Derivation of Loop Gain and Phase from Output Impedances in DC-DC Buck Converter

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Research Background

• Measurement of the loop gain is important to evaluate the stability of the negative feedback system.

Conventional Method

• Measurement requires breaking the feedback loop, which is inconvenient.

Disadvantage of Conventional Method

• It is necessary to inject a voltage signal into the feedback loop by breaking the loop.
• If the control circuits are implemented on an IC, this method is NOT applicable.

Purpose of This Work

• To measure the loop gain without breaking the feedback loop.
• To develop a new method to derive the loop gain from output impedances in dc-dc buck converter.
• To demonstrate the proposed method by simulation and experimental evaluations.

Derivation of Proposed Method

Conventional

Proposed

Contribution

Phase of Loop Gain

Comparator

Vin

Vo

L

Co

RL

SW=On: Zo meas.

SW=Off: Zoc meas.

Q1

Evaluation board

FRA

DC-DC Buck Converter Circuit

Functional Block Diagram

Phase of Loop Gain

Magnitude of Loop Gain

Phase of Loop Gain

arg(T) = arg(Zo) - arg(Zoc)

Parameter

Vin = 12V

Vo = 5V

RL = 50

L = 120μH

Co = 1.2μF

Vin L

Co RL

Error Amp

Comparator

Saw-Tooth

Generator

Vref

Vo

Vo'

D1

Q1

Phase Margin

Gain Margin

|Aβ| dB

Phase ∠Aβ

Gain

|Zo| dB

Phase (°)

Conventional

Proposed

Simulation Results

Experimental Results

• We have proposed a method to derive the loop gain from the output impedances in dc-dc buck converter.
• We showed effectiveness of the proposed method with simulations and experiments of dc-dc buck converter.
• We found out that sufficient evaluation of phase margin and gain margin is possible.