

High Power LED Driver

The EL7801 is a high-power LED backlight driver with an integrated 36V FET designed to drive up to 8 high-power LEDs in series while running from a 12V input supply. The PWM converter runs from an internally generated 1MHz clock. With efficiencies over 90% the regulator provides tight control of LED current and may be configured in either boost or buck topologies, allowing from 1 to 8 series diodes to be driven from a 12V input.

LED light level may be controlled either by:

1. LED DC bias current set via the LEVEL pin, or
2. External low frequency PWM control via the ENABLE/PWM pin.

In both control modes optional over temperature thermal protection of the LED reduces the LED DC bias current above a customer set temperature, protecting the LED from thermal damage. An optional fault monitor drives an external FET between the input supply and inductor, providing short circuit current protection for the LED and inductor as well as load dump protection for automotive applications. For low cost applications the pass transistor may be omitted and the fault pin bypassed.

The EL7801 is packaged in a 20 Ld QFN package and is specified for operation over the -40°C to +85°C temperature range.

Ordering Information

PART NUMBER	TAPE & REEL	PACKAGE	PKG. DWG. #
EL7801ILZ	-	20 Ld QFN	MDP0046
EL7801ILZ-T7	7"	20 Ld QFN	MDP0046
EL7801ILZ-T13	13"	20 Ld QFN	MDP0046

NOTE: Intersil Pb-free plus anneal products employ special Pb-free material sets; molding compounds/die attach materials and 100% matte tin plate termination finish, which are RoHS compliant and compatible with both SnPb and Pb-free soldering operations. Intersil Pb-free products are MSL classified at Pb-free peak reflow temperatures that meet or exceed the Pb-free requirements of IPC/JEDEC J STD-020.

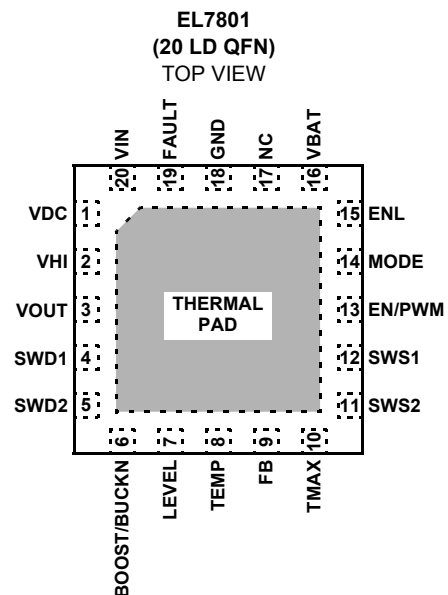
Features

- Drives 1-8 high-power LEDs in series, up to 32V
- 2.7V to 16V input voltage range
- Boost or buck configurable switch
- 3A integrated FET
- Automotive load dump protection
- Light output temperature compensation
- LED over-temperature protection
- LED disconnect
- PWM/analog light level control
- Small, 20 Ld QFN package
- LED camera flash mode
- Pb-free plus anneal available (RoHS compliant)

Applications

- Display backlighting
 - Automotive
 - LCD monitor
 - Notebook displays
- LED accent lighting
- Automotive lighting

Pinout



EL7801

Absolute Maximum Ratings (T_A = 25°C)

Supply Voltage, V _{IN} 18V	Storage Temperature Range -65°C to +150°C
Input Voltage GND -0.3V to V _{SP} +0.3V	Ambient Operating Temperature -40°C to +85°C
Continuous Output Current 1A	Operating Junction Temperature +125°C
Battery Input, V _{BAT} 24V	Power Dissipation See Curves

CAUTION: Stresses above those listed 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.

IMPORTANT NOTE: All parameters having Min/Max specifications are guaranteed. Typical values are for information purposes only. Unless otherwise noted, all tests are at the specified temperature and are pulsed tests, therefore: T_J = T_C = T_A

Electrical Specifications V_{BAT} = V_{IN} = 12V, V_{DC} = 5V, I_{OUT} = 350mA, T_A = -40°C to +85°C unless otherwise specified.

PARAMETER	DESCRIPTION	CONDITIONS	MIN	TYP	MAX	UNIT
V _{IN}	Input Supply Voltage	Normal operating range	2.7		16	V
V _{BAT}	Input Supply Monitor	Normal operating range	2.7		16	V
V _{BATMAX}	Supply Fault Threshold	If V _{BAT} > V _{BATFAULT} , FAULT pin is switched to ground	17.6	20	24.4	V
I _{SEN}	Supply Current in V _{IN}	No switching, EN/PWM = 1	TBD	2		mA
I _{SDIS}	Supply Current in V _{IN}	No switching, EN/PWM = 0	TBD	10		μA
R _{SWITCH}	Power FET On Resistance	I _{SWITCH} = 1.2A		0.15		Ω
V _{DC}	Regulated Auxiliary Supply		4.75	5	5.25	V
R _{OUTOL}	Auxiliary Supply Open Loop Output Resistance	V _{IN} < V _{DC}			50	Ω
R _{OUTCL}	Auxiliary Supply Closed Loop Output Resistance	V _{IN} > 5V, F < 100Hz			5	Ω
C _{MIN}	V _{DC} Filter (Compensation) Capacitor		0.1			μF
I _{OUT}	Output Drive Current	4 LED output string			1000	mA
I _{LIMBOOST}	Power Switch Current Limit	BOOST/BUCKN = V _{DC}		3.6		A
I _{LIMBOOST}	Power Switch Current Limit	BOOST/BUCKN = GND		2.4		A
I _{LIMFLASH}	Power Switch Current Limit	TEMP = V _{DC}		6		A
T _{DELOV}	Transition Delay from Current to Voltage Mode	LX fault protection activation		20		ns
OVPH	Over Voltage Positive Going Voltage Mode Threshold	Upper threshold to enter overvoltage fault mode	TBD	34		V
OVPL	Over Voltage Negative Going Voltage Mode Threshold	Lower threshold to exit overvoltage fault mode		17	TBD	V
V _{HIGATE}	Switch Driver Supply	In buck mode (V _{HI} - V _{IN}), In boost mode (V _{HI} - GND)			V _{DC}	V
V _{FB}	Feedback Voltage	System in regulation, V _{LEVEL} = 1V		0.2		V
V _{FLASH}	Feedback Voltage in Flash Mode	Independent of V _{LEVEL}		0.4		V
V _{LEVEL}	Light Control Voltage Input Range	Mode = 1, analog control of LED current	GND		3	V
F _{SW}	Switching Frequency		TBD	1	TBD	MHz
F _{MOD}	External Light Modulation Frequency	Mode = 1, modulation signal applied to EN/PWM			600	Hz
T _{SWITCH}	Load Switch Transition Time	C _{GATE} = 2nF		100		ns
RLSDRIVER	Load Switch Driver Impedance			25	TBD	Ω
T _{FAULT}	Fault Timer Period		TBD	50	TBD	ms
T _{FLASH}	Flash Timer Period	Maximum flash timer period	TBD	16	TBD	ms

