

Dynamic Switching with the Coil Driver™

The previous generation of switching technology had topology-based restrictions on the conditions during a switch from series to parallel or vice versa.

This restriction is fundamentally due to the fact that the motor coils are “unclamped” which would result in large over voltage of the semiconductor devices if the switches are actuated with current present. Therefore before actually switching modes, the machine currents must be brought to zero. This had two impacts, a brief torque interruption during operation and more critically, operation in field weakening region is not possible since currents cannot be made zero before transitioning.

The result was typically a 10-20ms “pause” in motor torque production.

Typical sequence of events:

1. The inverter current is set to 0A
2. Once zero current is confirmed the parallel switch is disengaged and the series switch is enabled
3. The inverter can then resume operation

A typical parallel to series switching sequence is shown below

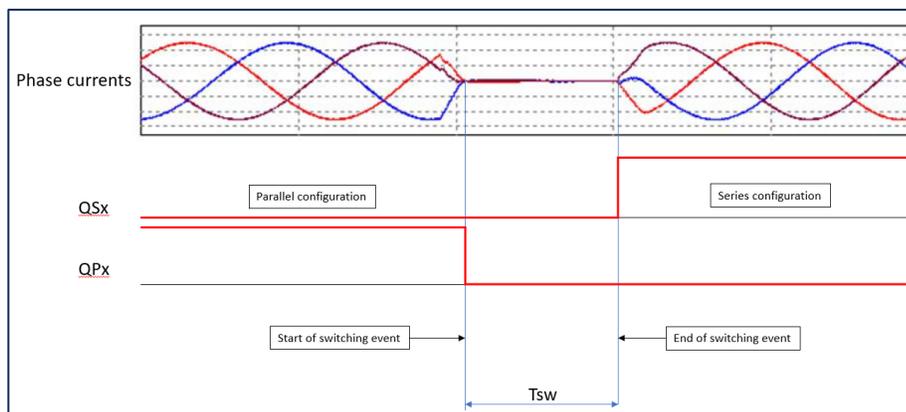


Figure 1. Traditional switching sequence, parallel to series.

With Exro's new Coil Driver topology, these restrictions disappear and there is complete freedom to change modes while the machine is operating. The mode change happens within one system period, in this case PWM frequency is 10kHz, so system period is 100us.

With this new topology mode, switching can happen anywhere in the operating range, including the field weakening region.

This of course presents its own unique set of challenges, namely that the operating point of the motor completely changes when switching modes and the control algorithm must adjust all the control parameters and restart operation without interrupting or affecting the actual phase currents in the machine.

Testing of the initial revision of the algorithm and hardware has been successful, dynamic switching while loaded has been demonstrated in the lab.

Below is a scope capture of the coil currents of one phase with approximately 100Arms of phase current.

- Ch4 = Mode selector pin on the micro controller
- CH1/CH2 are the coil currents of one phase.

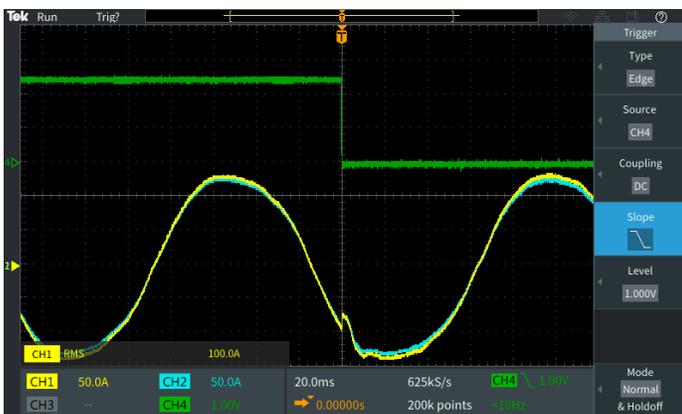


Figure 2. Series to parallel switch with Coil Driver™

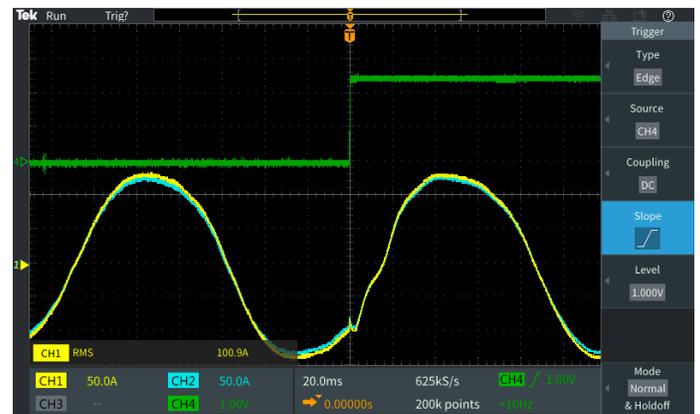


Figure 3. Parallel to series switch with Coil Driver™