

Power Supply Topologies



Type of Converter	BUCK	BOOST	BUCK BOOST (Inverting)	SEPIC	FLYBACK	FORWARD	2 SWITCH FORWARD	ACTIVE CLAMP FORWARD	HALF BRIDGE	PUSH PULL	FULL BRIDGE	PHASE SHIFT ZVT
Circuit Configuration												
Ideal Transfer Function*	$\frac{V_{OUT}}{V_{IN}} = \left(\frac{t_{ON}}{T_P}\right) = D$	$\frac{V_{OUT}}{V_{IN}} = \left(\frac{T_P}{T_P - t_{ON}}\right) = \frac{1}{(1-D)}$	$\frac{V_{OUT}}{V_{IN}} = -\left(\frac{t_{ON}}{T_P - t_{ON}}\right) = -\left(\frac{D}{1-D}\right)$	$\frac{V_{OUT}}{V_{IN}} = \left(\frac{D}{1-D}\right)$	$\frac{V_{OUT}}{V_{IN}} = D \times \sqrt{\frac{T_P \times V_{OUT}}{2 \times I_{OUT} \times L_P}}$	$\frac{V_{OUT}}{V_{IN}} = \left(\frac{N_S}{N_P}\right) \times \left(\frac{t_{ON}}{T_P}\right) = \left(\frac{N_S}{N_P}\right) \times D$	$\frac{V_{OUT}}{V_{IN}} = \left(\frac{N_S}{N_P}\right) \times \left(\frac{t_{ON}}{T_P}\right) = \left(\frac{N_S}{N_P}\right) \times D$	$\frac{V_{OUT}}{V_{IN}} = \left(\frac{N_S}{N_P}\right) \times \left(\frac{t_{ON}}{T_P}\right) = \left(\frac{N_S}{N_P}\right) \times D$	$\frac{V_{OUT}}{V_{IN}} = \left(\frac{N_S}{N_P}\right) \times \left(\frac{t_{ON}}{T_P}\right) = \left(\frac{N_S}{N_P}\right) \times D$	$\frac{V_{OUT}}{V_{IN}} = 2 \times \left(\frac{N_S}{N_P}\right) \times \left(\frac{t_{ON}}{T_P}\right) = 2 \times \left(\frac{N_S}{N_P}\right) \times D$	$\frac{V_{OUT}}{V_{IN}} = 2 \times \left(\frac{N_S}{N_P}\right) \times \left(\frac{t_{ON}}{T_P}\right) = 2 \times \left(\frac{N_S}{N_P}\right) \times D$	$\frac{V_{OUT}}{V_{IN}} = 2 \times \left(\frac{N_S}{N_P}\right) \times \left(\frac{t_{ON}}{T_P}\right) = 2 \times \left(\frac{N_S}{N_P}\right) \times D$
Drain Current*	$I_{Q1}(\text{max}) = I_{OUT}$	$I_{Q1}(\text{max}) = I_{OUT} \times \left(\frac{1}{1-D}\right)$	$I_{Q1}(\text{max}) = I_{OUT} \times \left(\frac{1}{1-D}\right)$	$I_{Q1}(\text{max}) = I_{OUT} \times \left(\frac{D}{1-D}\right)$	$I_{Q1}(\text{max}) = \left(\frac{V_{IN} \times t_{ON}}{L_P}\right)$	$I_{Q1}(\text{max}) = \left(\frac{N_S}{N_P}\right) \times I_{OUT}$	$I_{Q1}(\text{max}) = \left(\frac{N_S}{N_P}\right) \times I_{OUT}$	$I_{Q1}(\text{max}) = \left(\frac{N_S}{N_P}\right) \times I_{OUT}$	$I_{Q1}(\text{max}) = \left(\frac{N_S}{N_P}\right) \times I_{OUT}$	$I_{Q1}(\text{max}) = \left(\frac{N_S}{N_P}\right) \times I_{OUT}$	$I_{Q1}(\text{max}) = \left(\frac{N_S}{N_P}\right) \times I_{OUT}$	$I_{Q1}(\text{max}) = \left(\frac{N_S}{N_P}\right) \times I_{OUT}$
Drain Voltage*	$V_{DS} = V_{IN}$	$V_{DS} = V_{OUT}$	$V_{DS} = V_{IN} - V_{OUT}$	$V_{DS} = V_{IN} + V_{OUT}$	$V_{DS} = V_{IN} + V_{OUT} \times \left(\frac{N_P}{N_S}\right)$	$V_{DS} = 2 \times V_{IN}$	$V_{DS} = V_{IN}$	$V_{DS} = V_{IN} \times \left(\frac{1}{1-D}\right)$	$V_{DS} = V_{IN}$	$V_{DS} = 2 \times V_{IN}$	$V_{DS} = V_{IN}$	$V_{DS} = V_{IN}$
