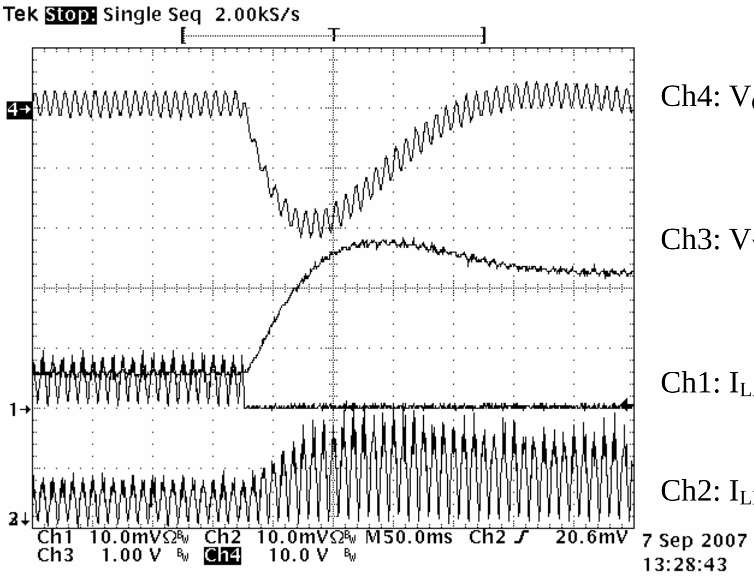
Phase-Management Demonstration

Sept 07, 2007

One common technique to increase light-load efficiency (when using interleaved phases) is to shut down a phase to eliminate its associated switching losses. This is accomplished externally to the UCC28070 by means of enabling and disabling the gate-drive IC driving the MOSFET(s) of the designated phase.

When a phase is shut down, the system voltage-loop gain is cut in half, and the UCC28070 VAO error voltage adjusts to re-establish regulation. V_{OUT} droops about 20V and substantially recovers within 200ms.



Ch4: V_{OUT} 10V/div

Ch3: V_{VAO} 1V/div

Ch1: I_{LA} 5A/div

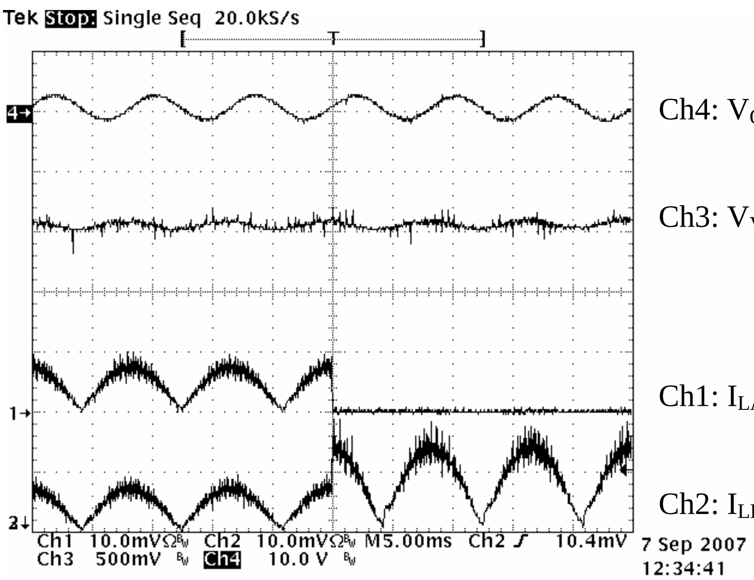
Ch2: I_{LB} 5A/div

A ~20V droop occurs on V_{OUT} because of the slow voltage-loop response of the voltage error amplifier when a phase is dropped.

In this case, P_{OUT} = 500W, V_{AC} = 100Vrms, and Phase-A is shutdown. The current on Phase-B increases as the loop gain is adjusted.

Disturbances at other line voltages are similar for a 500W load. Lower loads have proportionately smaller disturbances.

A simple circuit is can be used to immediately double the R_{IMO} value to compensate for the voltage-loop gain reduction. As a result, the disturbance on V_{OUT} is practicably undetectable.



