Regulated Voltage-Doubling Stabilized, Floating DC Supply Using the PE22100

Application Note 81

Summary

The objective of this application note is to provide pSemi customers with a general recommendation for a generic voltage-doubled output from a standard PE22100 evaluation kit (EVK) by simple modification of the standard application circuit. A table is given that shows the expected output voltages when substituting a variety of stock Murata® transformers in the unmodified circuit.

Introduction

A standard EVK schematic for the PE22100 is shown in **Figure 1**. It takes a 5V DC input and provides an isolated and approximate 5V DC output (under load), positive relative to the isolated DC ground. This application note outlines how to achieve a higher output voltage, though at a proportionally lower current. An example is also given for a discrete regulator providing a stable, temperature-compensated 10 volts DC output at a current of up to approximately 150 milliamps. A further benefit of this approach is to prevent any input voltage disturbances from being passed on to the output. The circuit may easily be modified for other voltages by choosing a different transformer and selecting a Zener diode voltage that must be at least a volt or two below the peak DC that feeds it to achieve adequate regulation.

Details

The EVK schematic is shown in **Figure 1**. For the regulated version, the following components must first be removed from the PCB: D1, D2, C3 and C4. These are then replaced with the additional components shown in the schematic in **Figure 2**.

Figure 1 • Standard EVK Schematic for the PE22100

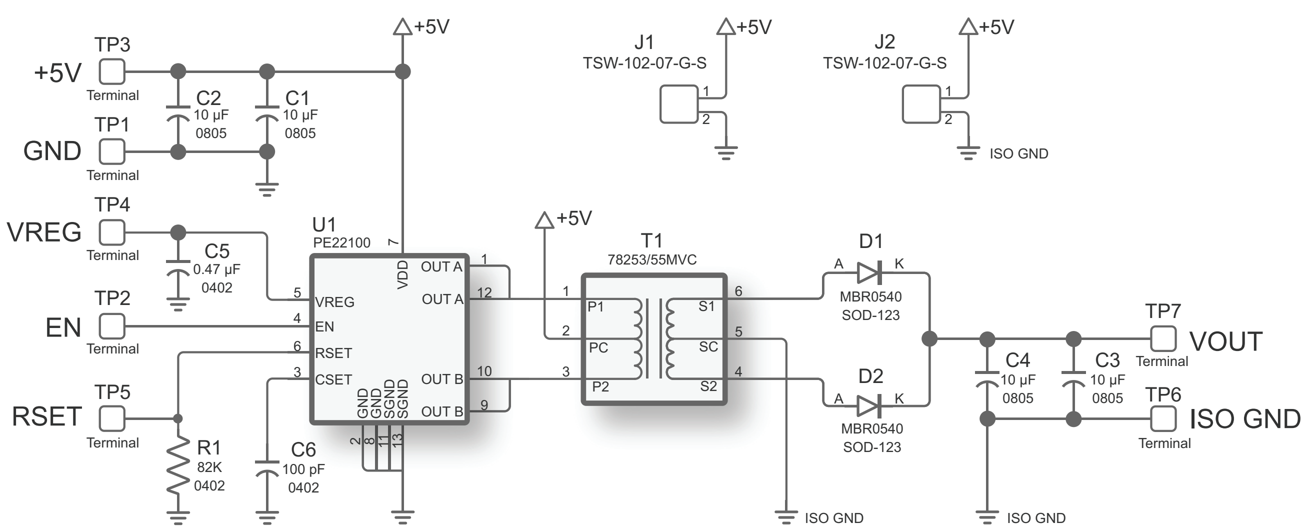


Table 1 provides a comparison of different types of transformers with resulting outputs, turns and voltage ratios when fitted to the T1 position.

In this table, the output DC rectified voltage is calculated as the (peak to peak – Vf of a diode) / 2 due to the 50% duty cycle. The (175 kHz) square wave was rectified, smoothed to DC, and terminated with a 1k Ohm load when taking the above measurements.

