

SMM766/SMM766B Six-Channel Active DC Output Controller, Monitor, Marginer and Sequencer Design Guide for Calculating Series TRIM Resistor Values

General Description

The information contained in Application Note 70 details the Hardware Implementation of the Trim function (ADOC) from the SMM766/766B to an external voltage converter. The implementation is shown to depend on finding the RSET formula of any given converter whether linear regulator, switch-mode module, discrete switch-mode regulator/controller, etc. After finding the RSET value, the value of the series Trim resistor (RTRIM) can then be found and **must** be used to limit the current from

the SMM766/766B Trim pin, eliminate some inherent offset in the SMM766/766B Trim circuitry, and prevent the voltage converter from causing circuit damage in the event the Trim pin of the SMM766/766B should fail (short) to ground or VDD.

Note: These calculations and hardware implementations also apply on the SMM665B/SMM665C family of products.

Hardware Implementation of ADOC Trim

Series Trim Resistor Selection

The series trim resistor primarily serves the purpose of preventing the converter from exceeding some maximum voltage in the event of a short of the SMM766/SMM766B TRIM pin or PCB trace to ground (or VDD) and to obtain the best possible accuracy of the trimmed (margined) converter voltage.

When selecting the trim resistor value, 2 parameters must be given:

1. Trim voltage target (Nominal, High and Low)
2. Voltage Margin in percentage (e.g., ±10%)

Furthermore, the transfer function of the output voltage versus setting resistor or resistor dividers must also be known so as to choose the best possible trim resistor value.

In general, all converter trim circuits have some variant of the circuit shown in Figure 1. From this circuit the output voltage is:

$$(2) V_{OUT} = V_{REF} \left(1 + \left(\frac{R1}{R2} \right) \right)$$

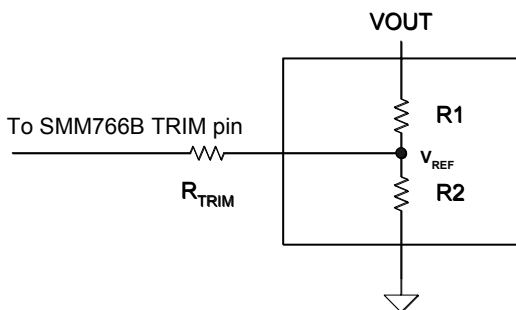


Figure 1: Typical resistor divider sets converter output voltage

To optimize the TRIM resistor for best resolution and protect against circuit overvoltages in the event the

SMM766/766B TRIM pin node should short to ground or VDD, we use the circuit in Figure 2 to calculate the TRIM resistor value.

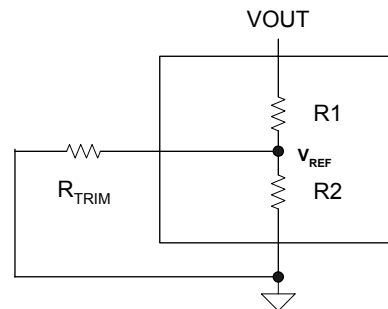


Figure 2: Thevenin equivalent of the TRIM circuit when calculating the optimal TRIM resistor value.

Here R_{TRIM} is taken to be in parallel with $R2$. For best resolution, the SMM766/766B TRIM pin output should operate from rail to rail when margining high to low. This will also ensure circuit protection against a short occurring on the SMM766/766B side of the TRIM resistor. From Figure 2, calculate the value of R_{TRIM} required to margining high. Add 2% to the required margin percentage needed to allow for component tolerance buildup. For a 10% margin range, calculate a new value for $R2$ that forces the output voltage to increase by 10%. For this example use the following:

$$\begin{aligned} V_{OUT}(\text{Nom}) &= 1.2\text{V} \\ V_{REF} &= 0.8\text{V} \\ R1 &= 10\text{k} \\ R2 &= 20\text{k} \end{aligned}$$

$$(3) R2(\text{New}) = \left(\frac{R1}{\left(\frac{(1.12)V_{OUT}}{V_{REF}} - 1 \right)} \right) \text{ or :}$$



$$(3E) 14.7k = \left(\frac{10k}{\frac{(1.12)1.2}{0.8} - 1} \right)$$

$$R_{TRIM} = \frac{1}{\frac{1}{14.7k} - \frac{1}{20k}} = 55.47k \text{ Choose } 54.0k, 1\%$$

For converters employing a single resistor from the TRIM pin (referred to as RSET here) to ground (Figure 3), it is necessary to know the RSET equation to obtain both the RSET and the series TRIM resistor value. For example, a given converter uses the following formula to set the output voltage:

$$(4) R_{SET} = \left(\frac{10500}{V_{OUT} - 5.021} - 1000 \right) \Omega$$

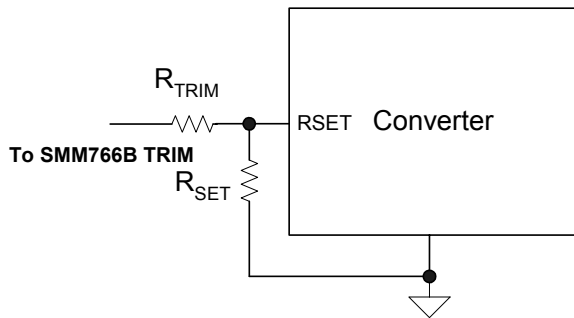


Figure 3: Converter uses RSET pin to set the output voltage.

To simplify the calculation and obtain maximum resolution from the SMM766/766B, the TRIM resistor is considered to be in parallel with the RSET resistor as in Figure 4. This is due to the SMM766/766B swinging to VDD or to ground to obtain the desired TRIM voltage target Add 2% to the required margin percentage to allow for circuit component tolerances:

$$(5) R_{SET'} = \left(\frac{10500}{V_{OUT'} - 5.021} - 1000 \right) \Omega$$

Where:

VOUT = The required margin voltage.
RSET' = The required resistor for VOUT'.

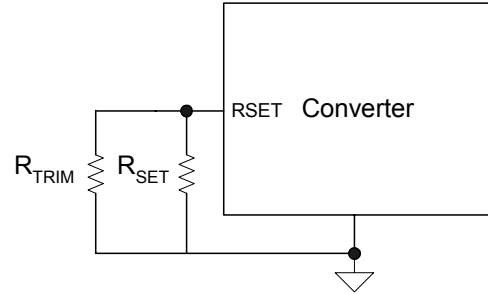


Figure 4: Thevenin equivalent of RTRIM resistor when margining

After finding the new value of the RSET resistor for the converter's desired margined output voltage (RSET'), Equation 6 finds the value of RTRIM for the margined output voltage:

$$(6) R_{TRIM} = \frac{1}{\frac{1}{R_{SET'}} - \frac{1}{R_{SET}}}$$

Please contact the factory if you encounter a situation where the RSET formula is not given or unclear.



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