Ch4: V_{OUT} 10V/div

Ch3: V_{VAO} 1V/div

Ch1: I_{LA} 5A/div

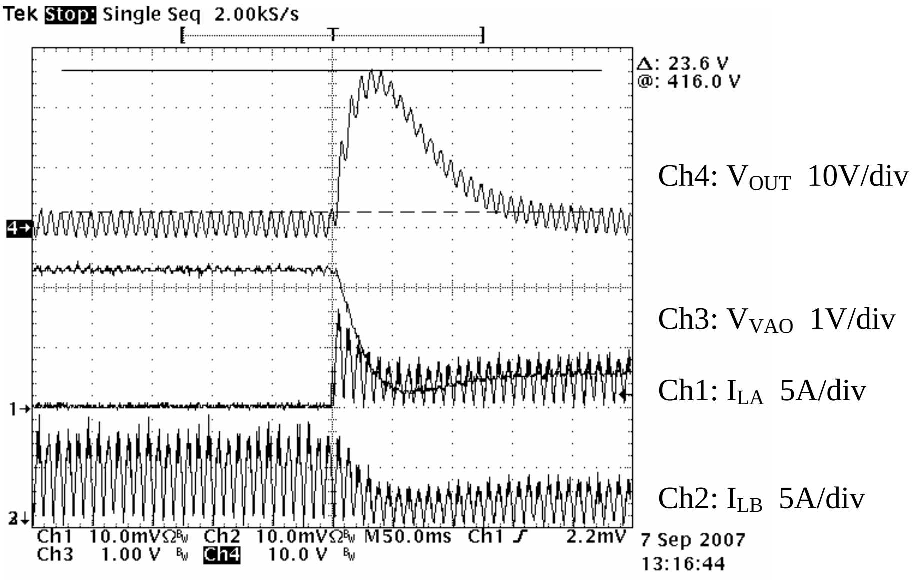
Ch2: I_{LB} 5A/div

With immediate compensation of the R_{IMO} value, virtually no disturbance occurs on V_{OUT} and the VAO output is also undisturbed.

Again in this case, P_{OUT} = 500W, V_{AC} = 100Vrms, and Phase-A is shutdown. The current on Phase-B immediately increases as the loop gain is compensated.

The compensated responses for other line voltages and output loads are the same.

When the shut-down phase is restarted, the system gain is restored, and the UCC28070 VAO error voltage adjusts to re-establish regulation. V_{OUT} overshoots about 24V and substantially recovers within 150ms.

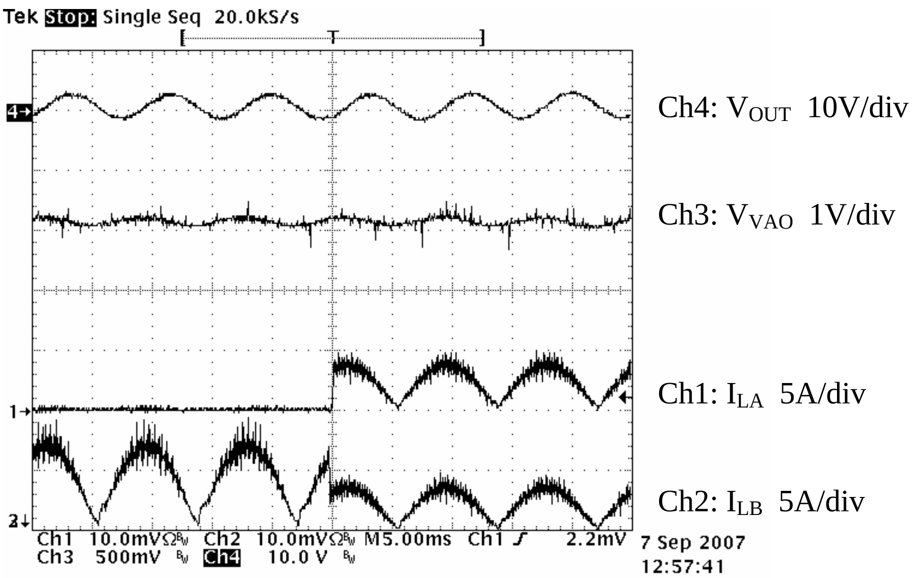


A ~24V overshoot occurs on V_{OUT} because of the slow voltage-loop response of the voltage error amplifier when a phase is added.

