SENSORLESS MOTOR CONTROL

How an inverter measures the motor it drives

Automatic identification of Rs, Ld, Lq and λm
with the hardware already on the board

Rs

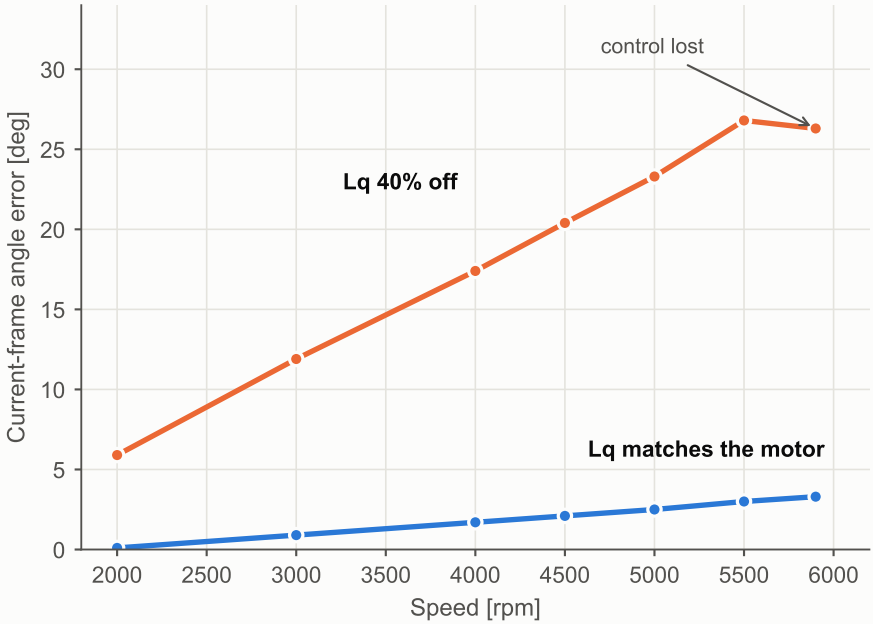
Ld · Lq

λm

THE PROBLEM

The observer is only as good as its motor parameters

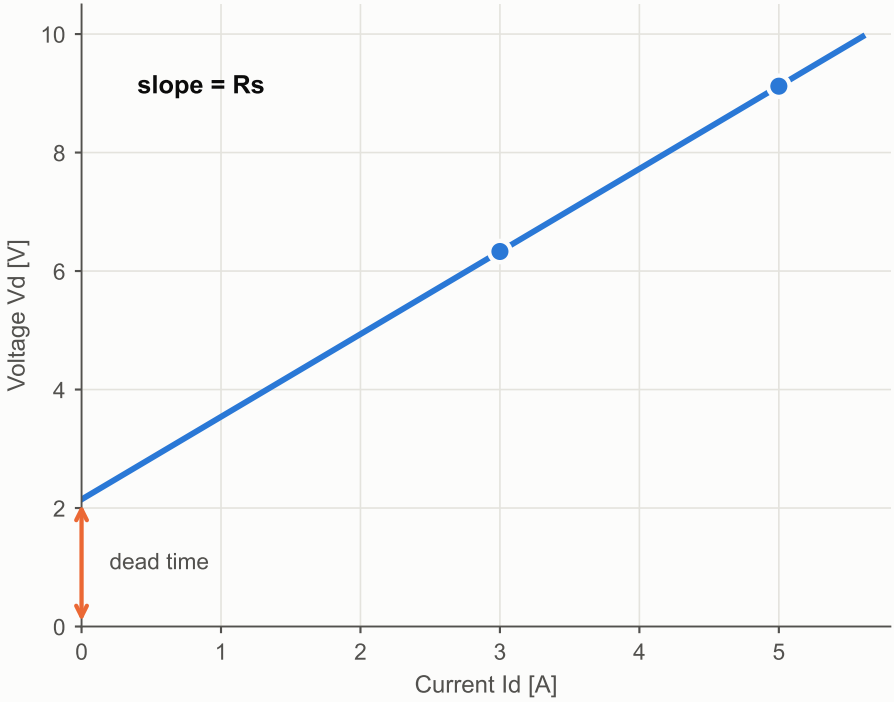
A sensorless DTFC estimates the rotor angle from a motor model. If Lq is off, the angle error grows with current and speed, until the control is lost.



STEP 1 · STANDSTILL

Stator resistance Rs

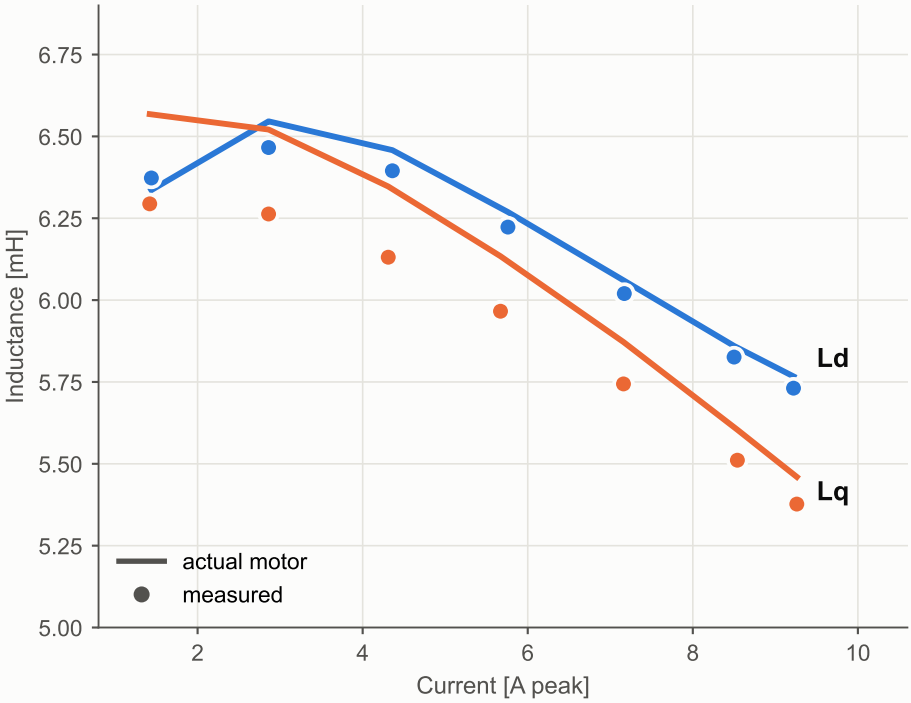
Two DC current levels during rotor alignment.
The slope of V vs. I is Rs.
The intercept is the inverter dead-time drop:
it cancels out of Rs and is reused in step 3.