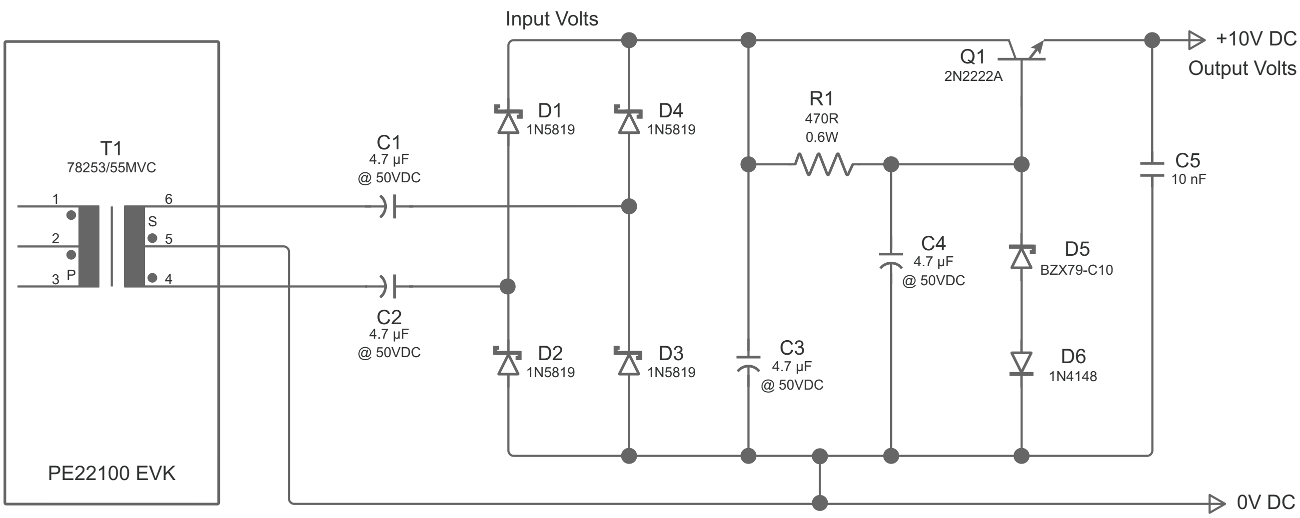
Table 1 ▪ Comparison of Transformers

Murata Part No.	Voltage Ratio	Turns Ratio	Secondary Volts (V, Peak-to-Peak)	Output DC Rectified Peak Voltage (V)	Comments
7825335JVC(1)	3:5	1 : 2.14	22.7	10.92	
78248233VC(2)(3)	3:3	1 : 1.33	14.7	6.89	
7825355MVC (J)(1)(3)	5:5	1 : 1.33	14.7	6.89	
78248235C(2)	3:5	1 : 1.14	12.7	5.85	78248253VC reversed(2)
78248253VC(2)	5:3	1.14 : 1	9.8	4.48	

1) This part number relates to MAX253-compatible series devices.
2) This part number relates to ADM2482E- or ADM2487E-compatible series devices.
3) Identical performance was observed in each instance; however, the data specifications are subtly different for these two parts.

Figure 2 depicts the modified right-hand section of the EVK schematic for the PE22100 to provide voltage doubling of the raw DC which is then regulated by the transistor-buffered Zener diode circuit.

Figure 2 ▪ Modified Right-hand Section of the EVK Schematic for the PE22100



Voltage doubling AC : DC rectification, smoothing and series regulator.

Circuit Description

As shown in **Figure 2** on page 3, the transformer T1 secondary is center-tapped to the floating ground of the DC regulator circuit. Two antiphase high-frequency square waves (see **Figure 3**) pass through coupling capacitors into a full-wave bridge rectifier, comprising four Schottky diodes D1–D4. The Schottky diodes drop less forward voltage than "standard" rectifiers. This arrangement also provides voltage doubling at half the current normally available, due to constant power.

The resulting DC is smoothed by C3 and filtered by R1 and C4. The Zener diode, D5, sets the output voltage to 10V. A series diode to ground is used to offset the Vbe of series pass transistor Q1, also providing thermal compensation and stability. The dominant temperature coefficient will then be due to that of the Zener diode D5 and this will alter as a function of its voltage. Only 5.1V and 5.6V types have equal and opposite gradients due to the Zener and avalanche mechanisms, which meet and largely cancel out and provide a near-ideal component at around those voltages.

