1. DC-DC Fundamentals

XIANG FANG: Hi, welcome to the DC/DC fundamentals.This is Xiang.In this section, we'll give you an introduction to the converter control.

...

2. What is Converter Control?

What is converter control?A converter can provide a constant voltage output at various conditions because of the closed-loop control system that's implemented inthe circuit.A simple control system has a feedback path from the output to the input.As you can see on this graph here, the system gain is actually the ratio of the control output ofthe reference input.Without the feedback path, H, it's an open loop system.And again, it's G With the feedback, the closed loop system, the gain can become G over 1 plus Gtimes H. And the GH is called the closed loop gain.

...

3. How Does a Control System Work?

So how does the control system work.Here on these slides, we a simplified control scheme of a non-synchronous buck regulator.As you can see, the output voltage is sensed through a sensor gain, HS, and the sensed gain signal, asensed voltage signal, is compared with reference voltage.And this error signal VE then goes through a compensator, becomes a control signal.The control signal will go through the power switch modulator to control the switch on and off time off theswitch.So in this way, the closed loop system can maintain the output stability of this regulator.

...

4. Bode Plots

Bode plots.A control system is often the analyzed in the plot of the gain magnitude and phase over the frequency domain.And it's known as the Bode plot.And the control system can be expressed in transfer function.So therefore, this transfer function can be plotted in the Bode plots.And as you can see, the gain magnitude is shown in dB units.And the phase is in angle degree.And the frequency is usually plotted in lock scale.

...

5. Poles and Zeros

Poles and zeroes of a transfer function, it's important characteristic parameters of a transfer function.On the left side, we show the Bode plot of a pole.As you can see, the gain magnitude, the slow change by negative 20 dB per decades.And you also can cause a negative 90 degree phase shift in the transfer function.On the right side, it is a zero Bode plot.The slope changes by plus 20 degrees for decades.And the phase shift, it's a positive 90 degree.And a zero can cancel the effect of a pole.

...

6. How to Get a Bode Plot

So how to get a Bode plot of a control system?Actually, from the paper design, the transfer function of a converter can be derived from its circuit model.So the Bode plot can be obtained from derived equations.Also, the Bode plot can be measured on the network analyzer by injecting a small AC signal into the feedbackloop.And, by sweeping the frequency, we can measure the AC signal, and, comparing these signals, we can get the Bodeplot. As so you can see, in the circuit graph here, we're injecting the AC signal through point A and pointB. And by measuring the signal over point A and point B, actually, the loop gain will be the signalat point A divided by the single at point B. Control stability.

...

7. Control Stability

A closed loop system becomes unstable when the phase of the loop gain approaches 180 degrees while the gain isstill positive.And this will cause instability issues through the regulation.So to ensure the stability, the phase margin must be positive at the crossover frequency.The crossover frequency is the frequency that where the loop gain magnitude is one.And the phase margin is the phase difference of the loop gain and minus 180 degree at crossover frequency.

...

8. Compensator

A compensator is included in the closed loop system to tune the loop gain.So to ensure the system is stable and has good transient response.The compensation is usually adjusted by changing the RC components around the error amplifier.As you can see here, on the left side, it shows the simplified circuit of a compensator.And on the right side, is how this loop gain going add it to the gain without the compensation andeffect the whole loop gain.

...

9. Summary

So in this section, we give you an introduction to the converter control and talk about the basics about theBode plot and talk about the control stability issue and the compensation of a control loop.

...

10. Thank you!

Thank you.

...