Transient Response of CamSemi Primary Side controllers

Describes how CamSemi products meet tough transient response requirements

- Explains transient response issues
- Real life issues of transient response in a mobile phone
- Proving that transient response >4.2 V is possible

Overview

The **transient response** of a power supply is the affect to it's performance when subjected to load changes.

A simple example would be the change in output voltage of a power supply when a load such as a mobile phone is connected: the transient response is voltage deviation from the time the load is applied until the output returns to its steady-state.

Damping

The response can be classified as one of three types of damping that describes the output in relation to the steady-state value.

Underdamped
An underdamped response is one that oscillates within a decaying envelope. The more underdamped the system, the more oscillations and longer it takes to reach steady-state. In this case the damping ratio is always <1.

Critically damped
A critically-damped response is the response that reaches the steady-state value the fastest without being underdamped. It is related to critical points in the sense that it straddles the boundary of underdamped and overdamped responses. Here, the damping ratio is always less than or equal to one (≤1) and in the ideal case there should be no oscillation about the steady-state value.

Overdamped
An overdamped response is when the response does not oscillate about the steady-state value but takes longer to reach it than the critically damped case. In this case the damping ratio is >1.

Properties

Rise time
Rise time is defined as "the time required for the response to rise from x% to y% of its final value", with 0 to 100% rise time common for overdamped second order systems and 10 to 90% for underdamped.

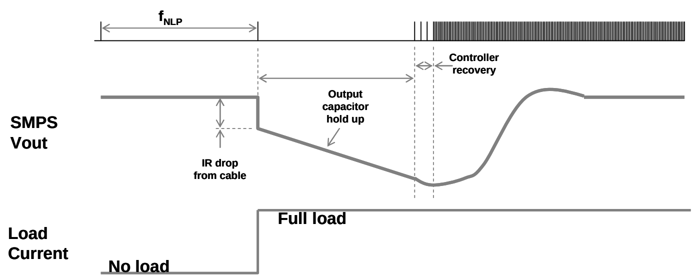
Overshoot
Maximum Overshoot is defined as "the maximum peak value of the response curve measured from the desired response of the system".

Settling time
Settling time as "the time required for the response curve to reach and stay within a range of certain percentage of the final value".

Steady-state error
Steady-state error of a system is "the difference between the desired final output and the actual one" when the system reaches a steady state, when its behaviour may be expected to continue if the system is undisturbed.

Transient Response in a mobile phone charger

Waveform



Key Parameters affecting transient response

IR drop from cable
- Determined by cable resistance (AWG)
- Larger cables have less IR drop

Output capacitor holdup
- Determined by load step size, output capacitance and fNLP

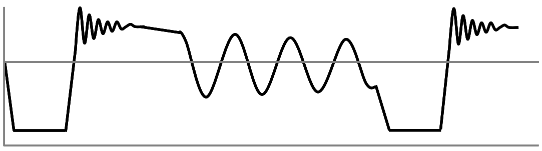
Controller recovery
- Determined by internal control loop of controller IC

Total transient droop

- VDROOP=IOUT * RCABLE + VHOLDUP + VLOOP

No-load operating frequency (f_{NLP})

- Lower f_{NLP} delivers lower no-load power but means more voltage drop from output capacitor holdup
- Very low primary peak current (small t_{ON}) enables higher f_{NLP}
  - Minimum energy must be supplied to SMPS at no-load
- "Tangent method" sampling enables very small t_{ON} from controller
  - Smaller t_{ON} results in smaller transformer reset waveform
  - Leakage inductance noise can impact feedback measurement for very small transformer reset measurements
  - Digital sampling techniques can be noisy
  - Fixed sampling technique cannot avoid leakage oscillation



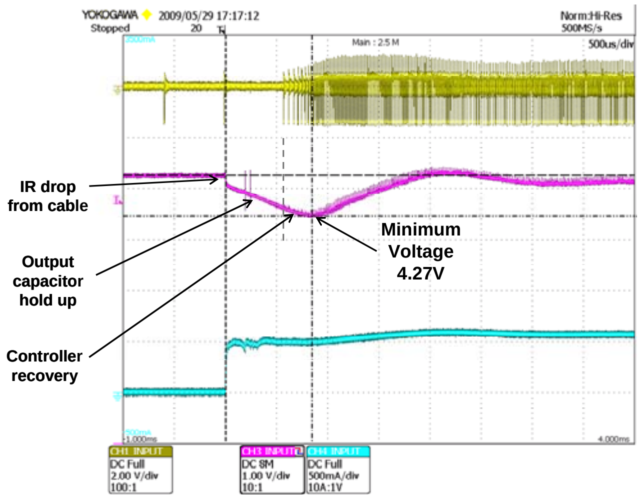
CamSemi transient response

A typical mobile phone manufacturer's specification includes transient response to protect components within and the performance of a mobile phone.

CamSemi has developed a demonstrator board to demonstrate that this can be achieved.

AD-2968 demonstrator specification using CamSemi C2161PX2 controller		
Requirement	**Result**	**Pass/Fail**
5.1 V/550 mA	5.1 V/550 mA	Pass
< 30 mW NLP (5-star)	28 mW	Pass
>4.2 V during 0% to 100% load transient	**4.31V to 4.27 V**	**Pass**
<1 s startup time	210 ms	Pass
64%	73%	Pass

Proving >4.2 V during 0 to 100% load transient



Vdroop=Iout*Rcable + Vholdup + Vloop

For 26AWG and 660uF (2x330uF):
Vdroop = 0.79 = 0.20 + 0.46 + 0.13
Vmin = 5.1 – 0.79 = 4.31V

4.31 V – 4.2 V = 110 mV of margin

For 28AWG and 800uF (330uF+470uF):
Iout*Rcable = 0.32
Vholdup = 0.38
Vdroop = 0.83 = 0.32 + 0.38 + 0.13
Vmin = 5.1 – 0.83 = 4.27V

4.27 V – 4.2 V = 70 mV of margin

Controller Series

The following controller options are available:

Part Number	Output Power W	Package
C2161PX2	1-4 W	SOT23-6

For more Information

For details of our channel partners and information on future product, technology or corporate announcements, visit www.camsemi.com

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