Single Synchronous Buck PWM and Linear Power Controller

General Description

The LD7129 consists of the dual-output power controller and the protection circuits in a single SOP-14 packaged chip for the graphic card and other applications. The dual-output power controller provides the regulation on a synchronous rectified buck converter by driving 2 N-MOSFETs and one N-MOSFET in a linear configuration.

The synchronous rectified buck converter provides simple, single feedback loop, voltage mode control with fast transient response. Internal 0.8V temperature-compensated reference voltage. A fixed 600KHz frequency oscillator reduces design complexity, while balancing typical application cost and efficiency.

The internal soft-start function and the 12V direct drive on switching output helps to eliminate the bootstrap circuit. Furthermore, the internal POR (power on reset) help to prevent the system from the sequence issue during the startup and turn-off. Considering the fault conditions, the LD7129 will shutdown both outputs when the voltage on either FB or FB2 pin drop below 51% of the nominal value.

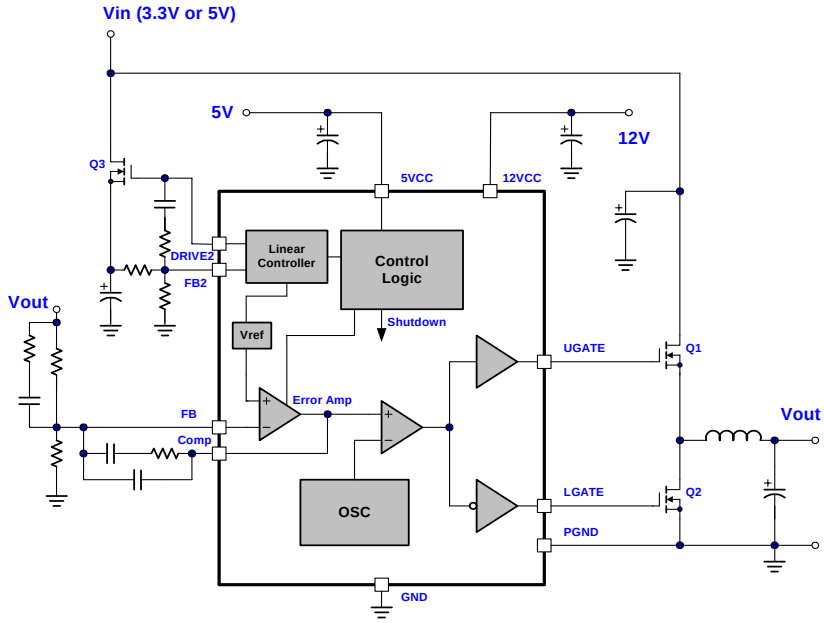
Features

- Controller Operates from 5V and 12V
- Drive Two N-channel MOSFETs for Switching Buck Converter
- Drive a N-channel MOSFET on Linear Output
- Fixed 600KHz Constant Switching Frequency
- Full Range 0~100% Duty-cycle
- Internal Soft-start
- Fast Transient Response
- UVP Monitoring on Both Outputs
- Internal 0.8V Reference Voltage.

Applications

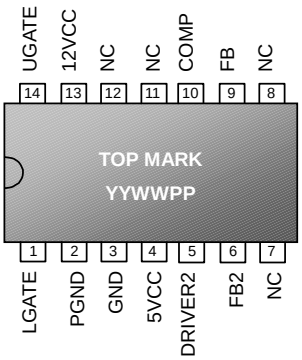
- Graphics-GPU and Memory Supplies
- ASIC Power Supplies
- Embedded Processor and I/O Supplies
- Cable Modem, Set Top Box, and DSL Modems
- DSP and Core Communications Processor Supplies

Typical Application



Pin Configuration

SOP-14 (TOP VIEW)



