 230	60.3% 65.2% 68.7% 71.6% 73.3% 74.2% 74.9% 67.6% Efficiency 0.0% 33.3% 50.5% 59.8% 68.5%	2736 48-volt supply Half Throttle Power (CycleAnalyst) 126 170 228 276 354 456 618 726 888 1128	Power (PowerTap)  0 50 100 146 217 305 425 500 600 710	65.1% Efficiency 0.0% 29.4% 43.9% 52.9% 61.3% 66.9% 68.8% 68.9% 67.6% 62.9%
552 660 786 984 1176 984 1176 1392 1692 2040 2664 48-voit supply Half Throttle Power (CycleAnalyst) 110 150 198 264 336 420	333 430 540 705 862 1033 1267 1520 1800  Power (PowerTap) 0 100 158 230	60.3% 65.2% 68.7% 71.6% 73.3% 74.2% 74.5% 67.6% Efficiency 0.0% 33.3% 50.5% 59.8% 68.5% 71.0%	2736 48-volt supply Half Throttle Power (CycleAnalyst) 126 170 228 276 354 456 618 726 888 1128	Power (PowerTap)  0 50 100 146 217 305 425 500 600 710	65.1% Efficiency 0.0% 29.4% 43.9% 61.3% 66.9% 68.8% 68.9% 67.6% 62.9%
552 660 786 984 1176 984 1178 1199 1199 12040 22040 2664 48-volt supply Half Throttle Power (CycleAnalyst) 110 120 120 120 120 120 120 120 120 120	333 430 540 705 862 1033 1267 1520 1800  Power (PowerTap) 50 10 158 230 298 402	60.3% 65.2% 68.7% 71.6% 74.2% 74.9% 74.5% 67.6% Efficiency 0.0% 33.3% 50.5% 68.5% 71.0%	2736 48-volt supply Half Throttle Power (CycleAnalyst) 126 170 228 276 354 456 618 726 888 1128	Power (PowerTap)  0 50 100 146 217 305 425 500 600 710	65.1% Efficiency 0.0% 29.4% 43.9% 61.3% 66.9% 68.8% 68.9% 67.6% 62.9%
552 660 786 984 1176 984 1176 1392 1692 2040 2664 48-voit supply Half Throttle Power (CycleAnalyst) 110 150 198 264 336 420	333 430 540 705 862 1033 1267 1520 1800  Power (PowerTap) 0 100 158 230	60.3% 65.2% 68.7% 71.6% 73.3% 74.2% 74.5% 67.6% Efficiency 0.0% 33.3% 50.5% 59.8% 68.5% 71.0%	2736 48-volt supply Half Throttle Power (CycleAnalyst) 126 170 228 276 354 456 618 726 888 1128	Power (PowerTap)  0 50 100 146 217 305 425 500 600 710	65.1% Efficiency 0.0% 29.4% 43.9% 61.3% 66.9% 68.8% 68.9% 67.6% 62.9%









Notes: Efficiency was measured by comparing energy drawn from the battery according to a Cycle Analyst and comparing that to energy sent to the rear wheel of the bicycle as read from a PowerTap hub. Motor power passes through a chain and sprocket (#25 chain; 111 - 90t) to a mid-drive, which is then passed to the rear wheel using normal bicycle chain (15t - 34t). Efficiency of the two-stage chain and sprocket drive is probably around 93%-95%, so actual motor/controller efficiency is about 6.5% greater. The right-most markers indicate the maximum usable power.