A Fully Integrated Cartesian Feedback Linearization System

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Joel L. Dawson
Ph.D. Candidate, Stanford University
Overview

- Cartesian feedback: merits, design issues
- The problem of phase alignment
- Fully integrated, linearized PA project
Bandwidth limitation, and phase alignment issues, but...
Fundamental strength of CFB:

Relaxes demand for an accurate, detailed PA model.
Using CFB to train a predistorter:

\[ H(s) \]

\[ \Sigma \]

\[ \sin(\omega t) \]

\[ \cos(\omega t) \]
In real CFB systems, apparent LO phase misalignment threatens stability.
Analog Control Solution
Part I

\[ \theta - \theta' = \phi \]

\[ IQ' - QI' = rr'sin(\theta - \theta') \]
Analog Control Solution
Part II

\[ \frac{d\theta}{dt} = -\kappa [r(t)]^2 G \sin(\theta - \theta') \]
Fully integrated prototype: exploiting CFB’s strengths

External compensation

Predistort I/O

Phase align

H(s)

I

Q

H(s)

I

Q

RF

LO

PA

I'

Q'

I

LO

RF

Q

I

Q
RF feedback: capacitive voltage divider
Loop gain and dynamics

External compensation

$H(s)$

Output

Compensation pins

bias1

bias2

bias3

bias4

Output

Consider the circuit diagram showing the loop gain and dynamics. The diagram includes a block labeled $H(s)$, which represents the transfer function of the system. The feedback loop is depicted with a summation symbol ($\Sigma$) and the output is indicated. The external compensation is shown with a separate block connected to the system. The diagram also highlights compensation pins that are crucial for adjusting the system's characteristics.
Downconverter design

Linearity of system limited by this block.
Current status of project

- Third version of IC has been fabricated, and testing in progress.
- Phase alignment system verified to be working, and characterized.
- Power output $> +13.4$ dBm
- Cartesian feedback loop successfully closed; linearization behavior observed but not yet measured.