MIC2290 48V Avalanche Photo Diode (APD) Application Circuit w/ 0603 Chip Inductor

Introduction

The MIC2290 is an internally compensated standard step-up switching regulator with an integrated power switch and Schottky diode. The attribute of an internal power switch and Schottky diode makes the MIC2290 the most optimized solution for 48V Avalanche Photo Diode (APD) applications. In addition to the critical integrated components, the MIC2290 can be used with 0603 size chip inductors when configured for 48V APD applications. The physically small inductor size comprised with the MIC2290 capabilities produces a very space optimized design.

Theory of Operation

Understanding how the MIC2290 APD application circuit works is similar to how a standard step-up switching regulator works. The same analytical methods can be employed when modeling the behavior of the APD application circuit. The simplified MIC2290 APD application circuit is in Figure 2. The MIC2290 APD circuit works in two phases. The first phase, or Phase 1, increases the energy stored in the magnetic flux of the inductor (L1). This is accomplished with the internal power switch (NPNx) turning on and allowing the inductor to experience a constant voltage from the input voltage (VIN) to ground. Phase 1 is illustrated in Figure 3. Upon the second phase, or Phase 2, the energy stored in the magnetic flux of the inductor is then released to the C3 capacitor and through the C2 capacitor where the energy is then stored for delivery in the C4 capacitor to the APD. Phase 2 is illustrated in Figure 4.

Another way to understand how the MIC2290 APD application circuit is operating is to understand how a charge pump works. The charge pump model is graphically illustrated by the theoretical waveforms in Figure 5. In Figure 5 the switch node (Node 1) of the MIC2290 goes from ground to Vx (an example voltage), the Vx is half of the desired output voltage. Due to the internal Schottky diode (Dx) the voltage stored on the C2 capacitor (Node 2) is Vx. Since the voltage across the C3 capacitor is a constant Vx, Node 3 tracks with the switch node to produce a signal between Vx and 2Vx. As a result of the D2 diode, the output stays at a constant 2Vx voltage.

Actual Operation

The actual operational waveforms for nodes one through four are in Figure 6. In each oscilloscope photo the voltage magnitude of each waveform is indicated. Additional information regarding load regulation for 48V, 36V, and 24V output voltage settings is included in Figure 7. All of the above mentioned data was obtained from the MIC2290 APD evaluation board, with the bill of material in Table 1.