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Electrical Specifications $V_{BAT} = V_{IN} = 12V$, $V_{DC} = 5V$, $I_{OUT} = 350mA$, $T_A = -40^{\circ}C$ to $+85^{\circ}C$ unless otherwise specified.

PARAMETER	DESCRIPTION	CONDITIONS	MIN	TYP	MAX	UNIT
T_{DELAY}	Start-up Delay	Timed LX switching delay	TBD	1		ms
V_{GATE}	External FET Gate Clamp	$ V_{FAULT} - V_{IN} $	TBD	10	TBD	V
$V_{FAULTPUMP}$	Fault Pin Charge Pump	$V_{BAT} = V_{IN} = 3V$	6			V
V_{MODEL}	Mode Pin Input Low Threshold	$V_{DC} = 5V$			$V_{DC}/3$	V
V_{MODEH}	Mode Pin Input Low Threshold	$V_{DC} = 5V$	$2 \times V_{DC}/3$			V
en_{FLASH}	Input Level Applied to TEMP Pin to Enter Flash Mode	$V_{DC} = 5V$			$0.96V_{DC}$	V
dis_{FLASH}	Input Level Applied to TEMP Pin to Exit Flash Mode	$V_{DC} = 5V$	$0.94V_{DC}$			V
en_{FAULT}	Input Level Applied to TMAX Pin to Enable Fault Protection	$V_{DC} = 5V$	$0.94V_{DC}$			V
dis_{FAULT}	Input Level Applied to TMAX Pin to Disable Fault Protection	$V_{DC} = 5V$			$0.96V_{DC}$	V
en_{TEMP}	Input Level Applied to TEMP Pin to Enable Temperature Compensation	$V_{DC} = 5V$			$0.06V_{DC}$	V
dis_{TEMP}	Input Level Applied to TEMP Pin to Disable Temperature Compensation	$V_{DC} = 5V$	$0.04V_{DC}$			V
T_{TRIP}	Internal Temperature Protection Threshold			125		C
$V_{EN/PWML}$	EN/PWM Pin Input Low Threshold				1.2	V
$V_{EN/PWMH}$	EN/PWM Pin Input High Threshold		2.5			V

TABLE 1. LIGHT OUTPUT CONTROL, $V_{DC} = 5.0V$

MODE	TEMP	OPERATING MODE
1	$(V_{DC} - 0.25V) > V > 0.25V$	Standard Mode light level to PWM modulation of EN/PWM input; LED bias current determined by LEVEL voltage, nominal 1V
Don't Care	$V > (V_{DC} - 0.25V)$	Flash Mode , internal current limit set to 6A; duration of flash set by ENABLE/PWM input; T_{ON} max limited internally to 25ms, $V_{FB} = 0.4V$, independent of V_{LEVEL}
Don't Care	$V < 0.25V$	Disable temperature compensation
0	$V < (V_{DC} - 0.25V)$	Fixed Bias Mode V_{FB} level internally set to 0.4V, independent of V_{LEVEL}

