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Output Voltage Trimming

General Description

Output voltage trimming allows the user to change the output voltage of the module. This greatly enhances the functionality of modules by allowing a few select, standard modules to be applied to virtually any application; regardless of the voltage requirements. This allows module users to reduce the number of models kept in stock.

This application note covers the basics of trimming modules and performance effects of trimming. It also covers some possible applications for trimming as well as some trimming precautions to observe.

Implementation

Basic Trimming Concepts

Astrodyne uses a simple approach to trimming modules that in most cases allows the module to be trimmed with a single external resistor.

To trim the module you must create a current source/ sink that provides current to the TRIM pin. To accomplish this, connect a resistor from TRIM to either +SENSE or -SENSE depending on whether you want a lower or higher than nominal output voltage. In trim-up applications the resistor will be connected from TRIM to -SENSE, and in trim-down applications the resistor will be connected from TRIM to +SENSE. *Figure 5a* shows the two connections.

To calculate the resistor value, use the following equations:

$$R_{trim-up} = \frac{Z_{TG} \times (V_{ref})}{V_o - V_{nom}}$$

$$R_{trim-dn} = \frac{Z_{TG} \times (V_{ref} - V_o)}{V_o - V_{nom}}$$

Where:

ZTG = the transimpedence gain of the module from the trim pin to the output (see tables).

Vref = the internal reference voltage of the module (see tables).

Vnom = the nominal output voltage of the module with no trimming (see tables).

Vo = The desired output voltage of the module after trimming.

MicroVerter Trimming

The trimming constants for the MicroVerter modules are given in *Table 5a*. These constants, along with the desired output voltage, are plugged into the resistor equations derived above.

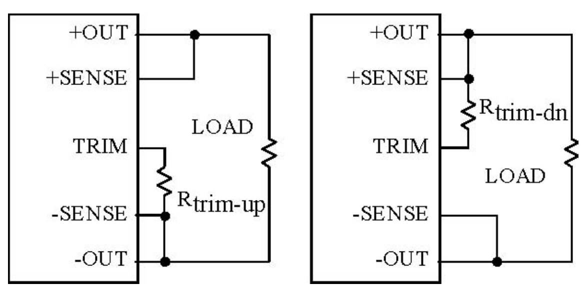

***Figure 5a** Basic circuits for trim-up and trim-down applications.*

Note: The trimming ranges in *Table 5a* represent the guaranteed ranges given in the data sheets. On some models extended ranges have been verified and are reflected in the table. Also note that the module performance specifications only apply when the output voltage is within the guaranteed adjustment range. If your application requires a trim voltage that is outside of the range given, contact the factory and they will assist you.

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Table 5a MicroVerter Module Trimming Constants

Model Suffix	**Vnom** (V)	Vref (V)	**ZTG** (kΩ)	-Trim Limit (V)	+Trim Limit (V)
-2	2.1	1.5	4.747	1.89	2.31
-3	3.3	1.5	12.60	2.97	3.63
-5	5	1.5	5.677	4.5	5.5
-8	8	1.5	10.56	5.5	8.8
-12	12	1.5	19.34	10.8	13.2
-15	15	1.5	19.89	13.5	16.5
-24	24	1.5	41.44	21.6	26.4
-28	28	1.5	41.83	25.2	30.8
-T512	5	1.5	1.051	4.5	5.5
-T515	5	1.5	1.051	4.5	5.5

Ω Resistor in series with the TRIM pin. This resistor must be subtracted from the calculated trim resistor value.

