· HUMAN · ROBOT · INTERACTION ·

Experimental test report: P90

PULSAR
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Contents

Introduction

This document presents experimental tests performed to validate the motor datasheet with respect to rated torque, speed at rated torque, peak torque, maximum speed at peak torque, and stall torque at zero speed.

Definitions:

Rated torque is the torque that the motor can sustain indefinitely at the rated speed, while ensuring that the motor hot-spot temperature stabilizes below 100 °C.

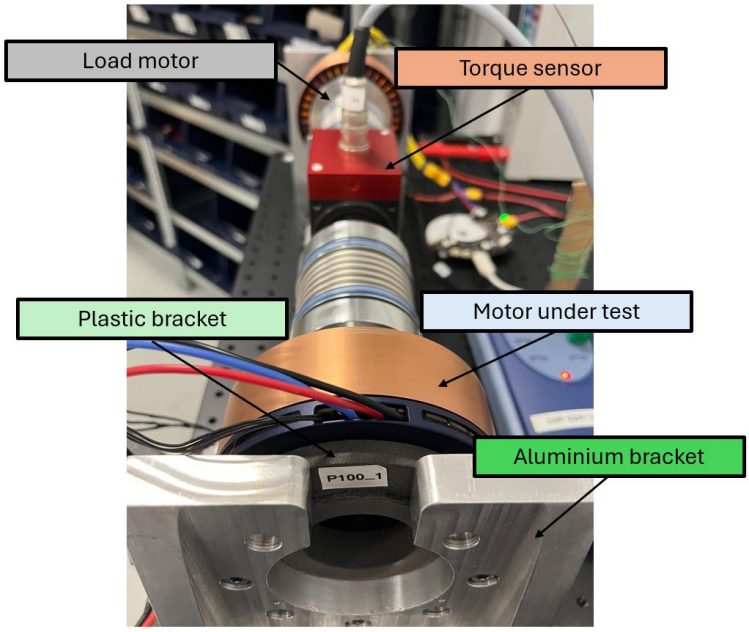
Peak torque is the torque that the motor can deliver during a 10% duty cycle with a period of 1 second. The cycle alternates between zero load for 90% of the period and peak torque for 10% of the period, for a total of 1,000 cycles. During this test, the winding temperature must remain below the limit of 100 °C.

Stall torque is the maximum torque that the motor can deliver at zero speed for a fraction of a second.

Test rig set up

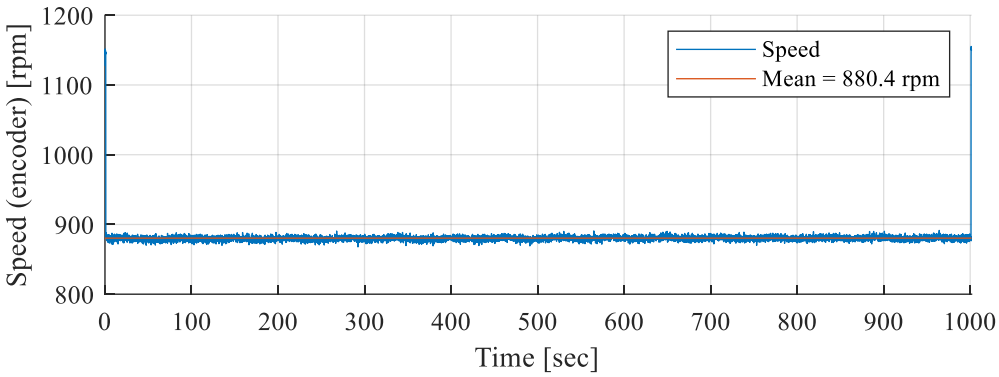
The test rig consists of the motor under test coupled to a load motor through mechanical couplings and a torque sensor. The motor under test is operated in speed-control mode, while the load motor is operated in torque-control mode.