Typical Application Diagram

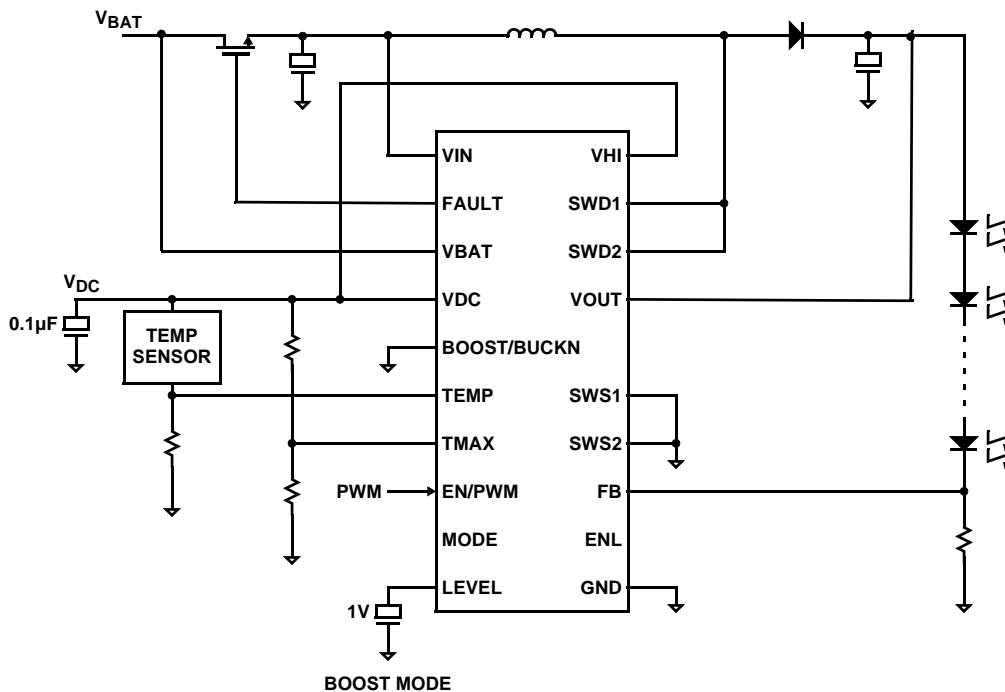


FIGURE 1. TYPICAL APPLICATION CIRCUIT

Pin Descriptions

PIN	NAME	DESCRIPTION
1	VDC	Internally regulated 5V supply, tracks V_{IN} for input voltages less than 5V
2	VHI	Power FET gate drive supply
3	V_{OUT}	Overvoltage monitor input; tie to V_{OUT} for normal operation
4	SWD1	NMOS power FET drain
5	SWD2	NMOS power FET drain
6	BOOST/BUCKN	Digital input, configures controller to operate in BOOST or BUCK mode, low for BOOST, high for BUCK
7	LEVEL	Sets LED bias current level; $V_{FB}(\text{nominal}) = V_{LEVEL}/5$
8	TEMP	Temperature reference, tie to GND to disable temperature compensation, tie to VDC to enable camera flash mode
9	FB	LED current feedback
10	TMAX	Maximum LED temperature set point; if TEMP voltage exceeds TMAX, FB set point is reduced
11	SWS2	NMOS power FET source
12	SWS1	NMOS power FET source
13	EN/PWM	Chip enable, light modulation PWM input
14	MODE	Digital Input; tie to GND to set FB reference to 400mV, tie to VDC to control FB reference with LEVEL input
15	ENL	LED load isolation switch gate driver
16	VBAT	Input supply monitor
17	N/C	Leave floating (internally connected)
18	GND	Ground return and FB ground reference
19	FAULT	Gate drive of fault FET. Driven low under fault conditions
20	VIN	Input supply and FB pin supply reference

