9.3 Common-Mode Rejection **613**

**There are lots of errata in the textbook’s version of this example.**

On page 614   
In the 9th line of the blue text-box replace “2% mismatch” with “1% mismatch”.   
In equation 9.87 change 0.02 to 0.01.   
About 2/3 down the page replace with   
Two more lines down replace with   
Two more lines down replace with   
Two more lines down replace with

On page 615  
At the top of the text box the caption label is missing. Insert “Example 9.4 *continued*” similar to that on page 614.  
About a quarter of the way down the page  
Replace with   
On the next line replace with   
Two lines down replace with   
On the next line replace with   
Two lines down replace with

The corrections above are minimal. There remain issues with units that are omitted.  
The example shown below contains additional corrections to units.

As printed in the textbook, some of the example is missing various units and algebraic details are omitted.   
The presentation below shows the units consistently and shows more of the algebra.

More complete algebra and units more consistently represented.

**Example 9.4b**

In this example we consider the design of the current source that supplies the bias current of a MOS differential amplifier. Let it be required to achieve a CMRR of 100 dB and assume that the only source   
of mismatch between and is a 2% mismatch in their ratios. Let and assume

**Example 9.4b** *continued*

that all transistors are to be operated at . For the CMOS fabrication process available, . If a simple current source is utilized for , what channel length is required?  
If a cascode current source is used, what channel length is needed for the two transistors in cascode?

Solution

A mismatch in results in a mismatch that can be found from the expression of . The expression on the next line can be derived from Eq (7.41) on Page 386 and Eq (5.11) on Page 252.

Define , a 2% increase. Similarly define

It is thus shown that an error of 2% in will result in an error in of 1%. That is, the 2% mismatch in the ratios of and will result in a 1% mismatch in their values. The resulting CMRR can be found from Eq. (9.85), repeated here:

Now, a CMRR for the input voltages corresponds to a ratio of ; thus,

The value of can be found from

Solving Eq. (9.90b) for gives

Now if the current source is implemented with a single transistor, its must be

Thus,

Substituting , we find the required value of as

Since , the required value of will be

which is very large!

**614 Chapter 9** Differential and Multistage Amplifiers

9.86b

9.87b

**Example 9.4b** *continued*

Using a cascode current source, we have

or, solving for ,

where

Thus,

and the required now becomes

or, solving for ,

which implies a channel length for each of the two transistors in the cascode of

a considerable reduction from the case of a simple current source, and indeed a practical value.

9.3 Common-Mode Rejection **615**