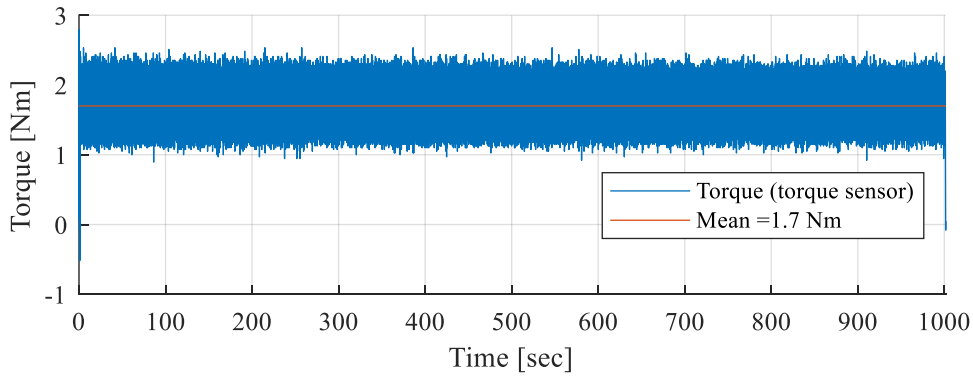
The motor under test is thermally insulated on the non-drive-end side using a plastic bracket**.**