Functional Block Diagram

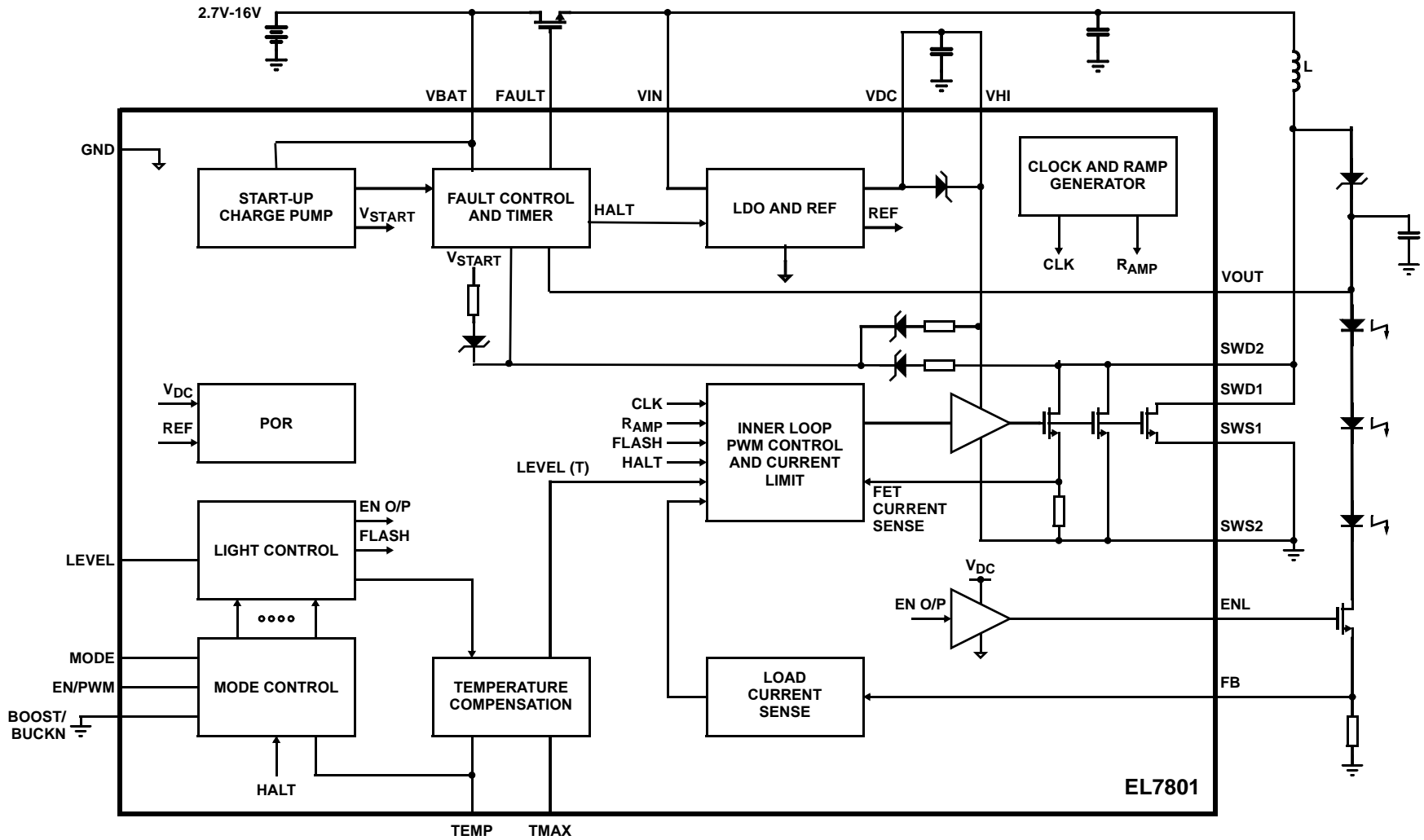


FIGURE 2. EL7801 BLOCK DIAGRAM

EL7801

Theory of Operation

General Description

The EL7801 is a flexible, highly integrated high-power LED driver consisting of a PWM switching controller and integrated 36V NDMOS power FET. The device can drive up to 8 series high-power LED's at currents up to 1A. The control loop can be configured as either as a boost or buck regulator, providing an output voltage above or below the input supply voltage, depending on the number of stacked LED's. The controller operates from 2.7V to 16V and can be powered by a single lithium ion battery, 5V or 12V regulated supplies or automotive electrical systems. LED Current is sensed through a low value resistor in series with the LED. The resistor may be referenced to ground or the input rail, allowing operation with supplies that span the output voltage, for example a lithium ion battery driving one LED. Load current can be adjusted using a thermistor to correct for the reduction in optical efficiency of white LED's with increasing temperature. The thermistor is also used to implement a thermal protection scheme to limit the maximum LED temperature to a preset customer level.

Switching Regulator

The EL7801 employs a current mode PWM control scheme with a nominal switching frequency of 1MHz. This provides fast transient response and enables the use of low profile inductors and compact multilayer ceramic capacitors. Settling time is optimized by the use of a simple control loop without an error amplifier, relying instead on intrinsic gain within the direct summing path. Due to the lower loop gain, offset must be accounted for when setting up initial LED bias current. Refer to the applications section of the datasheet for further information. Figure 2 shows a block diagram of the system.

Application Configurations

Operating Modes

The EL7801 can operate as either a buck or boost regulator. Hardwire BUCK/BOOSTN to GND for boost mode or to VDC for buck mode. In buck mode the power NDMOS drive circuit is "floated" (boot-strapped) allowing the NDMOS gate to be driven above VIN to fully enhance the power NDMOS. An internal Schottky diode between VDC (5V) and VHI reduces external component count. Use a ceramic capacitor of at least 50nF between VHI and SWS1/2 to bootstrap VHI.

LED Load Connection

EL7801 includes an auto-sensing FB level shift circuit that enables the LED load to be connected to either GND or VIN. An internal sense circuit monitors the FB pin voltage. When the level exceeds VDC/2, the feedback reference voltage is switched from GND to VIN. Refer to the application section of the datasheet for typical application schematics.

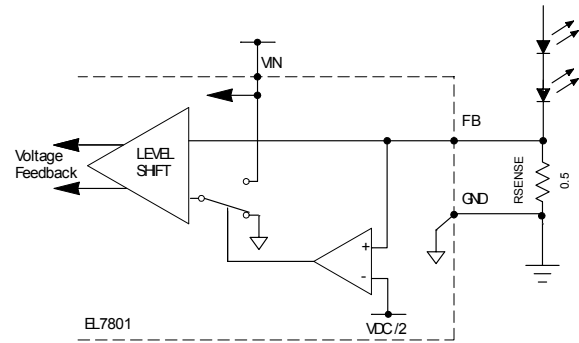


FIGURE 3. FB REFERENCE AUTO SWITCH

Start Up

To maximize external PWM switching speed, the EL7801 doesn't include an internal soft-start circuit. When VDC exceeds the power on reset threshold, switching is delayed for 1ms (TDELAY) allowing the output capacitor to charge through the inductor. If soft-start control is required, a suitable application circuit is shown in Figure 4.

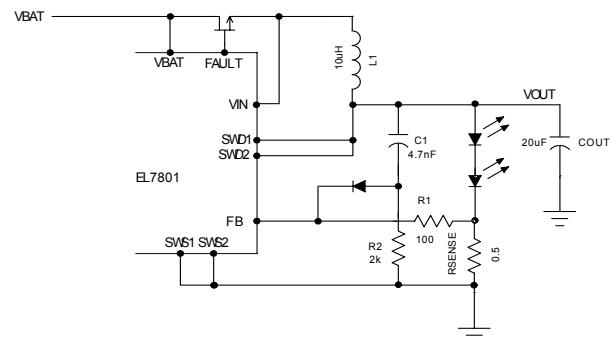


FIGURE 4. EXTERNAL SOFT START CIRCUIT

Light Level Control

Two light control schemes are provided:

1. An external PWM signal via the EN/PWM pin, providing low frequency PWM dimming.
2. Bias current level adjustment via the LEVEL input or fixed internal bias.

PWM Dimming

LED color temperature varies with bias current. In backlighting applications PWM dimming offers better control of color temperature because current through the LED's is kept constant. A 5V gate driver (ENL) synchronized to EN/PWM can be used to control an external FET and disconnect the LED stack during the PWM off period. The switch prevents discharge of the output capacitor by the LED load, maintaining a constant bias independent of PWM duty cycle. Operation at 1kHz PWM rate is shown in Figure 5 and

Figure 6. The load disconnect switch improves PWM dynamic range, linearity and color temperature control. To further improve the linearity of PWM dimming, an internal timer delays system shutdown via EN/PWM for 50ms.

