MATLAB simulation of Inverter with use of Park-transforms and cascaded loop

Summary

Specifications:

three-phase four-wire inverter, 115 V rms line-to-neutral, 400 Hz, 30 kW, 400 V DC bus.

Per phase: 87 A rms / 123 A peak into a 1.32 Ω wye load.

Topology:

four-leg voltage source inverter.

Bridge3 (Universal Bridge, 3 arms) drives A/B/C;

BridgeN (1 arm) drives the neutral.

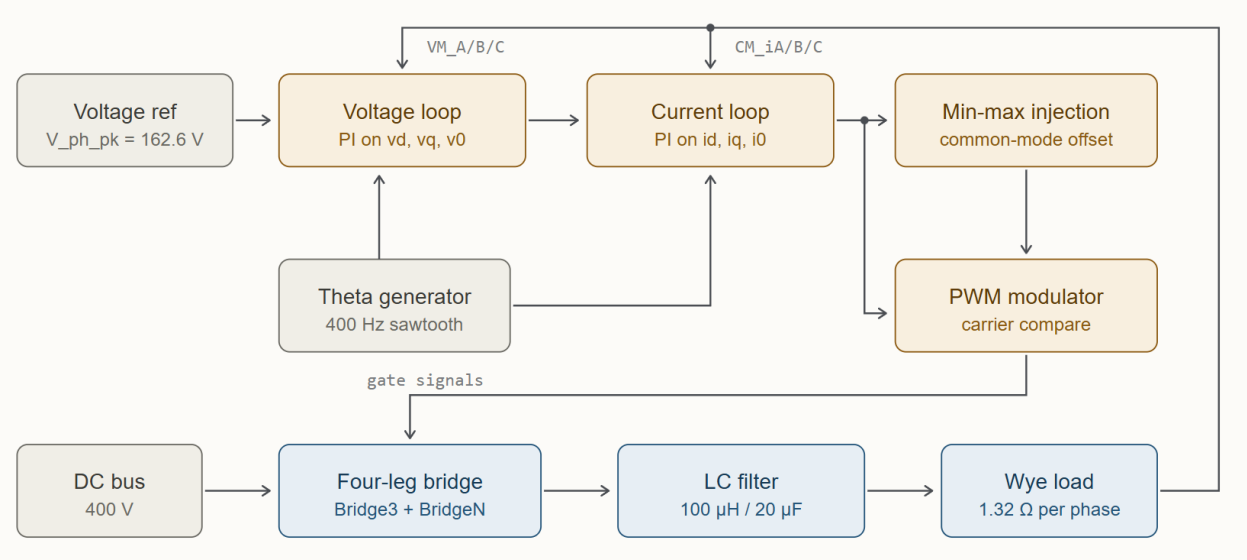
Each phase has a 100 µH / 20 µF LC filter;

The neutral leg has its own 100 µH inductor feeding the neutral bus.

Switching frequency is 40 kHz, control step Ts = 25 µs.

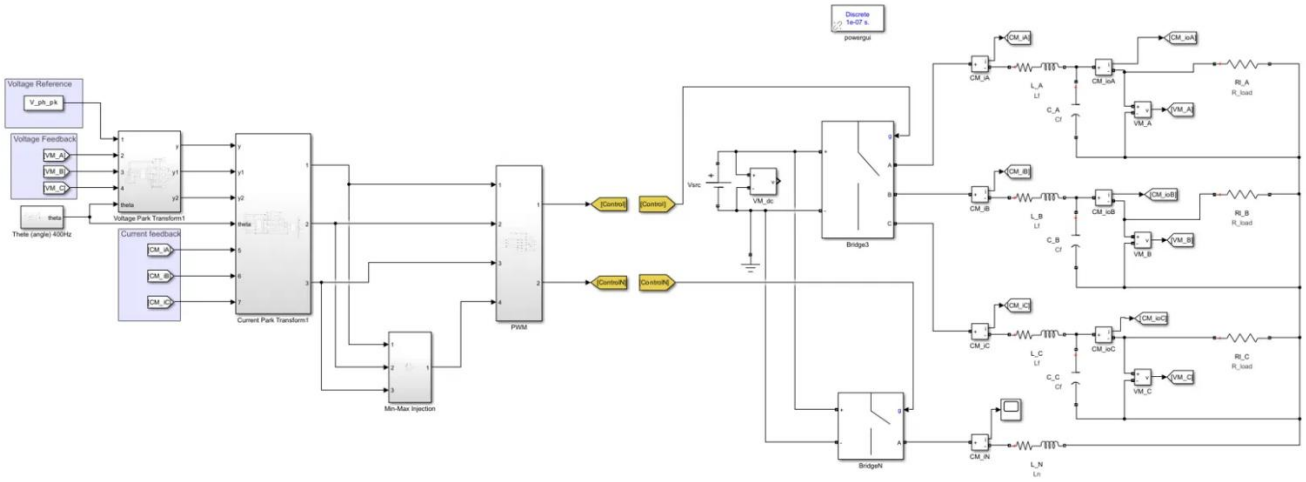
Control:

cascaded dq0. The outer voltage loop Park-transforms VM_A/B/C, compares vd against V_ph_pk = 162.6 V (vq and v0 against zero), and its three PI outputs become idref, iqref, i0ref — these are the reference inputs to the inner loop, which is what makes up the cascaded loop. The inner current loop Park-transforms CM_iA/B/C, forms its errors against those three references, runs PI with ωL cross-coupling decoupling, and inverse-Park's the result into an abc voltage command. Both transforms share one theta source.