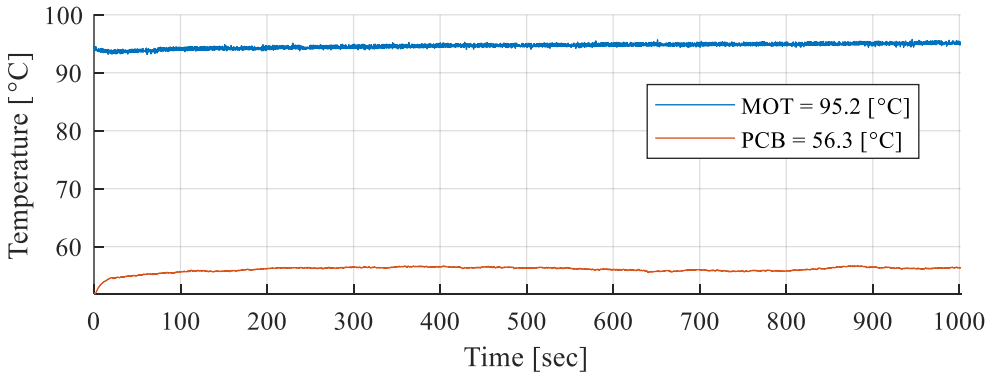


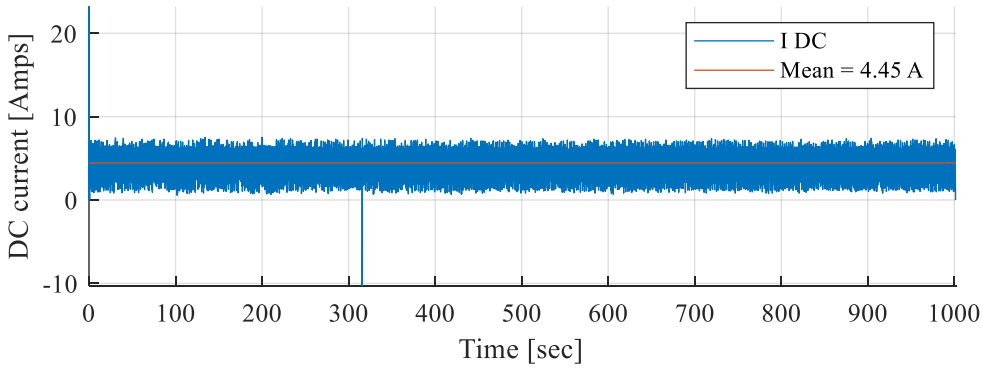
Rated operating point

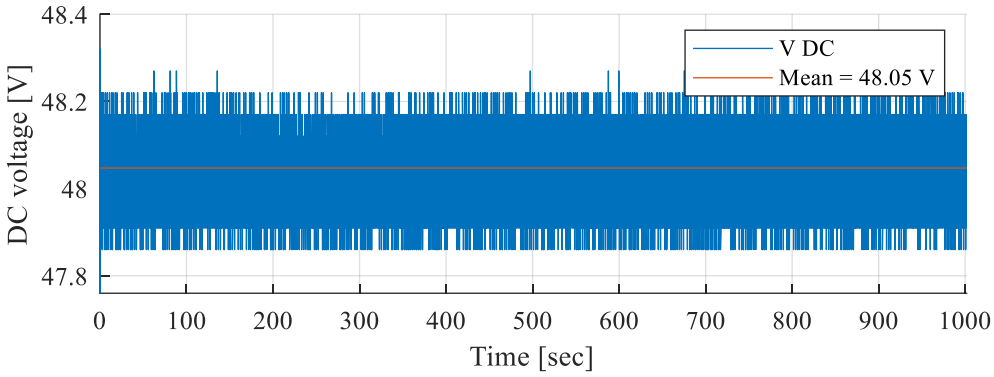
The motor under test, **P90**, delivered a torque of **1.7 Nm** at the rated speed of **880 rpm**. During the test, the winding temperature stabilized at **95.2°C**, remaining below the specified thermal limit. Under these operating conditions, the combined efficiency of the motor and drive electronics was measured at **73.3%**.





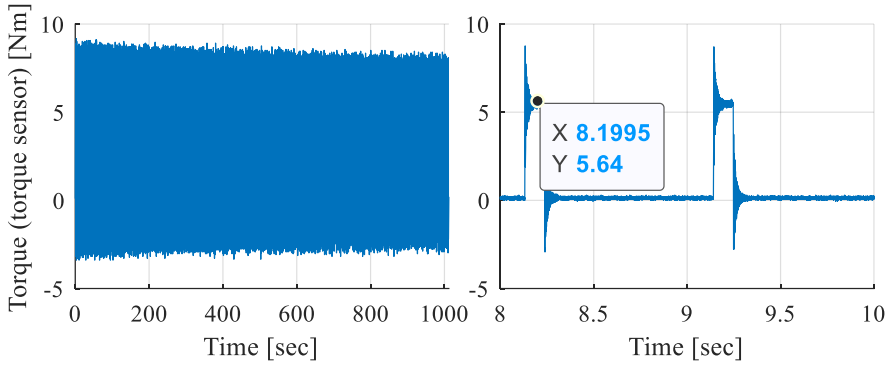


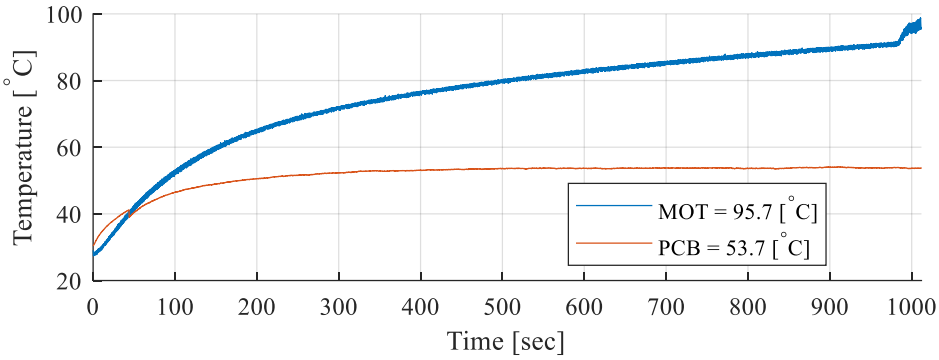

I DC
Mean = 4.45 A
DC current [Amps]
20
10
0
-10
0
100
200
300
400
500
600
700
800
900
1000
Time [sec]