EXAMPLE: An application requires 9A at 26V to drive a RF amplifier in a cellular transmitter. In this application we could use either a 28V module trimmed down to 26V or a 24V module trimmed up to 26V. The 28V module would have a current limit of 9A. The 24V module has a power rating of 24V x 10A or 240W. At 26V the output current must be limited to 240W / 26V = 9.23A which is acceptable for the application. For our example we will choose the 24V module since it will be more efficient (module efficiency improves when the output is trimmed up and degrades when the output is trimmed down) and we don't need the 9A current limit feature. The required trim resistor is:

$$R_{trim-up} = \frac{41.44k\Omega \times (1.5V)}{26V - 24V}$$

$$R_{trim-up} = 31.08k\Omega$$

For our application we will use a 30.9kΩ, 1%, temperature stable, metal film resistor such as a RN55D connected from TRIM to -SENSE.

NanoVerter Trimming

The trimming constants for the NanoVerter modules are given in *Table 5b*. These constants, along with the desired output voltage are plugged into the resistor equations derived above. There is one significant difference between the NanoVerter modules and other modules in that NanoVerter module have an internal 332Ω resistor in series with the TRIM pin. This resistor must be subtracted from the calculated trim resistor value.

The modified trim resistor equations are:

$$R_{trim-up} = \frac{Z_{TG} \times (V_{ref})}{V_o - V_{nom}} - 0.332k\Omega$$

$$R_{trim-dn} = \frac{Z_{TG} \times (V_{ref} - V_o)}{V_o - V_{nom}} - 0.332k\Omega$$

Note: The trimming ranges in *Table 5b* represent the guaranteed ranges given in the data sheets. On some models extended ranges have been verified and are reflected in the table. Also note that the module performance specifications only apply when the output voltage is within the guaranteed adjustment range. If your application requires a trim voltage that is outside of the range given contact the factory and they will assist you.

Table 5b NanoVerter Module Trimming Constants

Model Suffix	**Vnom** (V)	**Vref** (V)	**ZTG** (kΩ)	-Trim Limit (V)	+Trim Limit (V)
-2	2.1	2.0	0.139	2.00	2.21
-3	3.3	2.5	0.297	2.97	3.47
-5	5	2.5	0.575	4.5	5.5
-12	12	2.5	1.275	10.8	13.2
-15	15	2.5	1.342	13.5	16.5
-24	24	2.5	2.750	21.6	26.4

EXAMPLE: A 5V logic system needs the capability to perform margin testing. The margin limits are 4.5V and 5.5V. The required trim down resistor is:

$$R_{trim-dn} = \frac{0.575k\Omega \times (2.5V - 4.5V)}{4.5V - 5V} - 0.332k\Omega$$

$$R_{trim-dn} = 1.968k\Omega$$

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The required trim up resistor is:

$$R_{trim-up} = \frac{0.575k\Omega \times (2.5V)}{5.5V - 5V} - 0.332k\Omega$$

$$R_{trim-up} = 2.543k\Omega$$

For this example we will use a 1.96kΩ, 1%, temperature stable, metal film resistor such as a RN55D for the trim down resistor and a 2.55kΩ, 1% temperature stable, and metal film resistor such as a RN55D for the trim up resistor. See *Figure 5b* for the proper connections.

PicoVerter Trimming

The trimming constants for the PicoVerter modules are given in *Table 5c*. These constants, along with the desired output voltage are plugged into the resistor equations derived above; and repeated here for clarity:

$$R_{trim-up} = \frac{Z_{TG} \times (V_{ref})}{V_o - V_{nom}}$$

$$R_{trim-dn} = \frac{Z_{TG} \times (V_{ref} - V_o)}{V_o - V_{nom}}$$

Table 5c PicoVerter module Trimming Constants.

Model Suffix	**Vnom** (V)	**Vref** (V)	**ZTG** (kΩ)	-Trim Limit (V)	+Trim Limit (V)
-3	3.3	1.24	1.602	2.97	3.47
-5	5	2.5	5.030	4.5	5.5
-12	12	2.5	16.72	10.8	13.2
-15	15	2.5	20.77	13.5	16.5
-24	24	2.5	41.76	21.6	26.4

Note: The trimming ranges *in Table 5c* represent the guaranteed ranges given in the data sheets. On some models extended ranges have been verified and are reflected in the table. Also note that the module performance specifications only apply when the output voltage is within the guaranteed adjustment range. If your application requires a trim voltage that is outside of the range given contact the factory and they will assist you.