Functional Diagram

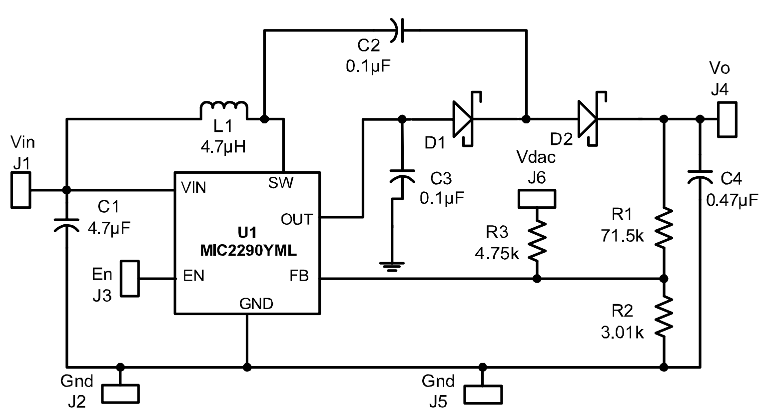

Figure 1. MIC2290 APD Evaluation Board Schematic

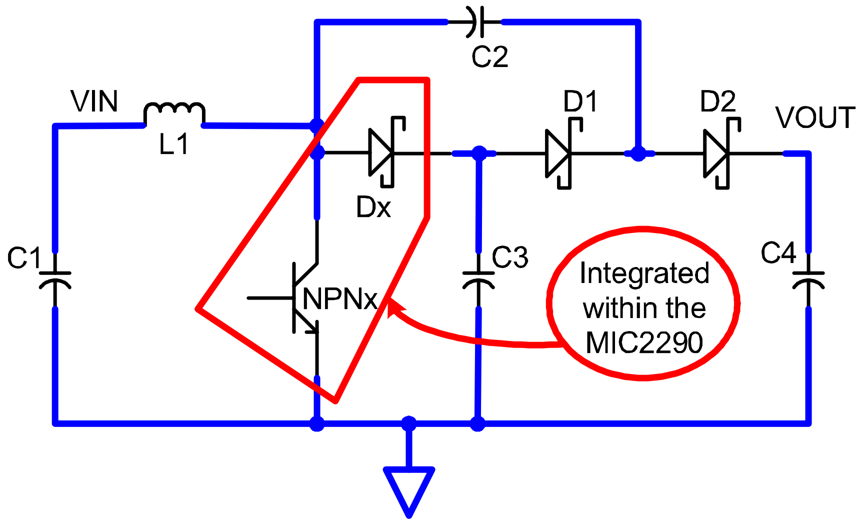

Figure 2. Simplified MIC2290 APD Application Circuit

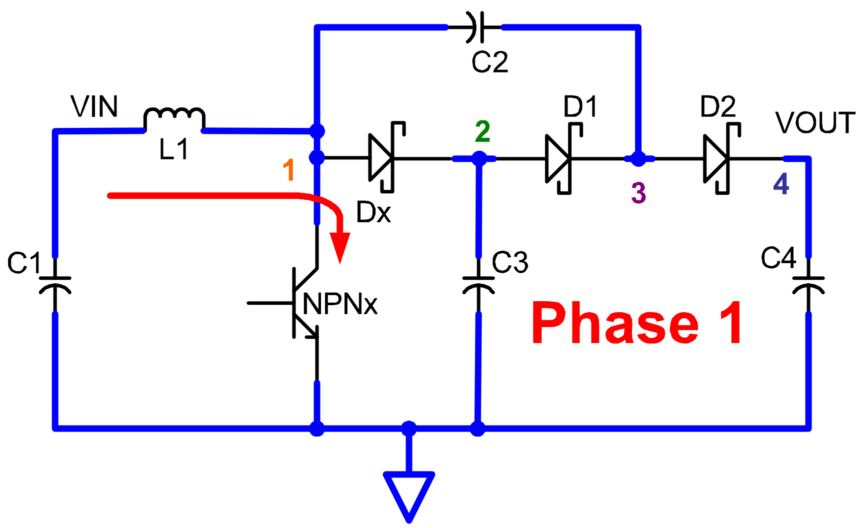

Figure 3. Phase 1 of Circuit Operation with Nodes 1 – 4 Marked

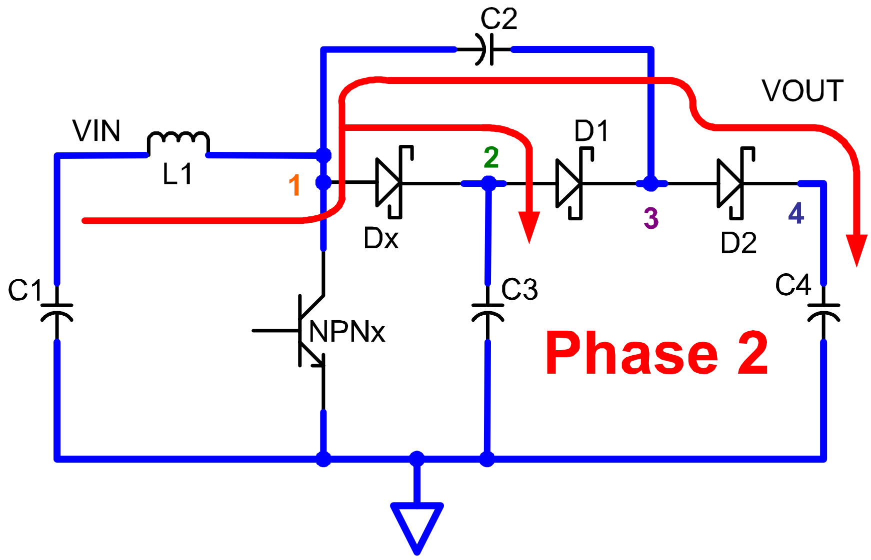

Figure 4. Phase 2 of Circuit Operation with Nodes 1 – 4 Marked

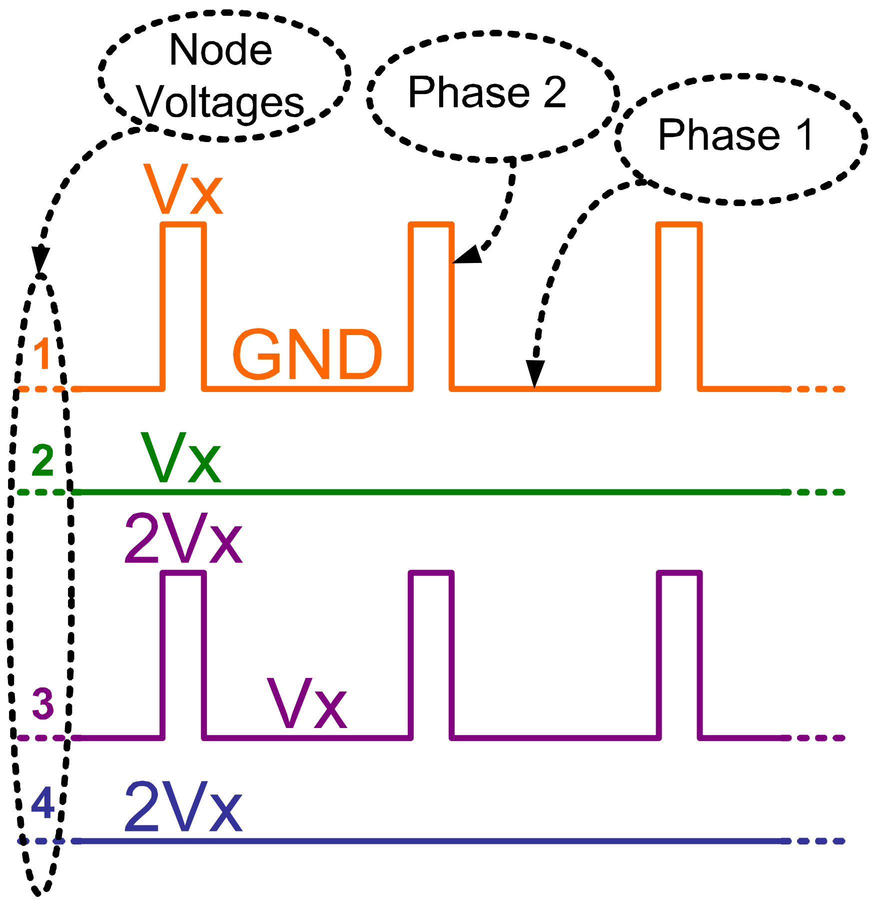

Figure 5. Theoretical Node Voltage Waveforms

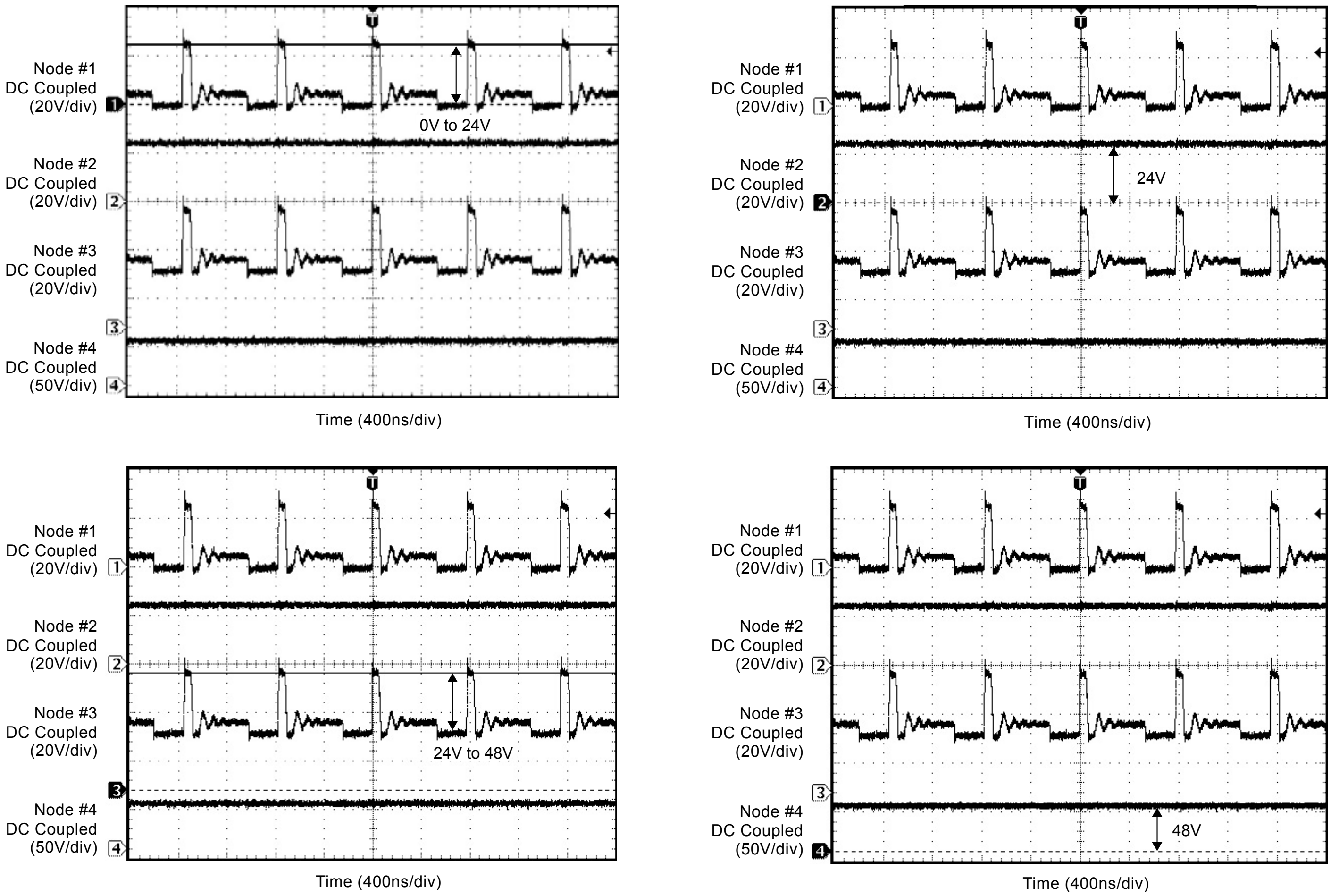