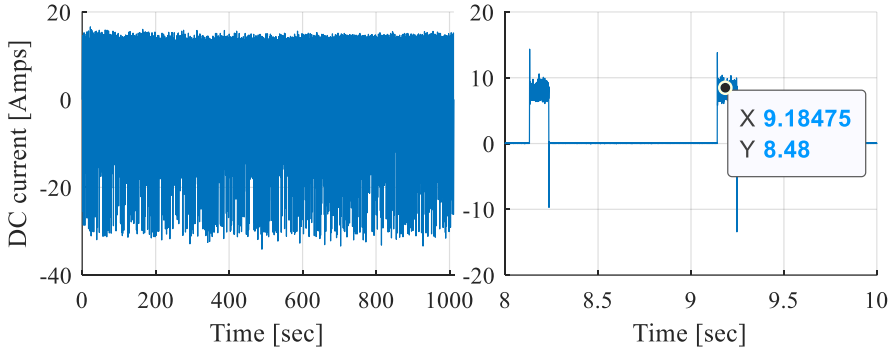

V DC
Mean = 48.05 V
DC voltage [V]
48.4
48.2
48
47.8
0
100
200
300
400
500
600
700
800
900
1000
Time [sec]

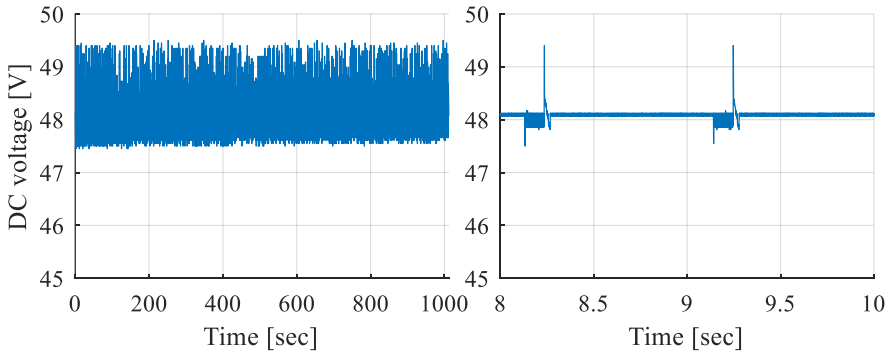
Peak operating point

The motor under test, **P90**, delivered a peak torque of **5.6 Nm** under the specified peak torque duty cycle. During the test, the motor temperature stabilized at **95.7°C**, remaining well below the defined thermal limit. The motor was also able to deliver this torque at a speed of **465 rpm**, confirming its capability to sustain the required peak-torque performance under the tested operating conditions.

