Step-Down DC-to-DC Controller

ADP1821

FEATURES

Wide power-input voltage range: 1 V to 24 V
Chip supply voltage range: 3.7 V to 5.5 V
Wide output voltage range: 0.6 V to 85% of input voltage
1% accuracy, 0.6 V reference voltage
All N-channel MOSFET design for low cost
Fixed-frequency operation 300 kHz, 600 kHz, or synchronized operation up to 1.2 MHz
No current sense resistor required
Power-good output
Programmable soft start with reverse current protection
Soft start, thermal overload, current-limit protection
Undervoltage lockout
10 µA shutdown supply current
Small, 16-lead QSOP

APPLICATIONS

Telecommunications and networking systems
Set-top boxes
Printers
Servers
Medical imaging systems
Microprocessor and DSP core power supplies
Mobile communication base stations

GENERAL DESCRIPTION

The ADP1821 is a versatile and inexpensive, synchronous, pulse-width-modulated (PWM), voltage-mode, step-down controller. It drives an all N-channel power stage to regulate an output voltage as low as 0.6 V. The ADP1821 can be configured to provide output voltages from 0.6 V to 85% of the input voltage and is sized to handle large MOSFETs for point-of-load regulators.

The ADP1821 is well suited for a wide range of high power applications, such as DSP and processor core power in telecommunications, medical imaging, high performance servers, and industrial applications. It operates from a 3.7 V to 5.5 V supply with a power input voltage ranging from 1.0 V to 24 V.

The ADP1821 operates at a pin-selectable, fixed switching frequency of either 300 kHz or 600 kHz, minimizing external component size and cost. For noise sensitive applications, it can be synchronized to an external clock to achieve switching frequencies between 300 kHz and 1.2 MHz. The ADP1821 includes soft start protection to limit the inrush current from the input supply during startup, reverse current protection during soft start for precharged outputs, as well as a unique adjustable lossless current-limit scheme utilizing external MOSFET sensing.

The ADP1821 operates over the −40°C to +125°C junction temperature range and is available in a 16-lead QSOP.

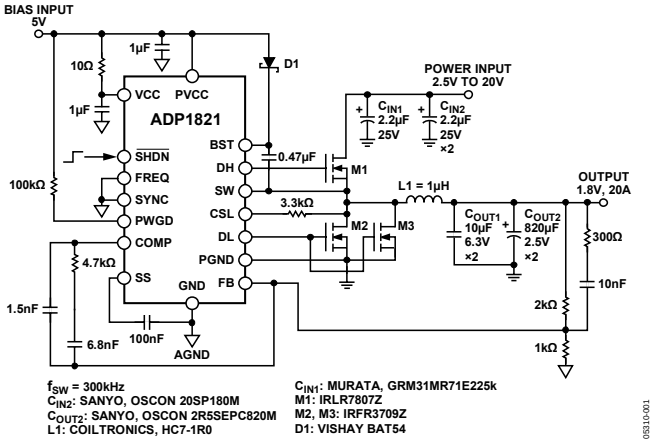

Figure 1. Typical Operating Circuit

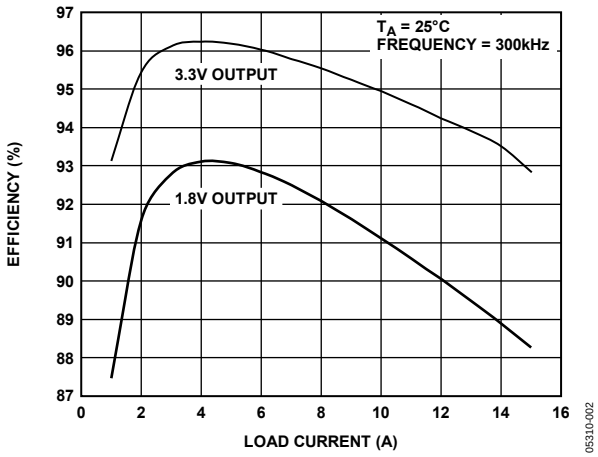

Figure 2. Efficiency vs. Load Current, 5 V Input

Rev. C

TABLE OF CONTENTS

REVISION HISTORY

4/07—Rev. B to Rev. C

Changes to Specifications Section ... 3
Changes to Absolute Maximum Ratings Section ... 5
Changes to Current-Limit Scheme Section ... 10
Changes to Setting the Current Limit Section ... 14
Added Figure 15 ... 14
Changes to Compensating the Voltage Mode Buck Regulator Section ... 15
Changes to Type II Compensator Section ... 17
Changes to Type III Compensator Section ... 18
Changes to Application Circuits Section ... 21
Changes to Figure 22 ... 21
Changes to Ordering Guide ... 23