Average Diode Current*	$I_{D1} = I_{OUT} \times (1-D)$	$I_{D1} = I_{OUT}$	$I_{D1} = I_{OUT}$	$I_{D1} = I_{OUT}$	$I_{D1} = I_{OUT}$	$I_{D1} = I_{OUT} \times D$	$I_{D1} = I_{OUT} \times D$	$I_{D1} = I_{OUT} \times D$	$I_{D1} = (I_{OUT} \times D) + \frac{I_{OUT}}{2} \times (1-2D)$	$I_{D1} = (I_{OUT} \times D) + \frac{I_{OUT}}{2} \times (1-2D)$	$I_{D1} = (I_{OUT} \times D) + \frac{I_{OUT}}{2} \times (1-2D)$	$I_{D1} = \frac{1}{2} \times I_{OUT}$
Diode Reverse Voltage*	$V_{D1} = V_{IN}$	$V_{D1} = V_{OUT}$	$V_{D1} = V_{IN} - V_{OUT}$	$V_{D1} = V_{OUT} + V_{IN}$	$V_{D1} = V_{OUT} + V_{IN} \times \left(\frac{N_S}{N_P}\right)$	$V_{D1} = V_{OUT} + V_{IN} \times \left(\frac{N_S}{N_P}\right)$	$V_{D1} = V_{OUT} + V_{IN} \times \left(\frac{N_S}{N_P}\right)$	$V_{D1} = V_{OUT} + V_{IN} \times \left(\frac{N_S}{N_P}\right) \times \left(\frac{1}{1-D}\right)$	$V_{D1} = V_{IN} \times \left(\frac{N_S}{N_P}\right)$	$V_{D1} = V_{IN} \times \left(\frac{N_S}{N_P}\right) \times 2$	$V_{D1} = V_{IN} \times \left(\frac{N_S}{N_P}\right) \times 2$	$V_{D1} = V_{IN} \times \left(\frac{N_S}{N_P}\right)$
Voltage and Current Waveforms												
<p>Application Notes:** Understanding Buck Power Stages in Switchmode Power Supplies (SLVA057)</p> <p>Controllers/Converters: TPS40020/21 TPS40180 TPS40007/09 TPS40192/3 TPS40040/41 TPS40200 TPS40075 TPS5410/20/30/50 TPS40077 TPS54350/550 TPS40140 TPS62110</p>	<p>Application Notes:** Understanding Boost Power Stages in Switchmode Power Supplies (SLVA061)</p> <p>High Voltage Power Supply Using a Highly Integrated DC/DC Converter (SLVA137)</p> <p>Controllers/Converters: TPS40200 UCC3572 TPS40061 UCC3801/01/02/03/04/05 TPS40057 UCC3807 TPS5410/20/30/50 UCC3810 (Dual) TPS54350/54550 UCC3813 TPS63700 UCC38C40/41/42/43/45</p>	<p>Application Notes:** Versatile Low Power SEPIC Converter Accepts Wide Input Voltage Range (SLUA158)</p> <p>High Power Factor Preregulator Using the SEPIC Converter (SEM900)</p> <p>Controllers/Converters: TPS3000 UCC3807 TPS61130 UCC3810 (Dual) UCC3800/01/02/03/04/05/3813</p>	<p>Application Notes:** Design of Flyback Transformers and Inductors (SEM400)</p> <p>Discontinuous Current Flyback Converter Design (SEM300)</p> <p>Controllers: TPS23750/70 (PoE) UCC35705/706 UCC3807 UCC3800/01/02/03/04/05/3813 UCC3570 UCC3809 UCC28220/21 UCC3809 UCC28600 (Green Mode) UCC3810 (Dual) UCC3570 UCC38C40/41/42/43/44/45 UCC35701/702</p>	<p>Application Notes:** 25-W Forward Converter Design Review (SLUA276)</p> <p>Multiple Output Forward Converter Design (SEM1200)</p> <p>Controllers: UCC28220/21 