Structured Electronic Design

Selection of the loop gain reference

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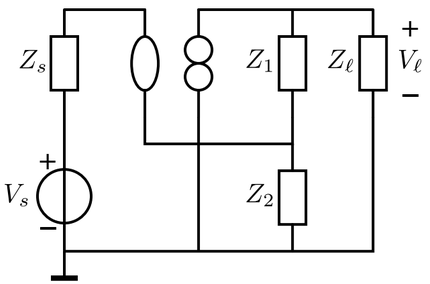
Two-step design

First design step: design of ideal transfer:

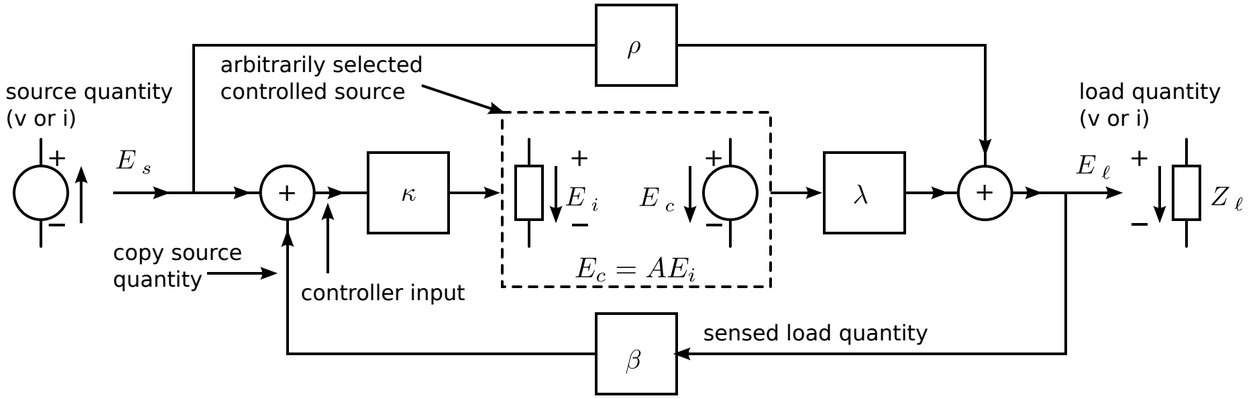
- Load quantity sensing
- Feedback network with reciprocal transfer
- Source quantity comparison
- Error nullification



controller = nullor:
ideal gain:

$$A_i = \frac{Z_1+Z_2}{Z_2}$$

Generalized model of network with feedback:



$$A_{f\infty} = \rho - \frac{1}{\beta}$$

$$A_f = A_{f\infty}\frac{-L}{1-L} + \frac{\rho}{1-L}$$

Ideal gain = asymptotic gain
if the controller behaves as a nullor in cases in which the gain of the loop gain reference becomes infinity

See example 10.3

Two-step design if:

$$A_{f\infty} = A_i$$

Step 1 → $A_f = A_i\frac{-L}{1-L}$ ← Step 2

Selection of the reference variable

If such a selection is not possible:

The loopgain is NOT the unique measure for describing the correspondence between the gain and the ideal gain

Problems

The controller seldom behaves as a natural two-port:

- According to network theory, a network can be modeled as a two-port if:
  - It has only three nodes
  - The ports are terminated with one-ports
  - The network is a natural two-port
- In other cases the network needs to be modeled with more than two equations:
  - Effects of common-mode port voltage/current cannot always be ignored

There often exist local feedback loops inside the controller

- The loop gain reference should not be selected inside such a loop

Check

Over the operating range of interest (frequency, signal excursions):

- The asymptotic-gain should approximate the ideal gain
- The direct transfer should be much smaller than the ideal gain

Conclusions

The source-to-load transfer obtained from asymptotic-gain model always equals the source-to-load transfer obtained from network analysis, regardless the selection of the reference variable.

The asymptotic-gain model facilitates the two-step design of feedback amplifiers

This requires proper selection of the loop gain reference

- Controller becomes nullor if loop gain reference is replaced with a nullor

Proper selection of the loop gain reference can be verified:

- Asymptotic-gain should approximate the ideal gain
- Contribution of direct transfer to the gain should be negligible