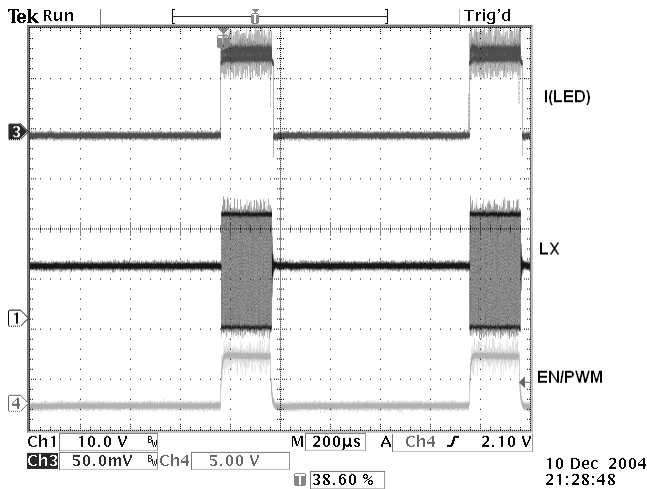


FIGURE 5. OPERATION WITH ENL

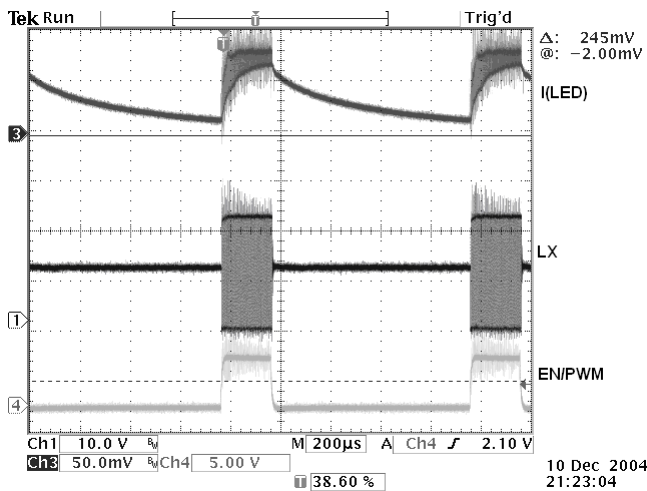


FIGURE 6. OPERATION WITH NO ENL

Bias Current Dimming

Current in the LED load is determined by the value of the feedback resistor and the target feedback regulation voltage:

$$I_{LED} = \frac{V_{FB}}{R_{SENSE}}$$

With MODE tied to VDC, voltage across the feedback resistor is set by V_{LEVEL} :

$$V_{FB} = \frac{V_{LEVEL}}{5}$$

The value of V_{FB} should be limited to between 50mV and 450mV for linear operation and is internally limited to 500mV. LEVEL voltages above 2.5V will have no effect on LED current. With MODE tied to GND, voltage across the feedback resistor is set at ~400mV via an internal reference. In either operating mode, if LED temperature control is enabled the value of V_{FB} will be reduced when maximum LED temperature is exceeded.

Input Overvoltage

For automotive applications, an external high voltage NFET driven by the FAULT pin disconnects the device from the input supply in response to voltage spikes on the input supply. During start up an internal charge pump drives the FAULT pin above the input voltage, ensuring the NFET is fully enhanced and powering up the device. In normal operation the switching node of the boost regulator or the floating supply of the buck regulator is used to pump FAULT above V_{IN} . On detection of an overvoltage, the FAULT pin is discharged to GND. The gate to source voltage of the NDMOS is internally limited to $\pm 10V$ to prevent voltage stress.

Fault Protection

The external NFET is also used as a fault protection switch, disconnecting the input supply if a fault occurs for more than 50ms. The system monitors feedback voltage regulation, output over-voltage and input over-voltage. In camera-flash mode, the fault switch disconnects the input supply when EN/PWM is held high longer than the 16ms flash time-out period. For applications not requiring input voltage or fault protection, connect VBAT and V_{IN} directly together. All faults except input supply over-voltage latch the EL7801 into an off state that can be cleared by either power cycling the input supply or the EN/PWM pin. Connecting the TMAX pin to VDC disables the fault latch function (LED over temperature control is also disabled.)

Output Overvoltage Protection (OVP)

If the FB pin is shorted to ground or an LED fails open circuit, output voltage in BOOST mode can increase to potentially damaging voltages. An optional overvoltage protection circuit can be enabled by connection of the OVP pin to the output voltage. The device will stop switching if the output voltage exceeds V_{FAULTU} and re-start when the output voltage falls below V_{FAULTL} . During sustained OVP fault conditions, V_{OUT} will saw-tooth between the upper and lower threshold voltages at a frequency determined by the magnitude of current available to discharge the output capacitor and the value of output capacitor used.

The OVP threshold can be set to a lower value by using an external zener diode and resistor, as shown in Figure 7. R1 should be adjusted to minimize offset in the FB voltage due to FB pin input current. A value of 100Ω is recommended.

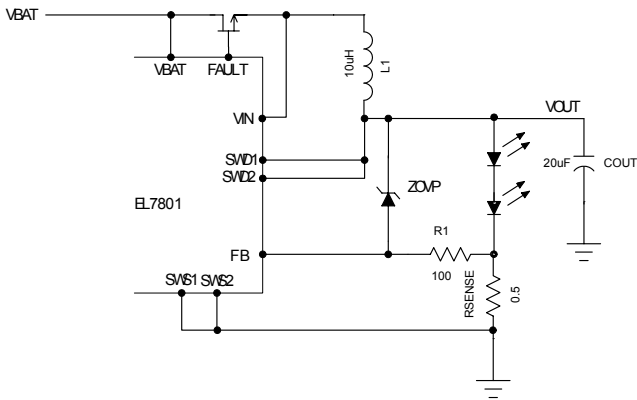


FIGURE 7. EXTERNAL OVP CIRCUIT

Over Temperature Shutdown

An internal sense circuit disables PWM switching if the die temperature exceeds 135°C. Switching is re-enabled when the temperature falls below 100°C.