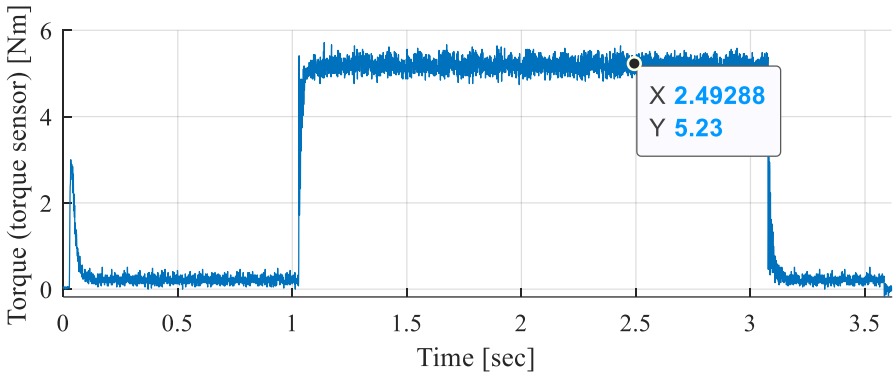


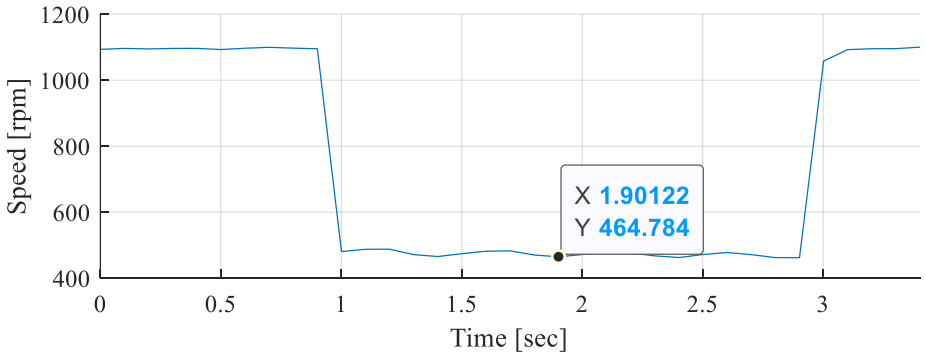


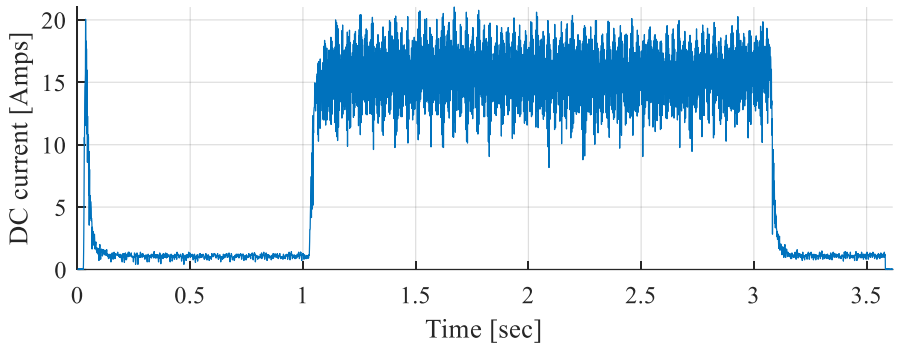


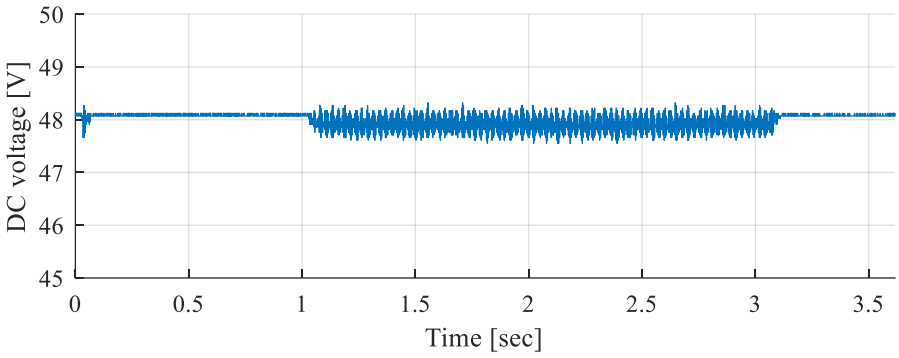


Below are the results of the dynamic experimental tests performed to identify the **maximum rotational speed at which the motor can deliver peak torque**.