12/06—Rev. A to Rev. B

Updated Format ... Universal
Changes to Features Section ... 1
Changes to Applications Section ... 1
Changes to General Description Section ... 1
Changes to Error Amplifier ... 3
Changes to PWM Controller ... 3
Changes to Oscillator Frequency ... 3
Changes to Theory of Operation Section ... 9
Changes to Application Information Section ... 12
Added PCB Layout Section ... 19
Changes to Application Circuits Section ... 21
Added Summary of Equations Section ... 23

1/06—Rev. 0 to Rev. A

Changes to Specifications Table ... 3
Changes to Theory of Operation Section ... 10
Changes to Input Voltage Range Section ... 11
Added Equation 1 ... 12
Changes to Equation 7 and Equation 8 ... 13
Added Equation 9 ... 13
Changes to Equation 16 ... 14
Changes to Figure 15 ... 14
Changes to Equation 21 ... 15
Changes to Figure 16 ... 15
Changes to Equation 28 ... 15
Updated Outline Dimensions ... 18

7/05—Revision 0: Initial Version

SPECIFICATIONS

$V_{VCC} = V_{PVCC} = V_{\overline{SHDN}} = V_{FREQ} = 5$ V, SYNC = GND. All limits at temperature extremes are guaranteed via correlation using standard statistical quality control (SQC). $T_J = -40°C$ to $+125°C$, unless otherwise specified. Typical values are at T_A=25°C.

Table 1.

Parameter	Conditions	Min	Typ	Max	Unit
POWER SUPPLY					
Input Voltage		3.7		5.5	V
Undervoltage Lockout Threshold	V_{VCC} rising, $T_J = -40°C$ to $+125°C$	2.4	2.7	3.0	V
Undervoltage Lockout Threshold	V_{VCC} rising, $T_A = 25°C$	2.5	2.7	2.9	V
Undervoltage Lockout Hysteresis	V_{VCC}		0.1		V
Quiescent Current	$I_{VCC} + I_{VCC}$, not switching		1	2	mA
Shutdown Current	$\overline{SHDN}$ = GND			10	µA
Power Stage Supply Voltage		1.0		24	V
ERROR AMPLIFIER					
FB Regulation Voltage	$T_J = -40°C$ to $+85°C$	594	600	606	mV
FB Regulation Voltage	$T_J = -40°C$ to $+125°C$	588	600	606	mV
FB Input Bias Current		−100	+1	+100	nA
Error Amplifier Open-Loop Voltage Gain			70		dB
COMP Output Sink Current			600		µA
COMP Output Source Current			110		µA
COMP Clamp High Voltage			2.4		V
COMP Clamp Low Voltage			0.75		V
PWM CONTROLLER					
PWM Peak Ramp Voltage			1.25		V
DL Minimum On Time	FREQ = VCC (300 kHz)	120	170	220	ns
DL Minimum On-Time	FREQ = VCC (300 kHz), $T_A = 25°C$	140	170	200	ns
DH Maximum Duty Cycle	FREQ = GND (300 kHz)	85	90		%
DH Minimum Duty Cycle	FREQ = GND (300 kHz)		1	3	%
SOFT START					
SS Pull-Up Resistance	SS = GND		95		kΩ
SS Pull-Down Resistance	$V_{SS} = 0.6$ V	1.65	2.5	4.2	kΩ
OSCILLATOR					
Oscillator Frequency	FREQ = GND	250	310	375	kHz
	FREQ = VCC	470	570	720	kHz
Synchronization Range	FREQ = GND	300		600	kHz
	FREQ = VCC	600		1200	kHz
SYNC Minimum Pulse Width				80	ns
CURRENT SENSE					
CSL Threshold Voltage	Relative to PGND	−30	0	+30	mV
CSL Output Current	$V_{CSL} = 0$ V	42	50	54	µA
Current Sense Blanking Period			160		ns
GATE DRIVERS					
DH Rise Time	$C_{GATE} = 3$ nF, $V_{DH} = V_{IN}$, $V_{BST} - V_{SW} = 5$ V		16		ns
DH Fall Time	$C_{GATE} = 3$ nF, $V_{DH} = V_{IN}$, $V_{BST} - V_{SW} = 5$ V		12		ns
DL Rise Time	$C_{GATE} = 3$ nF, $V_{DL} = V_{IN}$		19		ns
DL Fall Time	$C_{GATE} = 3$ nF, $V_{DL} = 0$ V		13		ns
DL Low to DH High Dead Time			33		ns
DH Low to DL High Dead Time			42		ns

