Structured Electronic Design

Quiz biasing techniques

Anton J.M. Montagne
Biasing Techniques
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Brute force
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Brute force

Fix the relation between a branch voltage and current simply through insertion of a two-terminal element with the desired v-i relation in that branch.
Biasing Techniques

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Fix the relation between a branch voltage and current simply through insertion of a two-terminal element with the desired v-i relation in that branch

Compensation
Biasing Techniques

Brute force
Fix the relation between a branch voltage and current simply through insertion of a two-terminal element with the desired v-i relation in that branch

Compensation
Reproduce the error at some location in a system
Biasing Techniques

Brute force
- Fix the relation between a branch voltage and current simply through insertion of a two-terminal element with the desired v-i relation in that branch

Compensation
- Reproduce the error at some location in a system
  Subtract it from the signal at that location
Biasing Techniques

Brute force
Fix the relation between a branch voltage and current simply through insertion of a two-terminal element with the desired v-i relation in that branch

Compensation
Reproduce the error at some location in a system Subtract it from the signal at that location

Negative feedback
Biasing Techniques

Brute force
Fix the relation between a branch voltage and current simply through insertion of a two-terminal element with the desired v-i relation in that branch

Compensation
Reproduce the error at some location in a system Subtract it from the signal at that location

Negative feedback
Measure the response
Biasing Techniques

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Compensation

Reproduce the error at some location in a system Subtract it from the signal at that location

Negative feedback

Measure the response

Compare it with the desired value
Biasing Techniques

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Compensation
Reproduce the error at some location in a system
Subtract it from the signal at that location

Negative feedback
Measure the response
Compare it with the desired value
Nullify the difference
Biasing Techniques

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Fix the relation between a branch voltage and current simply through insertion of a two-terminal element with the desired v-i relation in that branch

Compensation

Reproduce the error at some location in a system Subtract it from the signal at that location

Negative feedback

Measure the response Compare it with the desired value Nullify the difference
Brute-force biasing
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BSc course structured electronic design:
Brute-force biasing

BSc course structured electronic design:

Insertion of impedances in series or in parallel with the signal path should be avoided:
Brute-force biasing

BSc course structured electronic design:

Insertion of impedances in series or in parallel with the signal path should be avoided:

  Deterioration of the noise performance
BSc course structured electronic design:

Insertion of impedances in series or in parallel with the signal path should be avoided:

- Deterioration of the noise performance
- Increase of power dissipation
Brute-force biasing

BSc course structured electronic design:
Insertion of impedances in series or in parallel with the signal path should be avoided:
- Deterioration of the noise performance
- Increase of power dissipation
- Increase of energy storage
Brute-force biasing

BSc course structured electronic design:

Insertion of impedances in series or in parallel with the signal path should be avoided:

- Deterioration of the noise performance
- Increase of power dissipation
- Increase of energy storage
- Deterioration of the overdrive recovery
Brute-force biasing

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Brute-force biasing

Brute-force fixing of the gate voltage:
Brute-force biasing

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Brute-force fixing of the gate voltage:

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Brute-force fixing of the gate voltage:

Deterioration of the noise performance

Brute-force fixing of the drain voltage for a given drain current:
Brute-force biasing

BSc course structured electronic design:

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Brute-force fixing of the gate voltage:
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Brute-force fixing of the gate voltage:
- Deterioration of the noise performance

Brute-force fixing of the drain voltage for a given drain current:
- Increase of power dissipation

AC coupling: insertion of a voltage level shift in series with the signal path through insertion of a capacitor:
Brute-force biasing

BSc course structured electronic design:

Insertion of impedances in series or in parallel with the signal path should be avoided:

- Deterioration of the noise performance
- Increase of power dissipation
- Increase of energy storage
- Deterioration of the overdrive recovery

Brute-force fixing of the drain voltage for a given drain current:

- Increase of power dissipation

AC coupling: insertion of a voltage level shift in series with the signal path through insertion of a capacitor:

- Deterioration of start-up behavior and overdrive recovery
Brute-force biasing

BSc course structured electronic design:

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- Deterioration of the noise performance
- Increase of power dissipation
- Increase of energy storage
- Deterioration of the overdrive recovery

Brute-force fixing of the drain voltage for a given drain current:

- Deterioration of the noise performance
- Increase of power dissipation

AC coupling: insertion of a voltage level shift in series with the signal path through insertion of a capacitor:

- Deterioration of start-up behavior and overdrive recovery
Model-based biasing
Model-based biasing

Application of Compensation
Model-based biasing

Application of Compensation

Requires reproduction of the error
Model-based biasing

Application of Compensation

Requires reproduction of the error
Limited improvement: imperfect reproduction (matching error):
Model-based biasing

Application of Compensation

Requires reproduction of the error
Limited improvement: imperfect reproduction (matching error):

Needs to change with temperature to ensure a temperature-independent drain current
Model-based biasing

Application of Compensation

Requires reproduction of the error
Limited improvement: imperfect reproduction (matching error):

Generates the temperature-dependent gate-source voltage

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Model-based biasing

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Limited improvement: imperfect reproduction (matching error):

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Needs to change with temperature to ensure a temperature-independent drain current
Feedback biasing
Feedback biasing

Automatic reduction of biasing errors
Feedback biasing

Automatic reduction of biasing errors

Only possible if frequency components of biasing errors and of signal do not overlap
Feedback biasing

Automatic reduction of biasing errors

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Requires a loop filter: DC transfer will (ideally) be zero
Feedback biasing

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Requires a loop filter: DC transfer will (ideally) be zero
Electronic self inductance
Electronic self inductance

At low frequencies: low impedance in parallel with the signal path
Electronic self inductance

At low frequencies: low impedance in parallel with the signal path
At high frequencies: high impedance in parallel with the signal path
Electronic self inductance

At low frequencies: low impedance in parallel with the signal path
At high frequencies: high impedance in parallel with the signal path
Electronic self inductance

At low frequencies: low impedance in parallel with the signal path
At high frequencies: high impedance in parallel with the signal path

Output impedance?
Electronic self inductance

At low frequencies: low impedance in parallel with the signal path
At high frequencies: high impedance in parallel with the signal path
Electronic self inductance

At low frequencies: low impedance in parallel with the signal path
At high frequencies: high impedance in parallel with the signal path

Output impedance?
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At low frequencies: low impedance in parallel with the signal path
At high frequencies: high impedance in parallel with the signal path

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At low frequencies: low impedance in parallel with the signal path
At high frequencies: high impedance in parallel with the signal path
Electronic self inductance
Some examples

Applied techniques

1. compensation
2. model-based biasing
3. brute force technique
4. negative feedback biasing
5. electronic self inductance