EXAMPLE: A designer has a system that uses both 12V and 15V PicoVerter modules. They would like to minimize part count and lower cost by only using one model of the PicoVerter modules. By checking with the factory they learned that the 15V

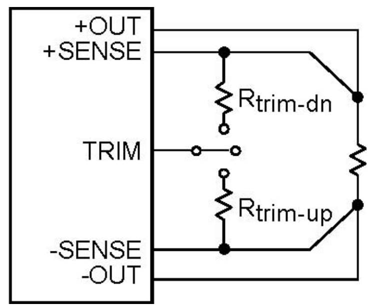

Figure 5b Circuit for** NanoVerter **trimming example: Voltage margining using a switch.

PicoVerter module can be trimmed down to 12V and still handle the modest load requirements. The required trim down resistor is:

$$R_{trim-dn} = \frac{20.77k\Omega \times (2.5V - 12V)}{12V - 15V}$$

$$R_{trim-dn} = 65.76k\Omega$$

For this example use a 66.5kΩ, 1%, temperature stable, metal film resistor such as a RN55D for the trim down resistor and connect it from TRIM to +SENSE.

Performance Effects of Output Trimming

Several of the module performance parameters will change as the output voltage is trimmed. All specifications given in the data sheets apply over the guaranteed adjustment range. The specifications of primary concern are: efficiency, output ripple, and output OVP.

Efficiency -The efficiency of a given model will decrease as the output voltage is trimmed down and increase as the voltage is trimmed up.

Output Ripple -As a percentage of the output voltage, the output ripple will increase as the voltage is lowered and decrease as the voltage is

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raised.

Output OVP - The OVP set point remains at a fixed voltage, independent of output trimming. In most cases the OVP set point is what limits the maximum trimmable voltage. As an additional note the user must pay attention to the current and power ratings when trimming the output voltage. All RO converters have a fixed current limit. As the output voltage is trimmed down the current limit set point remains constant. Therefore, in terms of output power, if the unit is trimmed down the available output power drops proportionally. Likewise, if the output is trimmed up the available power appears to go up.
Do not exceed the maximum rated output power of the module when trimming the output up.

Possible Applications

Eliminating the need for remote sense - Output trimming can be used instead of remote sense when the load current change is limited and the voltage drop between converter and load is relatively constant.

System testing (margining) - Often, it's helpful to test system operation with the supply voltage - usually the +5V logic voltage - set first at one extreme, then at the other. Any circuitry that fails to perform properly under these manufacturers' test conditions might also fail under conditions found in the user's environment. Margin testing helps insure trouble-free system operation.

Obtaining non-standard output voltages - When a non-standard output voltage is necessary, it may be available simply by trimming the output voltage of a module with an output voltage that is close to the desired voltage. Although the published data sheet limits are valid for the guaranteed adjustment range, lower output voltages are commonly available by using the trim function. Contact the factory for details.

Reducing the number of stocked models - When two output voltages are necessary, such as 24V and 28V, one model may be able to supply both, using the trim function to set the lower voltage.

Precautions

Connect trim resistor to sense, not to output - The trim resistor(s) should be connected to the sense leads, not to the output leads or to the load. Otherwise, load current changes could cause the converter's trimmed output voltage to vary.

Noise sensitivity - The TRIM pin is noise sensitive. External resistors (either fixed or variable) should be located within one cm of the converter. If wires are necessary, use twisted or shielded wires.

Output power, output current - If the output voltage is increased, output current must be derated to avoid exceeding module maximum output power. If the output voltage is decreased, output current is limited to its maximum rating and the available output power decreases.

Adjustment range limits - In some cases, the output voltage can be trimmed outside the guaranteed adjustment range. However, data sheet specifications are only valid within the specified voltage range.

Related Topics

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