Internal 5V LDO

An internal LDO between VIN and VDC regulates VDC to 5V, to power control and gate drive circuits when VIN exceeds 5.1V. In normal operation decouple VDC with at least 0.47µF. In applications where the input supply is less than 5.5V, VDC should be tied directly to VIN.

Temperature Compensation

At a constant current, high power white LED light intensity reduces as junction temperature increases.

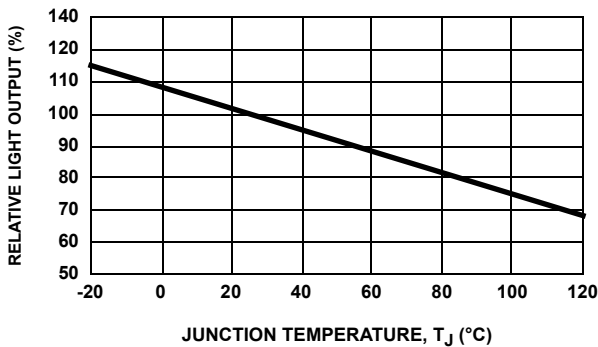


FIGURE 8. HIGH POWER WHITE LED LIGHT OUTPUT VARIATION WITH JUNCTION TEMPERATURE

EL7801 incorporates a supply referenced temperature interface to increase LED load current with temperature. Disable the function by connecting the TEMP pin to GND.

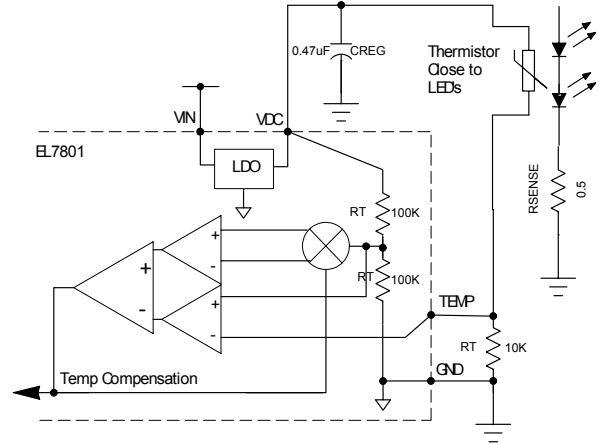


FIGURE 9. TEMPERATURE COMPENSATION CIRCUIT

In use, connect a potential divider comprised of an NTC thermistor and low temperature coefficient resistor between VDC and GND. Locate the thermistor physically close to the LED load for accurate temperature sensing. Connect the tap point of the divider to the TEMP pin. Temperature changes vary the VDC divider ratio and adjust the voltage present at VTEMP, providing up to ±30% adjustment in FB bias level. A 10K resistor and Muarta NCP18XH103f03RB thermistor will set VTEMP at VDC/2 at room temperature. Different thermistor and resistor values may be used to tailor the system temperature coefficient for specific LED families. Alternatively, temperature coefficient can be fine tuned by inserting limit resistors in series and parallel with the thermistor to bound impedance variation with temperature. For the LED temperature variation shown in Figure 8, a suitable arrangement is shown in Figure 11.

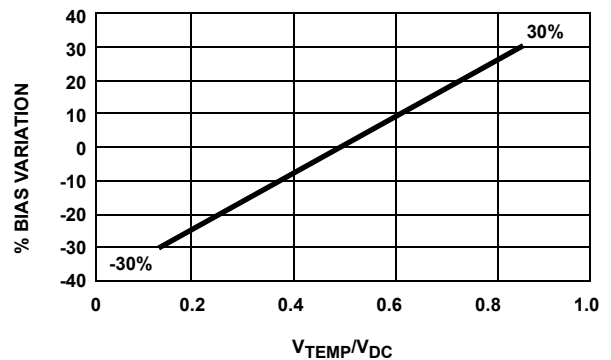


FIGURE 10. FB VOLTAGE VARIATION WITH V_{TEMP}/V_{DC} RATIO

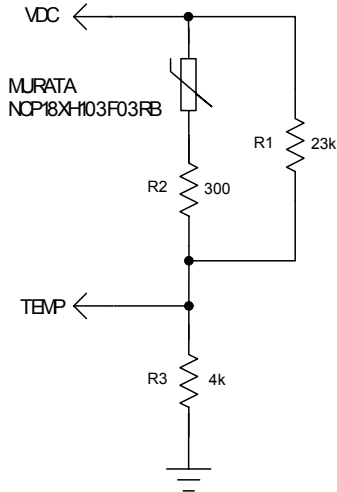


FIGURE 11. THERMISTOR VOLTAGE COEFFICIENT ADJUSTMENT

LED Temperature Control

LED lifetime reduces dramatically with elevated temperature. An over temperature control circuit utilizing the thermistor voltage at TEMP reduces the LED bias current when VTEMP exceeds the threshold voltage on TMAX. To minimize noise injection use a potential divider between VDC and GND to set the voltage on TMAX, as shown in Figure 12. The value of TMAX for a specific shut down temperature is determined by the choice of thermistor temperature coefficient. Disable the function by connecting the TMAX pin to GND.

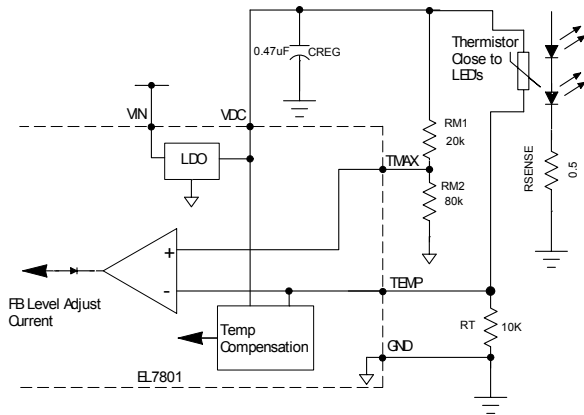


FIGURE 12. OVER-TEMPERATURE CIRCUIT

Component Selection

Input Capacitor

Switching regulators require input capacitors to deliver peak charging current and to reduce the impedance of the input supply. This reduces interaction between the regulator and

input supply, improving system stability. The high switching frequency of the loop causes almost all ripple current to flow in the input capacitor, which must be rated accordingly.

