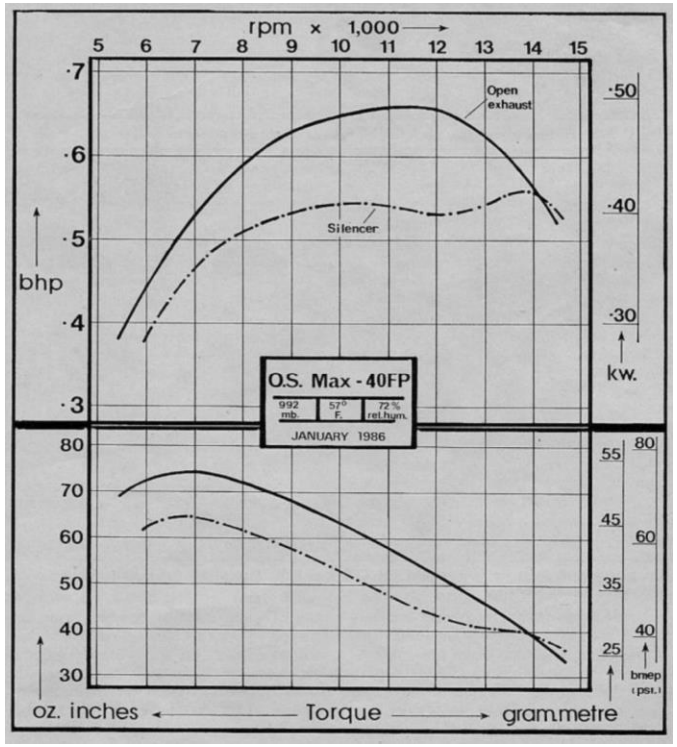
Glow / Gas to Electric Conversion

Airplane: Carl Goldberg Falcon 56 Mk 3
Weight: 54 ounces or 3. 375 pounds
Wingspan: 56 inches
Wing area:
Engine: OS 40 LA
Propeller: APC 11 X 7
RPM: 10,000 approximately
Engine test data: [OS Max 40FP (sceptreflight.com)]



Performance:

Max. BHP—.657 @ 11,900 rpm. (Open Ex./10% Nitro.)

—.560 @ 13,800 rpm. (Silencer/10% Nitro.)

Max. Torque—75 oz. in. @ 6,870 rpm (Open Ex. 10% Nitro)

—65 oz. in. @ 6,710 rpm. (Silencer 10% Nitro)

Rpm on Standard propellers:	Open Ex.	Silencer
12 x 6 Graupner	8,910	8,350
10 x 8.3 Graupner (3 blade)	9,200	8,570
11 x 8 Zinger	9,222	8,745
11 x 5 Topflite	10,660	10,160
10 x 6 MK Glass	11,400	10,640
10 x 4 Zinger	13,200	12,430
9 x 4 Zinger	—	13,820

Max HP: .56 hp at 13, 800 rpm with silencer fitted.
Weight: 11.3 ounces
Watts: .56hp * 750 watts/hp = 420 watts
Watts per horsepower: 420/3.375=125 watts per pound

Parts Removed for Conversion.

Engine
Fuel tank: Kraft Hayes 4 ounce
Receiver battery: 4 cell NiMH 500 mAh
Throttle servo: Futaba S148

Parts Added for Conversion.

Brushless motor. Badass 2826 690 Kv
https://rcdude.com/pub/propcharts/BA2826-690-Specs.htm

Motor spacer: bass wood block
ESC: FrSky Neuron 60s

- Dimension: 44*22*12mm
- Weight: 37.7g
- Lipo Cells: 3~6S
- Adjustable SBEC Voltage: 5~8.4V (Voltage Step: 0.1V)
- Current: 60A
- Peak Current: 80A

Lipo battery: Pulse 6S1800

Specifications:

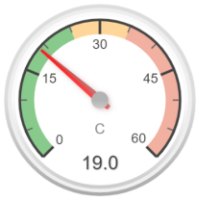
- Voltage | Cell Count : 22.2V 6S Lipo Battery
- Capacity: 1800mAh Lipo Battery
- Discharge Rate | Max Burst : 70C | 140C
- Dimensions: 110 x 34 x 48mm (LxWxH)
- Weight: 353g
- Balance Tap: JST-XH Connector
- Battery Connector: XT60 Connector

Battery mount:

1/8” lite ply, and velcro

Simulation Data from eCalc

This shows the motor selected should perform better than the glow engine it is replacing.