R1 is chosen to be small enough to ensure that the Zener voltage is not influenced by base current drawn through the transistor with increasing load. The Q1 emitter produces a stable output voltage of +10V DC with respect to ground (0V). C5 removes any RF oscillation and ringing by shunting it to ground. The output voltage remains stable up to and just beyond approximately 100 mA, as shown in **Figure 4** on page 5.

This circuit may be used as a versatile, floating DC supply, for example, for bias in RF circuit applications, isolated LV supplies in HV circuits, and as a standalone general purpose 9V battery eliminator for low-power applications. For the latter application, D5 should be changed to a 9.1V Zener diode.

Figure 3 shows the antiphase AC node waveforms at C1 and C2, with just the regulator as a load. (**Note**: This was measured before the resultant DC is lowered by the forward voltage drop of the rectifiers.)

Figure 3 ▪ Antiphase AC Node Waveforms at C1 and C2, with Only the Regulator as a Load

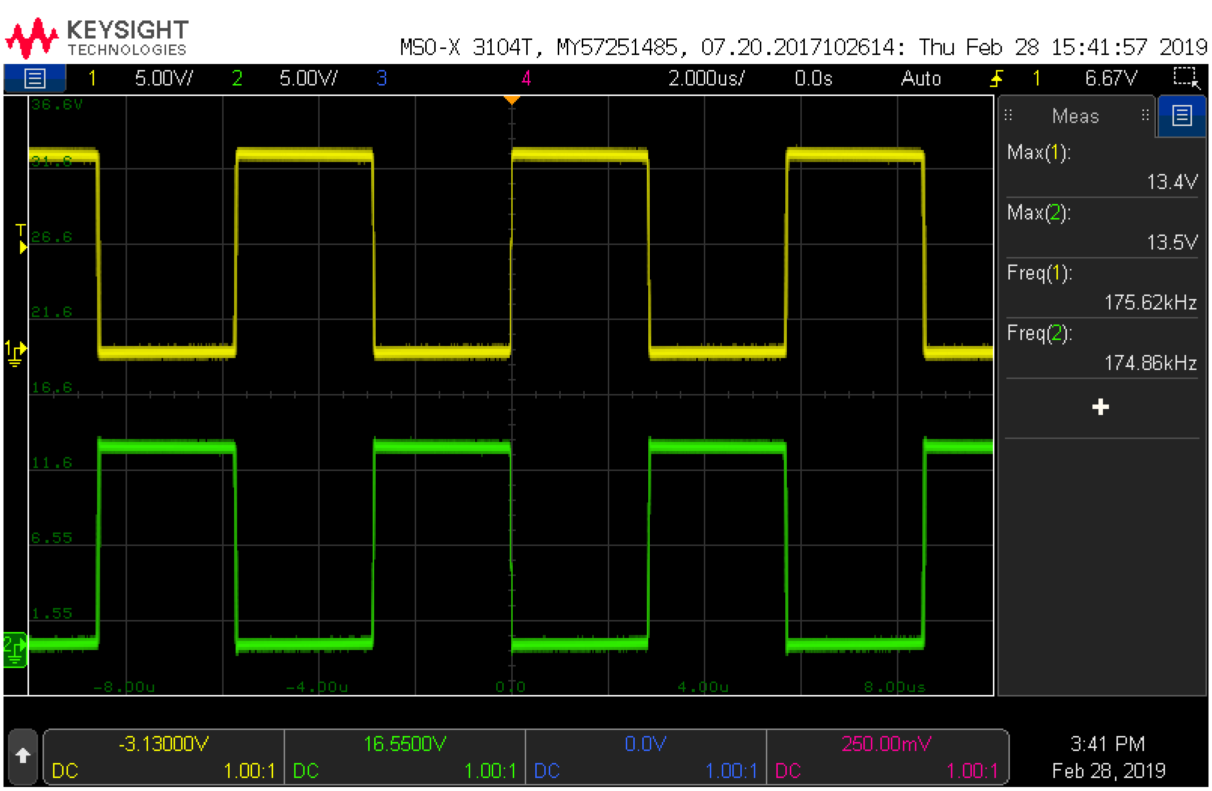
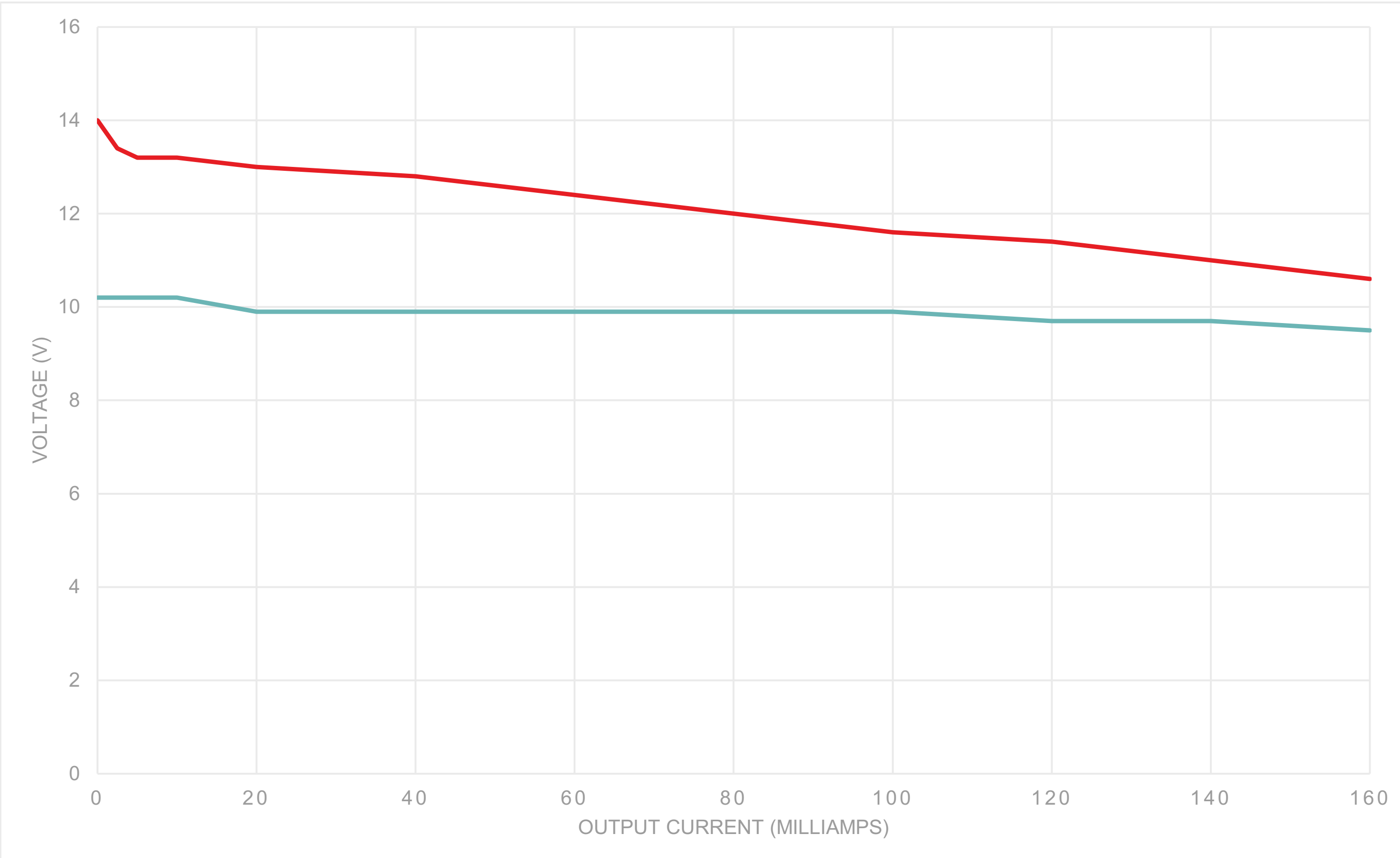


Figure 4 depicts a plot of input (red/top line) and output (blue/bottom line) voltage versus output current, showing the stabilizing action of the series regulator.

Figure 4 ▪ Input and Output Voltage vs. Output Current



Conclusion

This circuit may be used as a versatile, floating DC supply such as for bias in RF circuit applications, isolated low voltage supplies in high voltage circuits and as a stand-alone, general purpose 9V battery eliminator for low-power applications. For the latter application, D5 should be changed to a 9.1V Zener diode.