YY: Year code
WW: Week code
PP: Production code

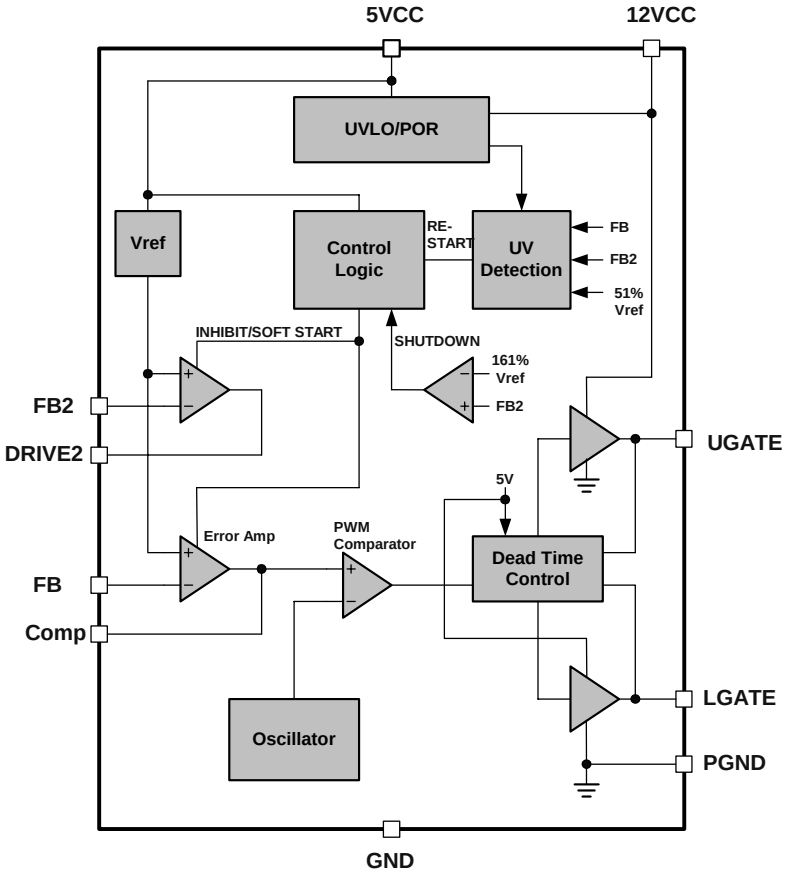
Ordering Information

Part number	Temperature range	Package	Top Mark	Shipping
LD7129 CS	0 to 70 (°C)	SOP-14	LD7129CS	2500 /tape & reel
LD7129 PS	0 to 70 (°C)	SOP-14 (PB Free)	LD7129PS	2500 /tape & reel

Pin Descriptions

PIN	NAME	FUNCTION
1	LGATE	Connect LGATE pin to the PWM converter's lower MOSEFT gate. This pin provides the gate drive for the lower MOSFET.
2	PGND	Power ground return
3	GND	Signal and power ground for the IC. All voltage levels are measured with respect to this pin.
4	5VCC	Connect this pin to 5V supply voltage. This pin provides the bias for the control circuitry. The voltage at this pin is monitored for Power-On Reset (POR) purpose.
5	DRIVE2	This pin is the output of linear controller. Connect this pin to the gate of an external N-MOSFET to provide a linear output power.
6	FB2	This pin is the inverting input of the internal error amplifier for the linear output. Connect this pin to the output of the converter via an external resistor divider.
7	NC	Not connected
8	NC	Not connected
9	FB	This pin is the inverting input of the internal error amplifier for the switching buck converter. Connect this pin to the output of the converter via an external resistor divider.
10	COMP	Error amplifier output
11	NC	Not connected
12	NC	Not connected
13	12VCC	Connect this pin to 12V supply voltage. This pin provides the bias for the driver circuitry. The voltage at this pin is monitored for Power-On Reset (POR) purpose.
14	UGATE	Connect UGATE pin to the PWM converter's upper MOSEFT gate. This pin provides the gate drive for the upper MOSFET.