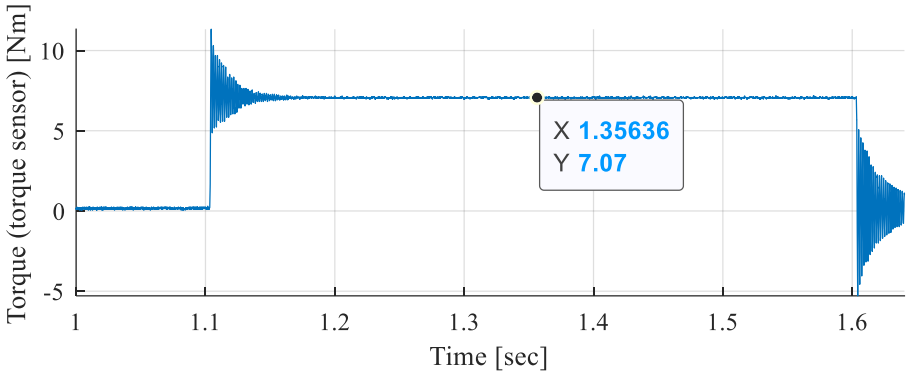


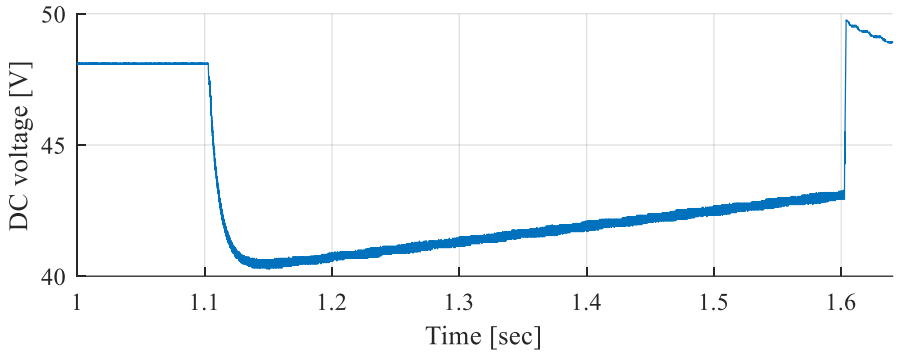

DC current [Amps]
20
15
10
5
0
0
0.5
1
1.5
2
2.5
3
3.5
Time [sec]

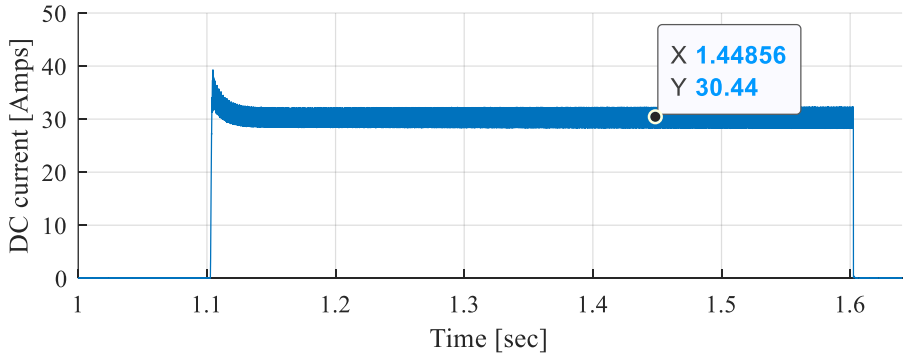

DC voltage [V]
50
49
48
47
46
45
0
0.5
1
1.5
2
2.5
3
3.5
Time [sec]