Parameter	Conditions	Min	Typ	Max	Unit
LOGIC THRESHOLDS ($\overline{SHDN}$, SYNC, FREQ)					
$\overline{SHDN}$, SYNC, FREQ Input High Voltage	V_{VCC} = 3.7 V to 5.5 V	2.0			V
$\overline{SHDN}$, SYNC, FREQ Input Low Voltage	V_{VCC} = 3.7 V to 5.5 V			0.8	V
SYNC, FREQ Input Leakage Current	SYNC = FREQ = GND		0.1	1	µA
$\overline{SHDN}$ Pull-Down Resistance			100		kΩ
THERMAL SHUTDOWN					
Thermal Shutdown Threshold			145		°C
Thermal Shutdown Hysteresis			10		°C
PWGD OUTPUT					
FB Overvoltage Threshold	V_{FB} rising		750		mV
FB Overvoltage Hysteresis			35		mV
FB Undervoltage Threshold	V_{FB} rising		550		mV
FB Undervoltage Hysteresis			35		mV
PWGD Off Current	V_{PWGD} = 5 V			1	µA
PWGD Low Voltage	I_{PWGD} = 10 mA		150	500	mV

ABSOLUTE MAXIMUM RATINGS

Table 2.

Parameter	Rating
VCC, $\overline{\text{SHDN}}$, SYNC, FREQ, COMP, SS, FB to GND, PVCC to PGND, BST to SW	−0.3 V to +6 V
BST to GND	−0.3 V to +30 V
CSL to GND	−1 V to +30 V
DH to GND	(V_{SW} − 0.3 V) to (V_{BST} + 0.3 V)
DL to PGND	−0.3 V to (V_{PVCC} + 0.3 V)
SW to GND	−2 V to +30 V
PGND to GND	±2 V
θ_{JA}, 2-Layer (SEMI Standard Board)	150°C/W
θ_{JA}, 4-Layer (JEDEC Standard Board)	105°C/W
Operating Ambient Temperature Range	−40°C to +85°C
Operating Junction Temperature Range	−55°C to +125°C
Storage Temperature Range	−65°C to +150°C
Maximum Soldering Lead Temperature	260°C

Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above those indicated in the operational section of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Absolute maximum ratings apply individually only, not in combination. Unless otherwise specified, all other voltages are referenced to GND.

ESD CAUTION

ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

SIMPLIFIED BLOCK DIAGRAM

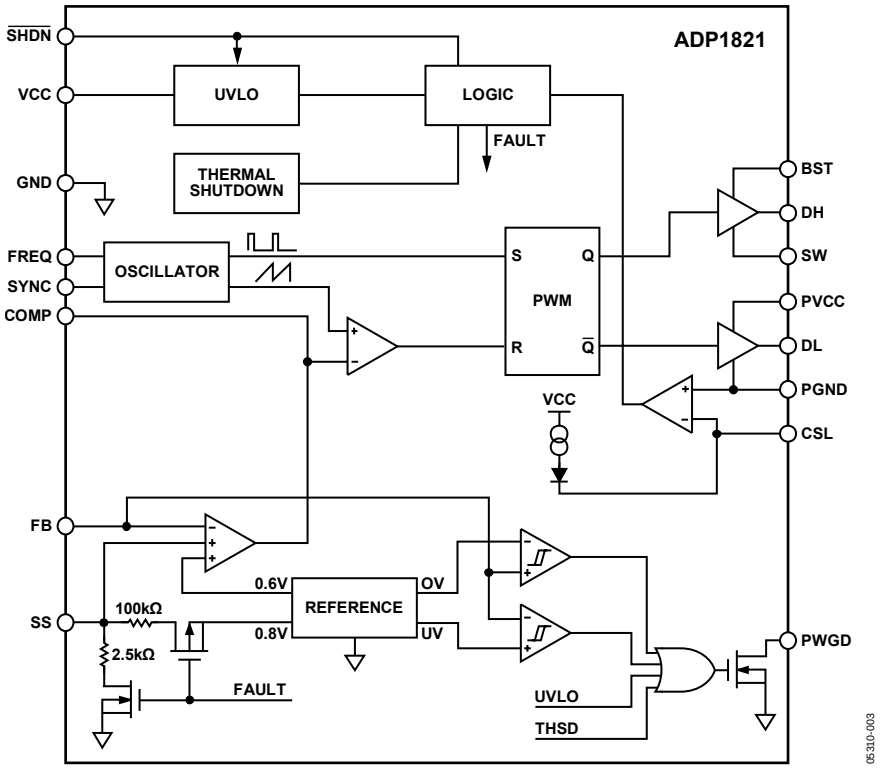

Figure 3. Simplified Block Diagram

DOCKET ALARM

Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts

Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research

With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips

Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS
Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS
Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS
Sync your system to PACER to automate legal marketing.