STEP 2 · STANDSTILL

Inductances Ld(Id), Lq(Iq)

HF sinusoidal voltage injected on d, then q;
synchronous demodulation solves v = R·i + L·di/dt.
Sweeping the current gives the saturation curves.
Lq uses AC current: zero mean torque, no rotation.

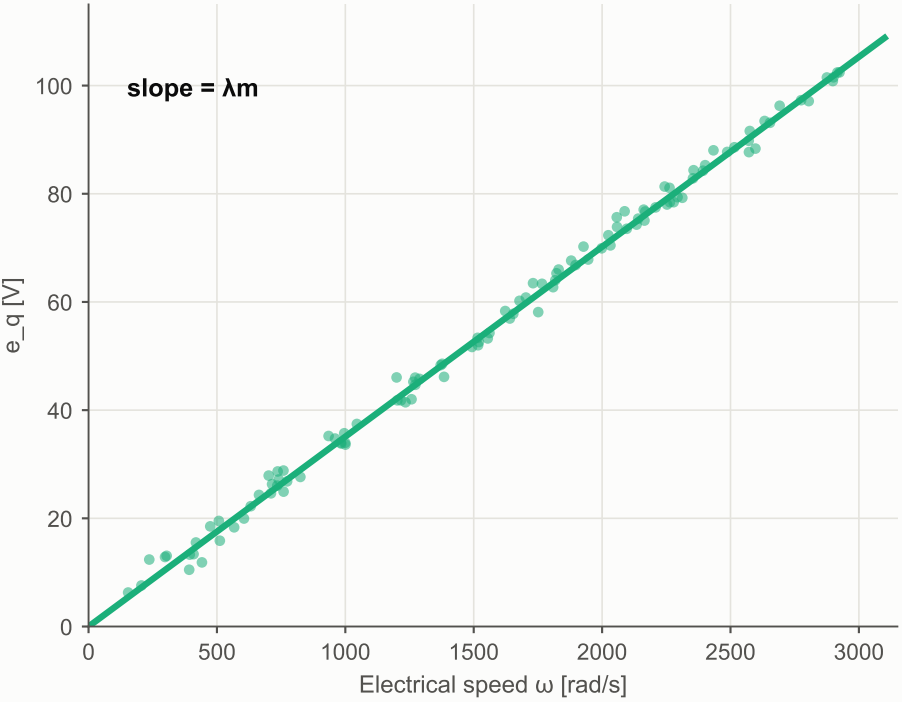


swipe →

STEP 3 · RUNNING

Magnet flux linkage λm

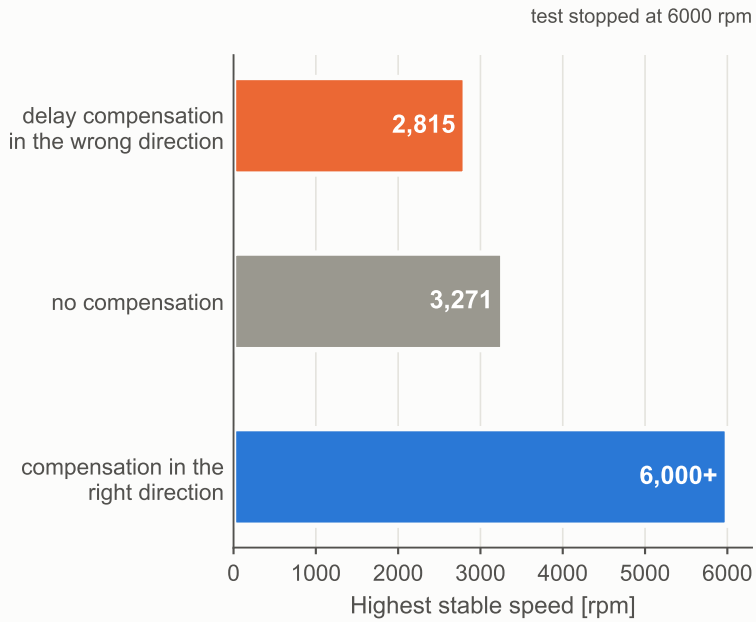
q-axis back-EMF after removing the R, L and dead-time drops: e_q = λm·ω. Least squares with forgetting gives λm, which tracks the magnet temperature.



LESSON LEARNED

Measuring is easy. Timing is hard.

Between sampling the current and applying the voltage there are ~1.5 PWM periods. At 6000 rpm that is 34° of rotation. Compensating it in the right direction moved the stability limit:



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RESULTS

What the inverter now knows on its own

Rs	**±0.4%**	standstill, every start
Ld, Lq	**±4%**	standstill, full saturation curves
λm	**±3%**	online, tracks temperature
Dead time	**±0.3%**	standstill, reused online

Validated in simulation with the real firmware.

How do you identify motor parameters in your drives?