Figure 6. APD Waveforms

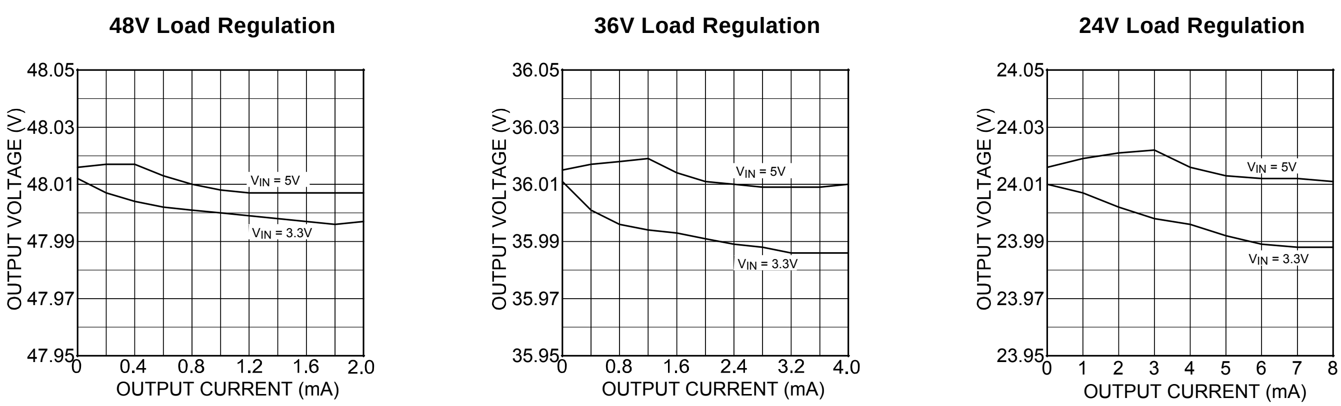

Figure 7. Load Regulation Data

MIC2290 (APD) Evaluation Board

Ref Des	Part Number	Description	Manufacturer
C1	GRM188R60J475KE19D	4.7µF 6.3V Ceramic Capacitor, Size 0603	Murata
	C1608X5R0J475M		TDK
C2, C3	GRM188R71H104KA93D	0.1µF 50V Ceramic Capacitor, Size 0603	Murata
	VJ0603Y104KXAACW1BC		Vishay
C4	GRM21BR71H474K	0.47µF 50V Ceramic Capacitor, Size 0805	Murata
	C2012X7R1H474M		TDK
L1	LBMF1608T4R7M	4.7µH 100mA Inductor, Size 0603	Taiyo-Yuden
	GLF1608T4R7M	4.7µH 115mA Inductor, Size 0603	TDK
D1, D2	SD101BWS	200mW, 50V Schottky Diode	Diodes, Inc.
R1	CRCW06037152FKEYE3	71.5kΩ Resistor, Size 0603	Vishay
R2	CRCW06033011FKEYE3	3.01kΩ Resistor, Size 0603	Vishay
R3	CRCW06034751FKEYE3	4.75kΩ Resistor, Size 0603	Vishay
U1	MIC2290YML	1.2MHz PWM Step-Up DC/DC Converter	Micrel, Inc.

Table 1. Bill of Material

Notes:

1. Murata: www.murata.com
2. TDK: www.tdk.com
3. Vishay: www.vishay.com
4. Taiyo-Yuden: www.t-yuden.com
5. Diodes, Inc.: www.diodes.com
6. Micrel Semiconductor: www.micrel.com

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