Load:

Mixed Flight Time:

Current:

est. Temperature:

Thrust-Weight:

Pitch Speed:

Remarks:

Battery		Motor @ Optimum Efficiency		Motor @ Maximum		Propeller		Total Drive		Airplane	
Load:	18.99 C	Current:	28.30 A	Current:	34.19 A	Static Thrust:	2685 g	Drive Weight:	583 g	All-up Weight:	1814 g
Voltage:	19.80 V	Voltage:	20.09 V	Voltage:	19.65 V		94.7 oz		20.6 oz		64 oz
Rated Voltage:	22.20 V	Revolutions*:	12223 rpm	Revolutions*:	11675 rpm	Revolutions*:	11675 rpm	Power-Weight:	418 W/kg	Wing Load:	50 g/dm²
Energy:	39.96 Wh	electric Power:	568.4 W	electric Power:	671.6 W	Stall Thrust:	- g		190 W/lb		16.4 oz/ft²
Total Capacity:	1800 mAh	mech. Power:	473.3 W	mech. Power:	556.9 W		- oz	Thrust-Weight:	1.48 : 1	Cubic Wing Load:	8.4
Used Capacity:	1530 mAh	Efficiency:	83.3 %	Efficiency:	82.9 %	avail.Thrust @ 0 km/h:	2685 g	Current @ max:	34.19 A	est. Stall Speed:	34 km/h
min. Flight Time:	2.7 min			est. Temperature:	71 °C	avail.Thrust @ 0 mph:	94.7 oz	P(in) @ max:	759.0 W		21 mph
Mixed Flight Time:	5.6 min				160 °F	Pitch Speed:	98 km/h	P(out) @ max:	556.9 W	est. Speed (level):	104 km/h
Weight:	270 g			**Wattmeter readings**			61 mph	Efficiency @ max:	73.4 %		65 mph
	9.5 oz			Current:	34.19 A	Tip Speed:	615 km/h	Torque:	0.46 Nm	est. Speed (vertical):	40 km/h
				Voltage:	19.8 V		382 mph		0.34 lbf.ft		25 mph
				Power:	677 W	specific Thrust:	4.00 g/W			est. rate of climb:	11 m/s
							0.14 oz/W				2173 ft/min

Motor Partial Load

Propeller	Throttle	Current (DC)	Voltage (DC)	el. Power	Efficiency	Thrust		Spec. Thrust		Pitch Speed		Speed (level)		Motor Run Time
rpm	%	A	V	W	%	g	oz	g/W	oz/W	km/h	mph	km/h	mph	(85%) min
1600	11	0.2	22.2	4.4	32.7	50	1.8	11.5	0.41	13	8	-	-	464.6
2400	17	0.4	22.2	9.4	51.2	113	4.0	12.0	0.42	20	13	-	-	215.4
3200	23	0.8	22.1	18.0	63.6	202	7.1	11.2	0.40	27	17	-	-	112.8
4000	29	1.4	22.1	31.2	71.4	315	11.1	10.1	0.36	34	21	-	-	64.7
4800	35	2.3	22.0	50.5	76.3	454	16.0	9.0	0.32	40	25	-	-	39.9
5600	41	3.5	22.0	77.1	79.4	618	21.8	8.0	0.28	47	29	50	31	26.0
6400	47	5.2	21.8	112.3	81.3	807	28.5	7.2	0.25	54	33	57	36	17.8
7200	54	7.3	21.7	157.6	82.6	1021	36.0	6.5	0.23	60	38	64	40	12.6
8000	61	10.0	21.5	214.3	83.3	1261	44.5	5.9	0.21	67	42	72	44	9.2
8800	**68**	**13.4**	**21.3**	**283.8**	**83.7**	**1525**	**53.8**	**5.4**	**0.19**	**74**	**46**	**79**	**49**	**6.8**
9600	**76**	**17.7**	**21.0**	**367.7**	**83.9**	**1815**	**64.0**	**4.9**	**0.17**	**81**	**50**	**86**	**53**	**5.2**
10400	85	22.9	20.6	467.5	83.9	2130	75.1	4.6	0.16	87	54	93	58	4.0
11200	94	29.2	20.1	584.6	83.8	2471	87.2	4.2	0.15	94	58	100	62	3.1
11675	100	34.2	19.8	671.6	82.9	2685	94.7	4.0	0.14	98	61	104	65	2.7

My Rationale for this Conversion.

1. Should perform equal to or better than the glow setup.
2. Should use things I already have.
3. Should not increase flying weight.