Block Diagram



Absolute Maximum Ratings

Supply Voltage 5Vcc	-0.3 ~ 7V
Supply Voltage 12Vcc	-0.3 ~ 14V
UGATE, LGATE, DRIVE2	-0.3 ~ 12Vcc
FB, FB2, COMP	-0.3 ~ 5Vcc+0.3
Operating Temperature Range	0°C to 70°C
Storage Temperature Range	-65°C to 150°C
Junction Temperature	0°C to 125°C
Package Thermal Resistance SOP-14	68°C/W
Lead Temperature (Soldering, 10sec)	300°C

Caution:

Stresses beyond the ratings specified in “Absolute Maximum ratings” may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

Electrical Characteristics

(T_A = +25°C unless otherwise stated, V_{CC}=5.0V)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Vcc Supply Voltage					
12Vcc		10.8	12	13.2	V
5Vcc		4.5	5.0	5.5	V
Vcc Supply Current					
Nominal Supply Current 12Vcc	UGATE and LGATE open		1.3		mA
Nominal Supply Current 5Vcc	UGATE and LGATE open		1.0		mA
Power On Reset					
5Vcc Rising Threshold		4.15	4.35	4.55	V
5Vcc Falling Threshold		3.7	3.9	4.1	V
12Vcc Rising Threshold		9.6	10.3	10.8	V
12Vcc Falling Threshold		9.2	9.6	10.2	V
Oscillator					
Frequency		550	600	650	KHz
Ramp Amplitude			1.5		Vp-p
Soft-Start					
Soft-Start Interval			3.4		mS
Reference					
Reference Voltage Tolerance		-2		+2	%
Nominal Reference Voltage			0.8		V
PWM Error Amplifier					
DC gain			70		dB
Gain Bandwidth Product			10		MHz
Slew Rate			6		V/μS
FB Input Bias Current			20	150	nA
Comp High Output Voltage			5		V
Comp High Output Current (Source)			-7.3		MA
Comp Low Output Voltage			0.5	1	V
Comp Low Output Current (Sink)			5.6		mA
PWM Gate Drivers					
UGATE & LGATE Source Current			-1		A
UGATE & LGATE Sink Current			1		A
UGATE Maximum Voltage		11	12		V
LGATE Maximum Voltage		4	5		V
UGATE & LGATE Output Impedance			3.1	4.3	Ω
PWM Protection					
Under-Voltage Level (VFB/VREF)			51		%

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Linear Regulator Error Amplifier					
DC gain			70		dB
Gain Bandwidth Product			10		MHz
Slew Rate			6		V/μS
FB2 Input Bias Current			20	150	nA
DRIVE2 High Output Voltage			12		V
DRIVE2 High Output Current			-14		mA
DRIVE2 Low Output Voltage			0	0.5	V
DRIVE2 Low Output Current			14		mA
Linear Regulator Protection					
Under-voltage Level (VFB2/VREF)			51		%
Over-voltage Level (VFB2/VREF)			161		%

