First order temperature independent resistors in analog and mixed signal IC design

In many applications of analog and mixed signal IC design, a temperature independent resistor may be required. This note describes a means to do this to a first order.

Figure 1.0 shows a series connection of two resistors which together will form the temperature independent resistor needed.

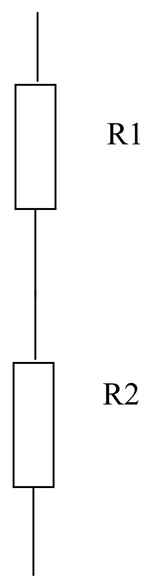

Figure 1.0

This configuration provides

$$Rtotal = R1 + R2 \qquad (0)$$

Now let ,

$$R1 = R01(1+A1*dt) \qquad (1)$$
$$R2 = R02(1+A2*dt) \qquad (2)$$

Signal Processing Group Inc., technical memorandum. August 2011. Website: http://www.signalpro.biz

Where A1, A2 are the tempcos of the two resistors respectively and dt is the temperature differential across them.

Then the sum of the two resistors can be written:

$$Rtotal = R01+R02 +dt(R01*A1+R02*A2) \qquad (3)$$

If,

$$R01*A1+R02*A2 = 0.0 \qquad (4)$$

Then R is temperature independent to a first order.

If A1 is a positive tempco and A2 is a negative tempco (a condition encountered commonly in practice) then we can write,

$$R01/R02 = A2/A1 \qquad (5)$$

Equation 5 and equation 3 provide the design equations for the Temperature independent resistor design.

As an example assume that a 100 Ohm temperature independent resistor is required. Lets say that poly resistors are to be used. Then a typical tempco couple may be,

$$A1 = 0.7E\text{-}3$$
$$A2 = -1.2E\text{-}3$$

Using equation 5, we get:

$$R01 = 1.71* R02 \qquad (6)$$

Thus the two equations lead to:

$$R01 + R02 = 100$$

Then,

$$R02 = 100/2.71 \qquad (7)$$

Or,

$$R02 = 36.9 \text{ Ohms} \quad (8)$$
$$R01 = 63.1 \text{ Ohms} \quad (9)$$

To cross check the results we use equation 4,

$$63.1*(0.7e\text{-}3) - 36.9*(1.2e\text{-}3) \sim 0.0$$

If necessary, slight trimming could be done using the circuit simulator to get the final values.