# LM1117,LM3411,LM5030,LP2951

***Versatility of the LM5030 PWM Push-Pull Controller***

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# Technology Edge

## Versatility of the LM5030 PWM Push-Pull Controller

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Electronic systems frequently require dc-dc converters to transform high dc voltages (up to 100V) into lower dc voltages with high conversion efficiency. The necessary functions in these converters including controlled start-up, MOSFET gate drive, voltage regulation across an electrical isolation boundary, short-circuit protection, over and under voltage protection, etc. add considerable complexity to the basic converter topology. A variety of converter designs can be simplified by designing around the LM5030 100V PWM Push-Pull Controller, a new highly integrated power management IC that provides many of the necessary dc-dc converter features. The versatility of this new controller IC has been demonstrated in a variety of power supply applications and topologies.

The LM5030 provides a complete current-mode PWM control in a small 10 pin MSOP package. It includes a high-voltage start-up regulator that operates over a wide input voltage range of 15-100V. A single resistor sets its switching frequency between 100kHz and 1MHz. A pull-up resistor at the output of its error amplifier can be used to directly bias an opto-coupler. Other features include a soft-start/enable input, error amp, feedback voltage reference, thermal protection, dual-mode over-current protection and two 1.5A peak MOSFET gate drivers.

A telecom push-pull converter designed with the LM5030 controller is shown in Figure 1. The input voltage range for the circuit is 36V to 100V and output delivers 120W at a voltage determined by the feedback network. In this design and all other applications the LM5030 can be easily synchronized to an external clock by applying a TTL level voltage of 15 to 150ns duration through a 100pF capacitor to the RT pin. The external clock frequency should be higher than the LM5030's free running frequency which is set by the RT resistor.

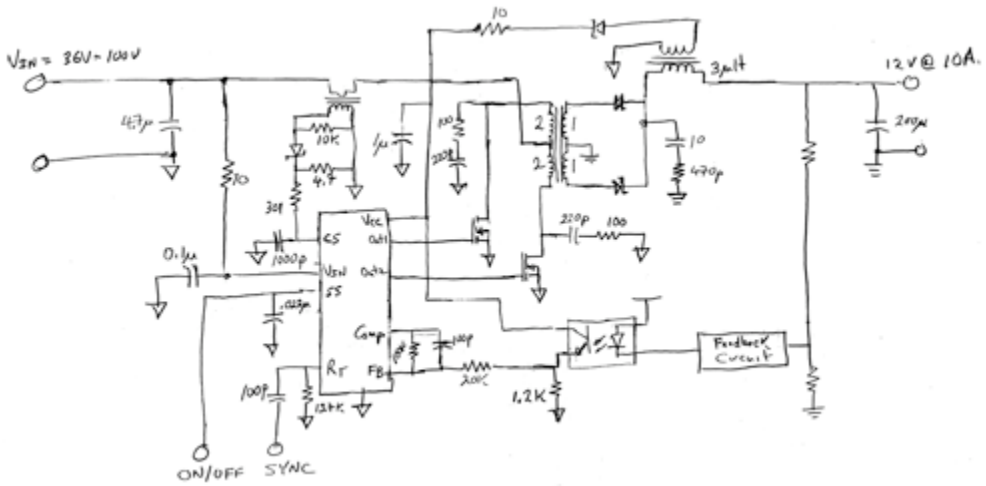


**Figure 1: Push-Pull Converter**

The 1.5A gate drivers of the LM5030 are configured for the push-pull converter but these outputs can also drive high side MOSFETs through a gate driver chip to implement half and full bridge topologies. The power transformers in bridge topologies have no center tap on the primary side, which simplifies their manufacture, and the MOSFETs are subjected to only half the voltage stress of the MOSFETs in the push-pull converter. Figure 2. shows a telecom half-bridge converter designed with the LM5030 controller and an LM5101 high side driver. The output delivers 5V at 20A and the switching frequency is 135kHz. This circuit illustrates the use of the internal pull-up resistor of the LM5030 error amplifier to directly bias the feedback opto-coupler U2. For this specific output voltage the secondary side control is simplified by implementing it with the LM3411-5.0V secondary regulator/driver IC which integrates the op-amp, voltage reference, and output voltage-setting resistors. The addition of the op-amp feedback network and the feedback opto-coupler complete the circuit. An identical control scheme can be used for a 3.3V output by changing the secondary regulator IC to the 3.3V version, the

LM3411-3.3V. The power transformer has an extra primary winding Np2 having the same number of turns as the main primary winding which, together with two diodes D8 and D9, functions to eliminate the tendency of the primary mid-point voltage in current-mode controlled half-bridges to drift and run away.