Typical Performance Characteristics

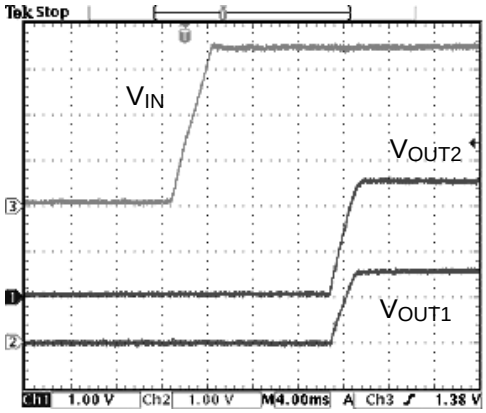


Fig. 1 Power ON

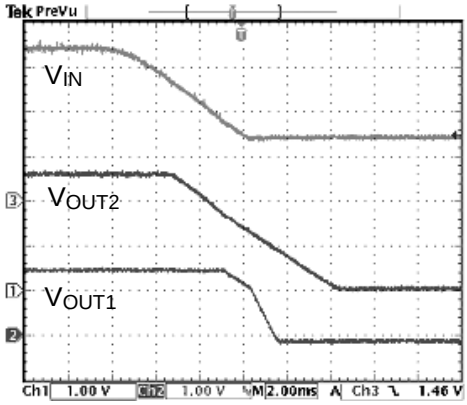


Fig. 2 Power Off

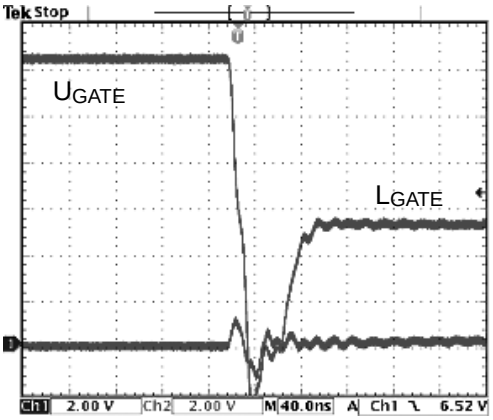


Fig. 3 Dead Time

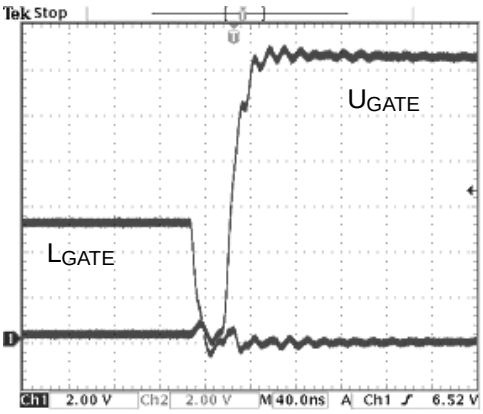


Fig. 4 Dead Time

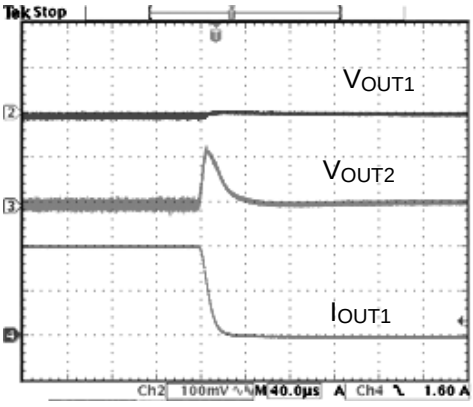


Fig. 5 Load Off Transient Response

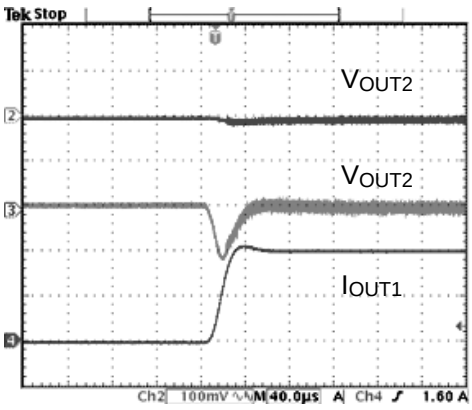


Fig. 6 Load On Transient Response

Application Information

Operation Overview

The more complicate it takes to design for the power design of a graphic card, the more important it is to have a smarter solution and less time to the market. The LD7129 is exactly right solution for it. It eliminates the bootstrap circuit while the LD7129 control circuit is supplied by 5V and high-side MOSFET driver is supplied by 12V.

The LD7129 integrates both of a synchronous-rectified buck controller and a linear power controller to control the supply of both high-current requirement on GPU and low-current requirement on memory. To prevent the fault a condition, the LD7129 also is implemented with UVP (under-voltage protection) on both outputs and OVP (over-voltage protection) on linear controller. And the 600kHz high switching frequency helps to shrink the component sizes and the output ripple.

Initialization

With smart power-on-reset (POR) circuit, the LD7129 monitors both 5Vcc and 12Vcc available to identify the function of the controller. This will prevent any fault condition resulting from possible power sequence. Therefore, it's not necessary to take care of the power sequence.

Soft Start

The POR function initiates the soft start function as soon as the 5Vcc and 12Vcc reach the threshold voltage. The built in soft start function is to prevent inrush current and output voltage overshoot during power on. An internal digital counter controls the soft start voltage. It clamps the ramping of reference voltage at the input of error amplifier and the pulse width of the output driver slowly. The typical soft start duration is 3.4mS.

Under-Voltage Protection

The under-voltage protection (UVP) of the LD7129 is implemented by monitoring the feedback signal at FB and FB2 pin. Whenever there's one of these 2 signals drops below 51% of the internal reference, the UVP will be triggered and then both outputs will quickly shut down. Unless the fault condition is removed, then both of the outputs will keep in hiccup operation mode.

Output Voltage Setting

The both of the LD7129 regulate with the feedback from the voltage dividers. Therefore, the output voltage can be easily programmed according to the resistor values from the following equations, respectively.