I removed the glow motor, prop, tank, fuel lines, throttle cable, tank mount, throttle servo, radio switch and radio battery.

Weight removed.

Engine: OS 40 LA. 13 ounces. I know the reports shows it should weigh 11 ounces but my scales disagreed with the report.
Battery and switch: 700 mAh NiMH battery and futaba switch 2.4 ounces
Servo:Futaba S148 1.6 ounces
Tanks and lines: kraft hayes 4 ounce. 1 ounce plus 4 ounces of fuel
Tank mount and lines: 1 ounce
Prop: APC 11 X 7

Total: 23 ounces

Weight added.

Motor: BadAss 2826 690 Kv 6.4 ounces
Mount: 2 ounces
Battery: 6S1800 12.5 ounces
Battery mount: 1 ounce
ESC: FrSky Neuron 60S 1.4 ounces
Prop: APC 11 X 5.5 E

Total: 22.1 ounces

The reason I chose the 6s1800 battery is they are used in my TREX 470 helicopter and they were the same physical size as the Kraft Hayes 4 ounce slim tank. The FrSky neuron was selected for its size and telemetry features. The bass wood block was selected because I had a chunk of basswood by my table saw and the firewall needed to be reinforced.
The glow engine can be restored by unscrewing the electric motor mount and then replacing all of the glow equipment.
The only modification made to the airframe was to allow cooling air to flow through the firewall, bulkheads and out cooling holes aft of the radio compartment.

Performance

BadAss BA-2826-690 Performance Test Data							
Magnets 14-Pole	Motor Wind 12-Turn Delta	Motor Kv 690 RPM/Volt		No-Load Current Io = 1.45 Amps @ 10v		Motor Resistance Rm = 0.037 Ohms	I Max 52 Amps	P Max (6S) 1150 W
Stator 12-Slot	Outside Diameter 35.6 mm, 1.402 in.	Body Length 46.0 mm, 1.811 in.		Total Shaft Length 66.5 mm, 2.657 in.		Shaft Diameter 5.00 mm, 0.197 in.	Motor Weight 180 gm, 6.35 oz	
Test Data From Sample Motor	Input Io Value	10.0 V 1.364 A	12.0 V 1.457 A	14.0V 1.479 A	16.0V 1.581 A	Measured Kv value 694 RPM/Volt @ 10V	Measured Rm Value 0.0351 Ohms	

6-cell Li-Po Test Data										
Prop Manf.	Prop Size	Li-Po Cells	Input Voltage	Motor Amps	Input Watts	Prop RPM	Pitch Speed in MPH	Thrust Grams	Thrust Ounces	Thrust Eff. Grams/W
APC	9x4.5-E	6	22.2	20.17	447.8	13,445	57.3	1886	66.54	4.21
APC	9x6-E	6	22.2	24.43	542.3	13,189	74.9	1877	66.22	3.46
APC	9x7.5-E	6	22.2	38.11	846.1	12,301	87.4	1980	69.82	2.34
APC	9x9-E	6	22.2	41.68	925.3	12,122	103.3	1990	70.18	2.15
APC	10x5-E	6	22.2	31.42	697.4	13,252	62.7	2468	87.07	3.54
APC	10x5.8-F2B	6	22.2	34.46	765.0	13,100	72.0	2801	98.80	3.66
APC	10x6-E	6	22.2	35.16	780.5	13,038	74.1	2577	90.90	3.30
APC	10x7-E	6	22.2	40.95	909.2	12,725	84.4	2700	95.24	2.97
APC	10x10-E	6	22.2	57.79	1283.0	11,817	111.9	2399	84.63	1.87
APC	11x5.5-E	6	22.2	44.45	986.8	12,513	65.2	3449	121.67	3.50
APC	11x7-E	6	22.2	52.59	1167.5	12,035	79.8	3473	122.49	2.97

At a little over half throttle this new electric propulsion system performs equal the glow propulsion system it replaced. Both systems provide five minutes of flight time. The bonus with the electric system is the full throttle performance. This was a very easy conversion to make and it meets every requirement I had identified.

Sources for the Parts I Selected

Motor- BadAss 2826 690Kv
RC Dude Hobbies Home - RC Dude Hobbies

ESC- FrSky Neuron 60s
Aloft - Home (alofthobbies.com)

Battery
Pulsebattery - RC Lipos, RC Heli Batteries and Accessories – Pulse Battery
These are available at many retailers.

Motor simulation software
eCalc - reliable electric drive simulations