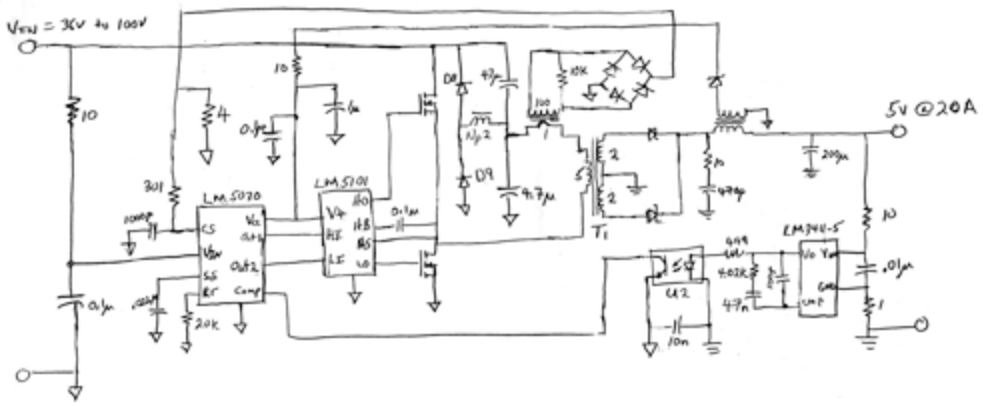


**Figure 2: Half-Bridge Converter**

Some applications require the converter to generate multiple isolated low power output voltages. In such cases a discontinuous mode flyback converter is a low cost and attractive candidate topology. Such a converter for a VoIP application is shown in Figure 3. The input voltage range is 20-60V and two outputs are provides 5V at 150mA and 3.3V at 700mA. The Power Over Ethernet (IEEE 802.3af) discovery impedance circuit is also included. The duty ratio is designed to be less than 50% under all conditions to keep the flyback voltage reasonably low, and therefore only one output of the LM5030 drives the power MOSFET. The 3.3V output is fed back to the primary for regulation through an LM3411-3.3V precision secondary regulator/driver IC. The 5V output is obtained through an LM1117 linear regulator from a second secondary winding. Additional output voltages can be generated using linear regulators powered from either output or from additional windings. Note that in this application, the LM5030 is used without an external primary bias supply. The bias for the LM5030 during steady state operation is supplied by its internal high voltage start-up regulator. The internal power dissipation of the LM5030 is equal to its supply current times the difference between the input voltage and 7.7V (the output voltage of the LM5030 start-up regulator). Since the supply current is primarily determined by the switching frequency and the gate charge of the MOSFETs being driven, this bias scheme is feasible only with lower switching frequencies and lower output power. The converter illustrated in Figure 3 operates at a switching frequency of 150kHz and delivers 3W to the outputs.

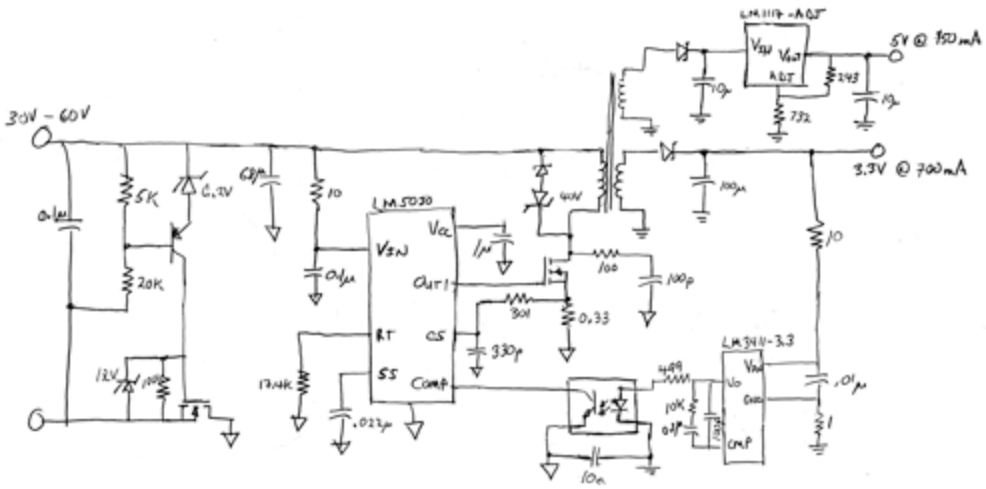


**Figure 3: VoIP Flyback Converter**

As illustrated in the flyback converter of Fig 3, the LM5030 Push-Pull Controller can be used effectively as a single ended PWM controller. This is possible even in situations where the duty ratio is unrestricted. Duty ratios greater than 50% can be