Stall operating point

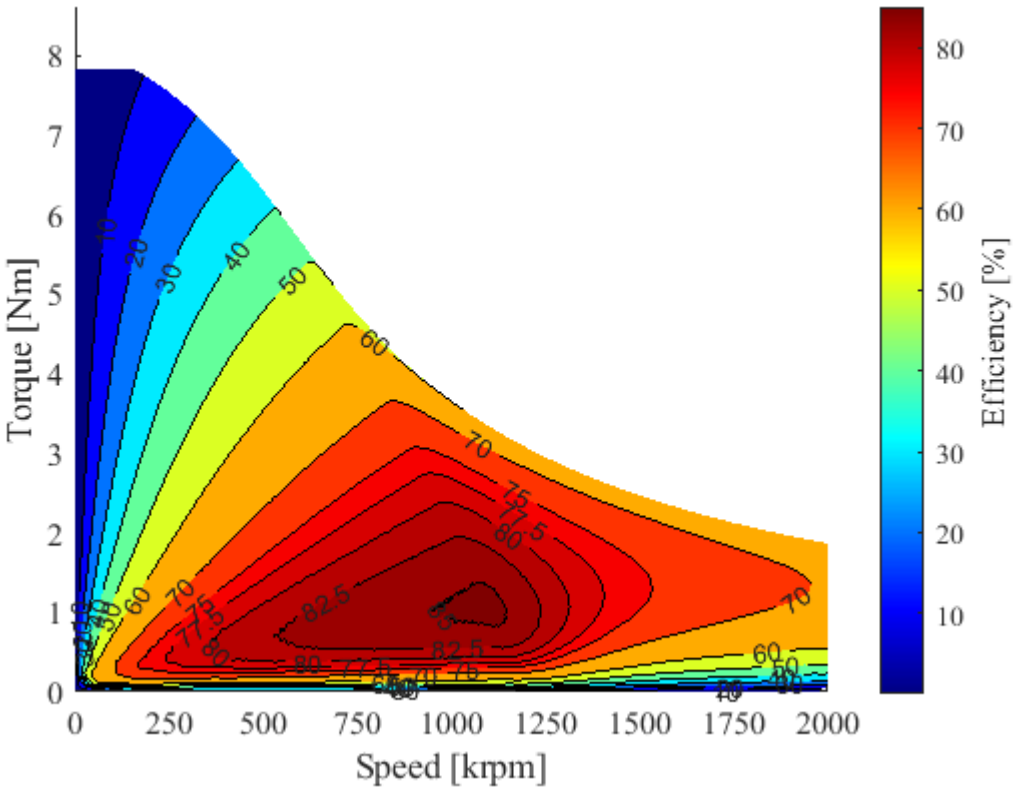
The motor under test, **P90**, delivered a stall torque of **7.07 Nm** at zero speed with a DC current of 30.4 Amps.







Efficiency motor map based on FE analysis



Data sheet

Parameters	Unit	Value
Rated DC voltage	Volt	48
Max AC current peak	A	33
BEMF constant Kv	rpm/V	20.8
Max speed in no-load	rpm	1000
Rated torque	Nm	1.7
Max speed @ rated torque	rpm	880
Rated DC current	A	4.54
Torque constant Kt	Nm/A	0.38
Peak torque	Nm	5.6
Max speed @ peak torque	rpm	465
Peak DC current	A	15
Torque constant Kt	Nm/A	0.37
Stall torque (zero speed)	Nm	7
Peak DC current	A	30.4
Torque constant Kt	Nm/A	0.23
Outer diameter	mm^2	90
Axial stack length	mm	12
Weight (framed)	grams	520
Torque density (frameless)	Nm/Kg	13.5
Inertia (frameless)	$g*m^2$	0.218269

Conclusions

Overall, the **P90 motor successfully demonstrated its capability across the three operating points tested**. At rated conditions, the motor delivered the required torque of **1.7 Nm at 880 rpm**, with the winding temperature stabilizing at **95.2°C**, remaining below the specified thermal limit. The measured combined efficiency of the motor and drive electronics was **73.3%**, confirming stable performance under continuous operation.

Under peak-torque conditions, the motor delivered **5.6 Nm** within the defined duty cycle, with the motor temperature stabilizing at **95.7°C**. This confirms that the motor can safely operate at the required peak torque without exceeding the thermal limit. In addition, the same peak torque was achieved at **465 rpm**, validating the motor's ability to provide high torque at low speed.

Based on these results, the experimental tests confirm that the **P90 motor meets the expected performance requirements in terms of rated torque, peak torque, operating speed, thermal behaviour, and overall efficiency** for the tested operating points.