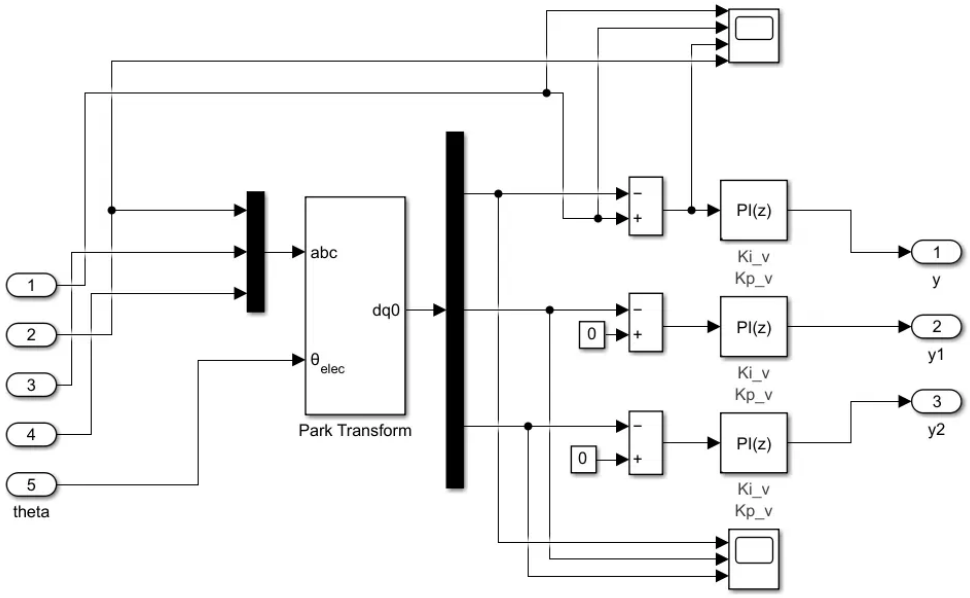


Min-max injection computes v0 = −(max + min)/2 from the three phase commands and adds it to all of them. This raises the usable peak from Vdc/2 = 200 V to Vdc/√3 = 231 V. At the 162.6 V target, modulation index is 0.704.

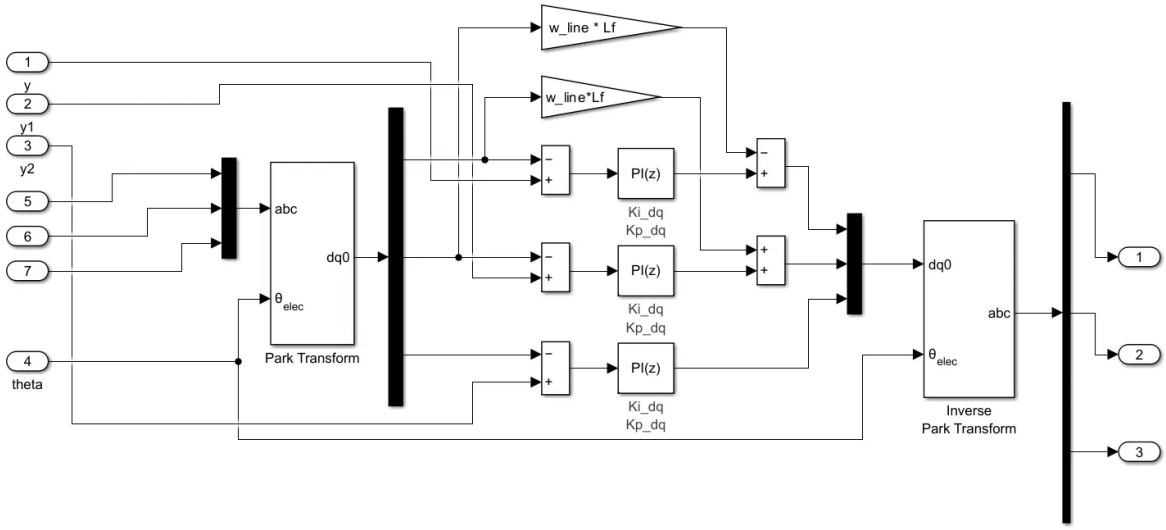
Result: closed-loop simulation settles to VM_A = 162.9 V peak, 112.6 V rms, with clean 400 Hz sinusoidal phase currents at rated load. Bugs found and fixed along the way: Universal Bridge port mapping, an inverted comparator operator, BridgeN driven by a fixed constant instead of the neutral duty command, and PI sample times left inherited rather than Ts.



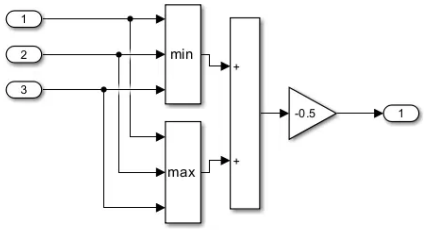
Voltage Park Transform



Current Park Transform



Min_Max Injection



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