obtained in two ways: the two outputs of the LM5030 can separately drive the gates of two paralleled MOSFETs or they can be OR-ed together (with suitable circuitry) to drive the gate of one MOSFET. Figure 4 shows an example of the former technique in a boost converter application. The input voltage is 9-18V and the output voltage is 48V at 1.5A. Although the LM5030 outputs switch at 160kHz, the converter effectively switches at twice that, or 320kHz, because the two MOSFETs are effectively interleaved. The LP2951 linear regulator is set to limit the voltage at the Vcc pin of the LM5030 to 10V. The LP2951 will drop out of regulation when the input voltage is below about 10.3V, but the LM5030 will continue to operate properly until the Vcc supply falls below 6.5 V.

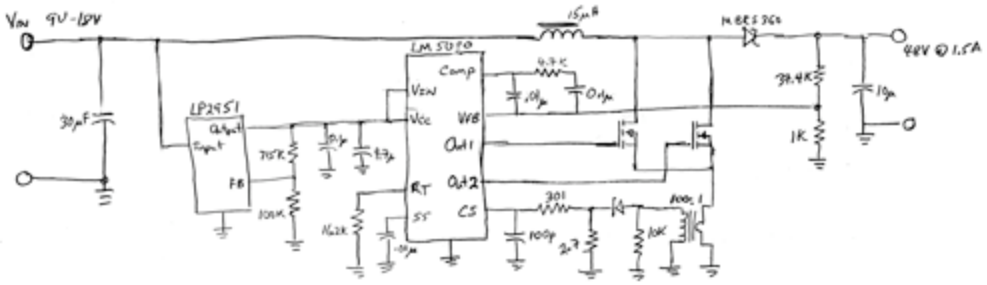


**Figure 4: Boost Converter**

The LM5030 can also operate in conjunction with high-side driver chips to implement a high voltage synchronous buck converters at input voltages well above the operating range of standard buck controllers. Such a high voltage buck converter is shown in Figure 5which also illustrates the technique of OR-ing the two outputs of the LM5030 together to drive one MOSFET (through the LM5104 gate driver).

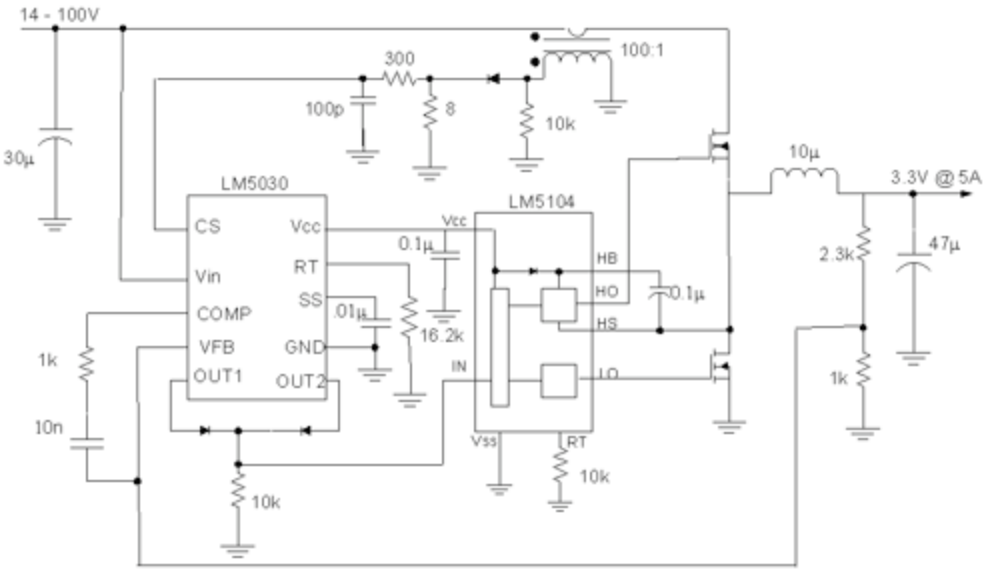


**Figure 5: High Voltage Buck Converter Using the LM5030**

Five unique topologies all designed with the LM5030 controller at the core illustrate the versatility of this new high voltage PWM control IC. While relatively simple and easy to use, the LM5030 provides high performance current mode control plus a variety of functions that simplify power supply designs.

**For more information regarding High Voltage Switching Regulator**

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