Considerably more input current ripple is generated in buck mode than boost mode. In buck mode input current is alternately switched between IOUT and zero. The rms current flow in the input capacitor is given by:

$$I_{CAPRMS} = I_{OUT} \cdot \sqrt{D - D^2}$$

Where: D = Duty Cycle

The input current is maximum for D = 0.5 and when IOUT approaches current limit (2.4A) giving a value of around 1.2A.

A capacitor with low internal series resistance should be chosen to minimize heating effects and improve system efficiency, such as X5R or X7R ceramic capacitors, which offer small size and a lower value of temperature and voltage coefficient compared to other ceramic caps.

In boost mode input current flows continuously into the inductor, with an ac ripple component proportional to the rate of inductor charging only and smaller value input capacitors may be used. It is recommended that an input capacitor of at least 10µF be used. Ensure the voltage rating of the input capacitor is suitable to handle the full supply range.

In automotive applications the input capacitor can be protected from exposure to high voltages present during fault conditions (load dump) by connecting it downstream of the fault protection switch, as shown in Figures 19 and 20.

Inductor

Careful selection of inductor value will optimise circuit operation. Inductor type and value influence many key parameters, including ripple current, current limit, efficiency, transient performance and stability. Internal slope compensation has been optimised for inductor values between 4.7µH and 10µH. Ensure the inductor current rating is capable of handling the current limit value in the configuration used (2.4A for buck, 3.5A for boost). If an inductor core is chosen with too low a current rating, saturation in the core will cause the effective inductor value to fall, leading to an increase in peak to average current level, poor efficiency and overheating in the core.

Rectifier Diode

A high speed rectifier diode is necessary to prevent excessive voltage overshoot, especially in the boost configuration. Low forward voltage and reverse leakage current will minimize losses, making Schottky diodes the preferred choice. Similarly to the Inductor, a diode with a suitable current rating to handle current limit in the configuration must be used.

Output Capacitor

The output capacitor acts to smooth the output voltage and in the boost configuration supplies load current directly during the conduction phase of the power switch. Ripple voltage consists of two components, the first due to charging and discharging of the capacitor; the second due to IR drop across the ESR of the capacitor by inductor ripple current.

In boost mode:

$$V_{RIPPLE} = \frac{I_O}{C_{OUT}} \times \frac{D}{f_s} + I_{LPK} \times ESR$$

where:

$$D = \frac{V_{OUT} - V_{IN}}{V_{OUT}}$$

and

$$I_{LPK} = \frac{I_O}{1-D} + \frac{(V_{OUT} - V_{IN})}{2 \times L} \times \frac{(1-D)}{f_s}$$

In buck mode:

$$V_{RIPPLE} = \frac{(V_{IN} - V_{OUT}) \times D}{2 \times f_s \times L} \times \left(\frac{D}{f_s \times C_{OUT}} + ESR \right)$$

where

$$D = \frac{V_{OUT}}{V_{IN}}$$

For a low ESR ceramic capacitor, output ripple is dominated by the charging and discharging of the output capacitor. Care should be taken to ensure the voltage rating of the capacitor exceeds the maximum output voltage.

Compensation

The EL7801 employs a direct summing control loop with current feedback. No error amplifier is used in the system. The arrangement provides fast transient response and makes use of the output capacitor to compensate the loop. The effect of the pole associated with the inductor is minimized by the current feedback. The number LEDs, their DC bias current and the value of feedback resistor alter loop stability due to their effect on feedback factor which is heavily influenced by the small signal impedance of the LEDs. Generally, higher numbers of LEDs, lower bias levels and smaller values of feedback resistor will require smaller output capacitors to achieve loop stability. A combination of low ESR electrolytic and ceramic capacitors may be used to reduce implementation costs.

TABLE 2. BOOST MODE COMPENSATION. 2.7V OPERATION

VFB	IOUT	VOUT	7	10.5	14	17.5	21	24.5	28
		LED's	2	3	4	5	6	7	8
50mV	50mA	Electrolytic	94µF	47µF				DMAX	DMAX
		Ceramic	40µF	20µF	40µF	20µF	20µF		
100mV	100mA	Electrolytic	94µF						
		Ceramic	60µF	60µF	40µF	40µF	40µF		
200mV	350mA	Electrolytic	94µF	47µF	47µF	47µF	ILIM	ILIM	ILIM
		Ceramic	60µF	40µF	40µF	40µF			
200mV	1A	Electrolytic	ILIM	ILIM	ILIM	ILIM	ILIM	ILIM	ILIM
		Ceramic							

TABLE 3. BOOST MODE COMPENSATION. 5V OPERATION

VFB	IOUT	VOUT	7	10.5	14	17.5	21	24.5	28
		LED's	2	3	4	5	6	7	8
50mV	50mA	Electrolytic	94µF	47µF					
		Ceramic	40µF	20µF	40µF	20µF	20µF	20µF	20µF
100mV	100mA	Electrolytic	141µF	47µF					
		Ceramic	60µF	60µF	60µF	40µF	40µF	40µF	40µF
200mV	350mA	Electrolytic	141µF	47µF	47µF				
		Ceramic	60µF	60µF	40µF	60µF	40µF	40µF	40µF
200mV	1A	Electrolytic	94µF	47µF	ILIM	ILIM	ILIM	ILIM	ILIM
		Ceramic	40µF	40µF					

TABLE 4. BOOST MODE COMPENSATION. 12V OPERATION.