UCC3807 UCC3570 UCC3809 UCC35701/702 UCC3810 (Dual) UCC35705/706 UCC38C40/41/42/43/44/45 UCC3800/01/02/03/04/05/3813</p>	<p>Application Notes:** 150-W Off-Line Forward Converter Design Review (SEM400)</p> <p>Practical Considerations in Current Mode Power Supplies (SLUA110)</p> <p>Controllers: UCC27200/01 (MOSFET Driver) UCC3807 UCC28220/21 UCC3807 UCC3570 UCC3809 UCC35701/702 UCC3810 (Dual) UCC35705/706 UCC3810 (Dual) UCC3801/04/05/13</p>	<p>Application Notes:** Active Clamp and Reset Technique Enhances Forward Converter Performance (SEM1000)</p> <p>Design Considerations for Active Clamp and Reset Technique (SEM1100)</p> <p>Controllers: UCC2891, 2, 3, 4, 7 UCC3580-1 UCC3807 UCC3824</p>	<p>Application Notes:** Practical Considerations in Current Mode Power Supplies (SLUA110)</p> <p>Zero Voltage Switching Resonant Power Conversion (SLUA159)</p> <p>Controllers: UCC28025 UCC3806 UCC3825A, B UCC3808A UCC27200/01 (MOSFET Driver) UCC3808A UCC28089 (2 x 50%) UCC38083/84/85/86</p>	<p>Application Notes:** The UC3823A,B and UC3825A,B Enhanced Generation of PWM Controllers (SLUA125)</p> <p>Practical Considerations in Current Mode Power Supplies (SLUA110)</p> <p>Controllers: UCC28025 UCC3808A UCC27200/01 (MOSFET Driver) UCC3808A UCC28089 (2 x 50%) UCC38083/84/85/86 UCC3806 UCC3825A, B</p>	<p>Application Notes:** Designing a Phase Shifted Zero Voltage Transition Power Converter (SEM900)</p> <p>Design Review: 500-W, 40-W/in3 Phase Shifted ZVT Power Converter (SEM900)</p> <p>Controllers: UCC3875 UCC3879 UCC3895</p>			

* Excludes ripple current and output diode voltage drop. Continuous conduction mode shown (unless otherwise noted). For reliable operation follow recommendations in datasheets and application notes.

** Go to: power.ti.com and place literature number in the "Key Word" box. For SEM topics, go to: power.ti.com/seminars

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products

Amplifiers	amplifier.ti.com
Data Converters	dataconverter.ti.com
DSP	dsp.ti.com
Clocks and Timers	www.ti.com/clocks
Interface	interface.ti.com
Logic	logic.ti.com
Power Mgmt	power.ti.com
Microcontrollers	microcontroller.ti.com
RFID	www.ti-rfid.com
RF/IF and ZigBee® Solutions	www.ti.com/lprf

Applications

Audio	www.ti.com/audio
Automotive	www.ti.com/automotive
Broadband	www.ti.com/broadband
Digital Control	www.ti.com/digitalcontrol
Medical	www.ti.com/medical
Military	www.ti.com/military
Optical Networking	www.ti.com/opticalnetwork
Security	www.ti.com/security
Telephony	www.ti.com/telephony
Video & Imaging	www.ti.com/video
Wireless	www.ti.com/wireless

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2008, Texas Instruments Incorporated