In this case, P_{OUT} = 500W, V_{AC} = 100Vrms, and Phase-A is restarted. The current on Phase-B decreases as the loop gain is adjusted.

Disturbances at other line voltages are similar for a 500W load. Lower loads have proportionately smaller disturbances.

The simple compensation circuit immediately restores the R_{IMO} value back to normal to compensate for the system voltage-loop gain increase. As a result, the disturbance on V_{OUT} is again practically undetectable.



With immediate compensation of the R_{IMO} value, virtually no disturbance occurs on V_{OUT} and the VAO output is also undisturbed.

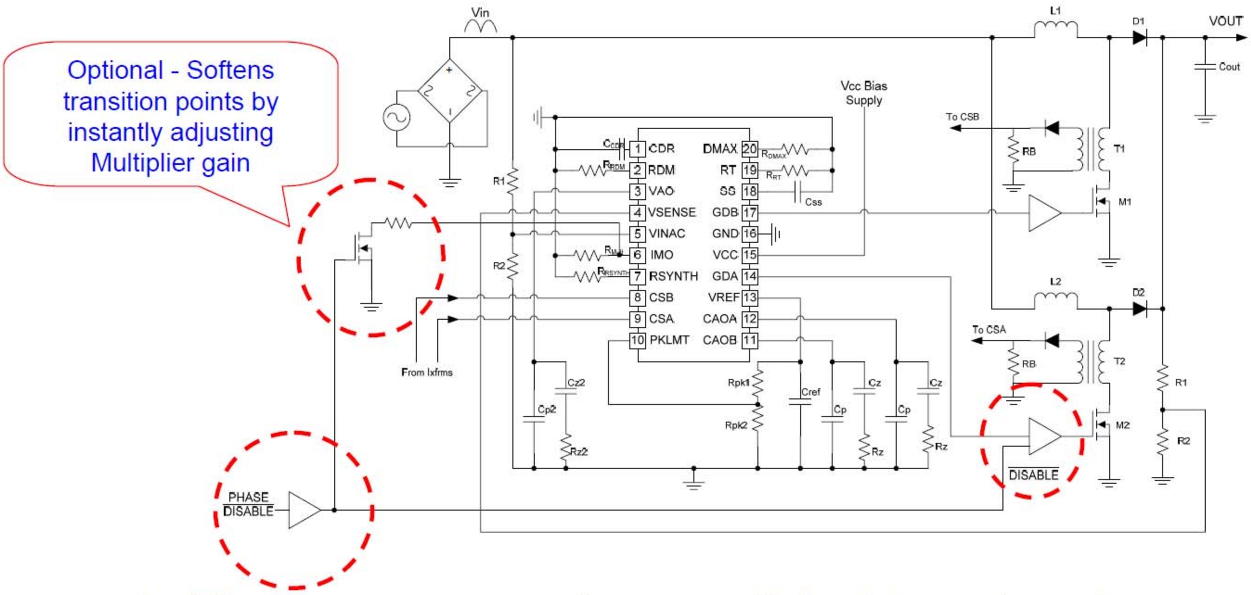
Again in this case, P_{OUT} = 500W, V_{AC} = 100Vrms, and Phase-A is restarted. The current on Phase-B immediately decreases as the loop gain is compensated.

The compensated responses for other line voltages and output loads are the same.

Note: In addition to changing R_{IMO}, the compensation circuit should connect the CAO output of the affected phase to ground to eliminate a restart current spike on I_{IN}. If this CAO output is not grounded when the phase is shut down, it will saturate to ~6V. When the phase is restarted, there is a short time-delay as the CAO voltage decreases from saturation back down to its normal level, during which time the input current for that phase may increase to the peak current limit. This brief current spike (lasting a few hundred microseconds) may add an overshoot to V_{OUT} of a few volts.

The POWER Behind Your Designs

Phase Management Options



- Phase management accomplished by external control of MOSFET-driver enable/disable.
- Simple 2-part circuit can reduce recovery time.