For switching output (figure 7),

$$V_{OUT1} \times \frac{R_4}{R_1 + R_4} = V_{Ref} = 0.8V$$

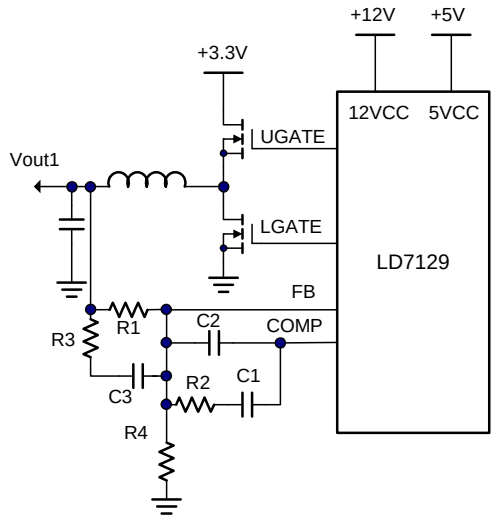


Figure 7. OUTPUT VOLTAGE SELECTION OF THE PWM OUTPUT

For linear output (figure 8),

$$V_{OUT2} \times \frac{R_6}{R_5 + R_6} = 0.8V$$

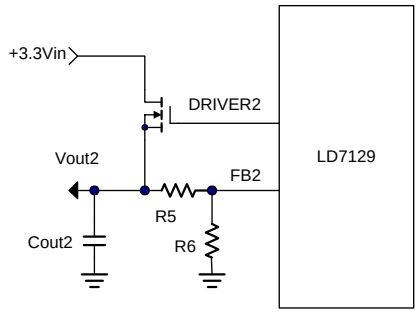


Figure 8. OUTPUT VOLTGAE SELECTION OF THE LINEAR OUTPUT

Converter Shutdown

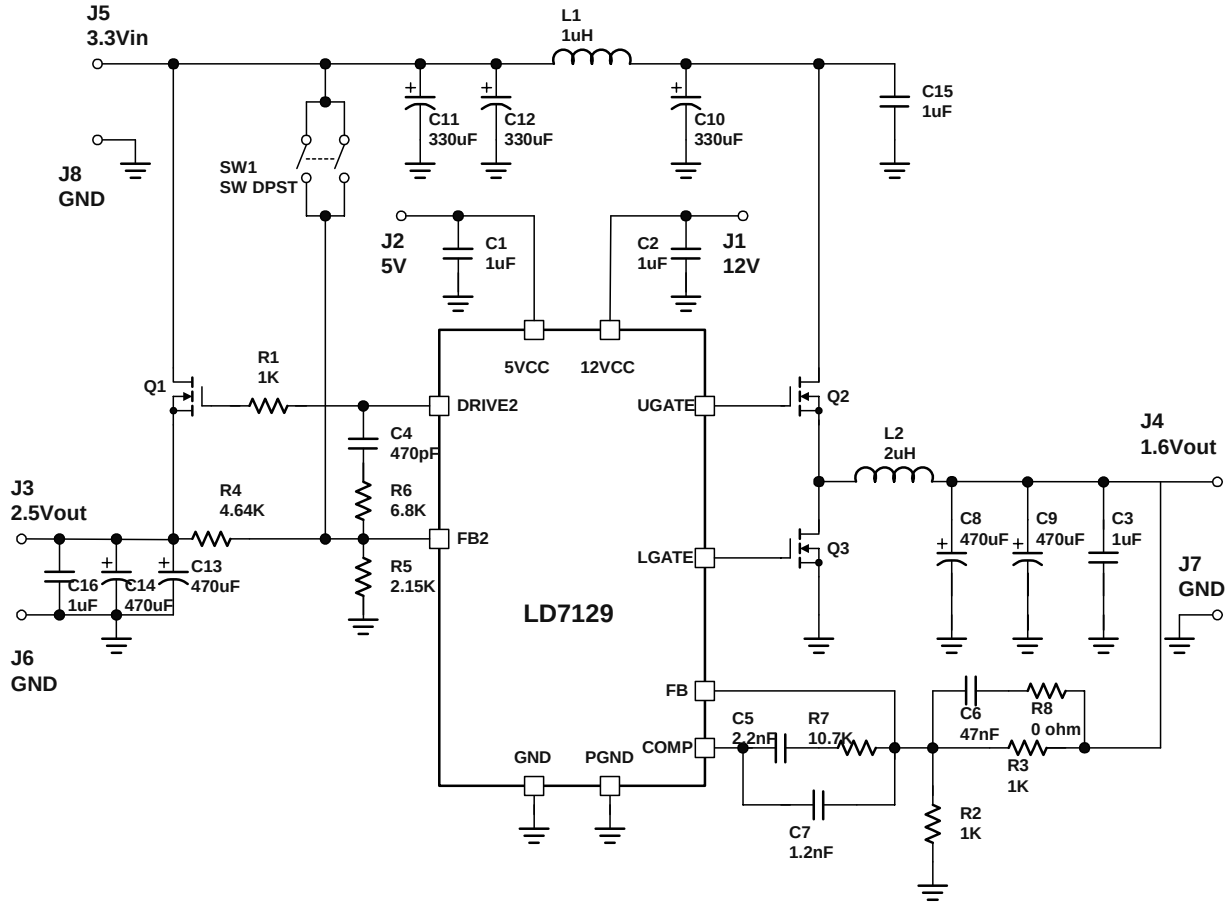
Force the FB2 pin to be higher than a threshold of 1.28V will shutdown both of these two regulators. When the applied voltage is removed, the regulators will turn into the re-start cycle and begin the soft-start process.

Layout Hint

There are some principles are recommended when LD7129 is being designed with:

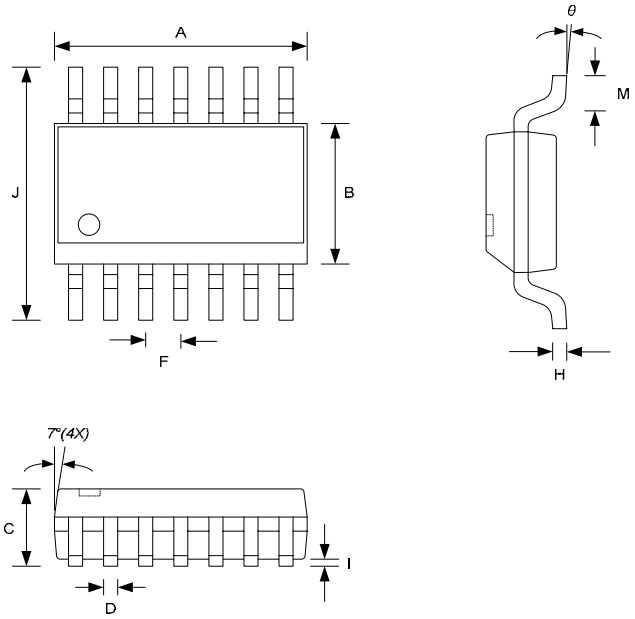
1. Keep the bypass capacitor of 5VCC and 12VCC very close to the IC.
2. Keep output voltage feed back network, FB pin and FB2 pin related components (small signal components) very close to the IC.
3. Signal ground plane of FB and FB2 pin (small signal components) should be connected to the power ground plane with a via or only one point to minimizes the effect of power ground currents.
4. Switching node such as UGATE and LGATE should be kept as small as possible and routed away from FB, FB2, and other linear circuit.
5. The PCB traces carrying discontinuous currents and any high current path should be made as short and wide as possible.
6. If possible, a multi-layer PCB is recommended. Please refer to the EV kit of LD7129 for a PCB layout example.

Typical Application Circuit



Package Information

Package: SOP-14



Symbols	Dimensions in Millimeters		Dimensions in Inch	
	MIN	MAX	MIN	MAX
A	8.534	8.738	0.336	0.344
B	3.810	3.988	0.150	0.157
C	1.346	1.753	0.053	0.069
D	0.330	0.508	0.013	0.020
F	1.194	1.346	0.047	0.053
H	0.178	0.254	0.007	0.010
I	0.102	0.254	0.004	0.010
J	5.791	6.198	0.228	0.244
M	0.381	1.270	0.015	0.050
θ	0°	8°	0°	8°

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