VFB	IOUT	VOUT	7	10.5	14	17.5	21	24.5	28
		LED's	2	3	4	5	6	7	8
50mV	50mA	Electrolytic							
		Ceramic	DMIN	DMIN	DMIN	60µF	40µF	40µF	40µF
100mV	100mA	Electrolytic				47µF	47µF		
		Ceramic	DMIN	DMIN	DMIN	40µF	20µF	40µF	40µF
200mV	350mA	Electrolytic				47µF	47µF		
		Ceramic	DMIN	DMIN	DMIN	40µF	20µF	40µF	40µF
200mV	1A	Electrolytic				47µF	47µF		
		Ceramic	DMIN	DMIN	DMIN	20µF	20µF	40µF	40µF

A Note about Ceramic Capacitors

Many ceramic capacitors have strong voltage and temperature coefficients which reduces effective capacitance as the applied voltage or operating temperature is increased. Pay careful attention when selecting ceramic capacitor type. X5R and X7R families provide much better stability than Y5V, which should generally be avoided unless additional capacitance is added to compensate for the significant changes in value which occurs over voltage and temperature.

TABLE 5.

Capacitor Type	Typical Voltage Variation	Temperature Variation
X7R, 10V	-30% at 10V	-15% at 125C
X5R, 25V	-50% at 25V	-9% at 85C
Y5V, 6.3V	-90% at 6.3V	-65% at 85C

Layout Considerations

PCB layout is very important for the converter to function properly. The following general guidelines should be followed:

- Separate the Power Ground and Signal Ground; connect them only at one point close to the GND pin
- Place the input capacitor close to VIN and SWS1,2 pins in boost mode
- Make the following PC traces as short as possible:
 - from SWD1,2 to the inductor in boost mode
 - from SWS1,2 to the inductor in buck mode
 - from Cout to PGND
- Feedback signals levels are small to improve efficiency. Ensure the reference connection (GND or VIN) between

the sense resistor and IC pin doesn't carry switching current.

- Place several via holes (thermal vias) under the chip to a backside ground plane to improve heat dissipation
- Maximize the copper area around the thermal vias to spread heat away from the chip.

The demo board is a good example of layout based on this outline. Please refer to the EL7801 Application Brief for more detailed information.

Cost-Sensitive Applications

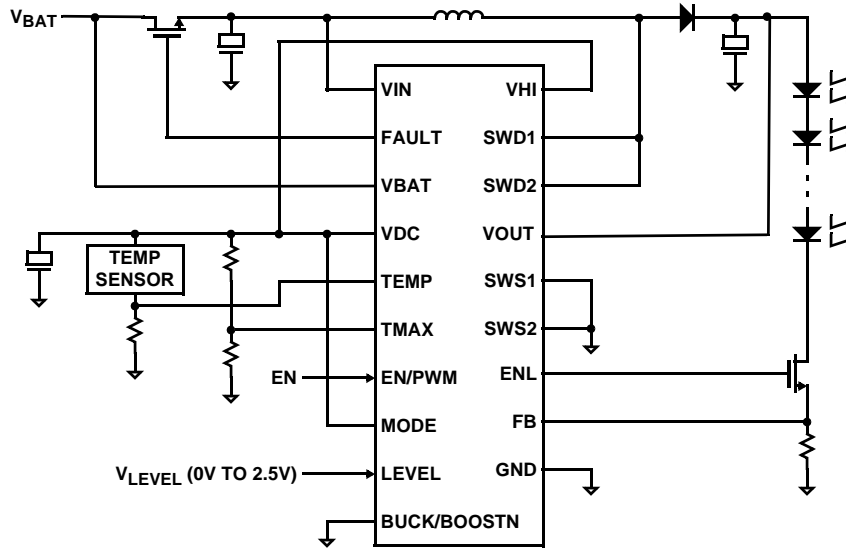
For cost-sensitive applications, the BOM can be reduced considerably by:

1. Removing temperature compensation
2. Removing the fault-protection switch
3. Removing the load isolation switch
4. Switching the FB into internal fixed bias mode (400mV across V_{FB})

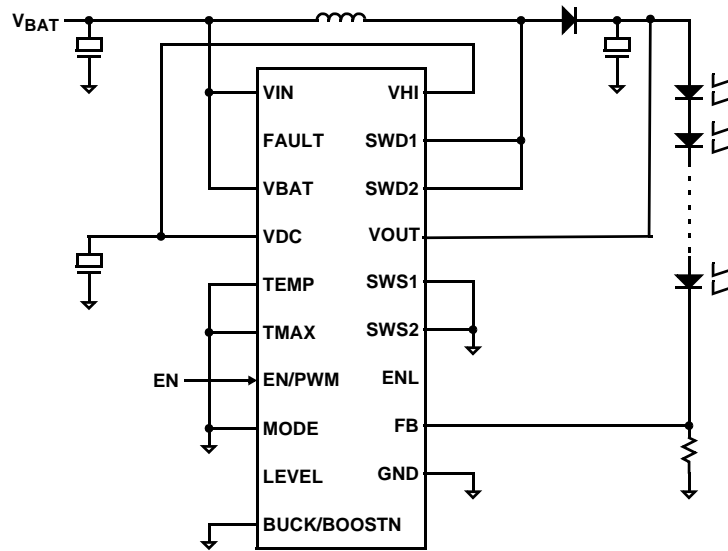
In this configuration, light level may be controlled using the EN/PWM input to chop the output current.

In the absence of the load isolation switch, LED bias current will vary with PWM duty cycle, due to the discharge of the output capacitor by the LED's during the PWM off time.

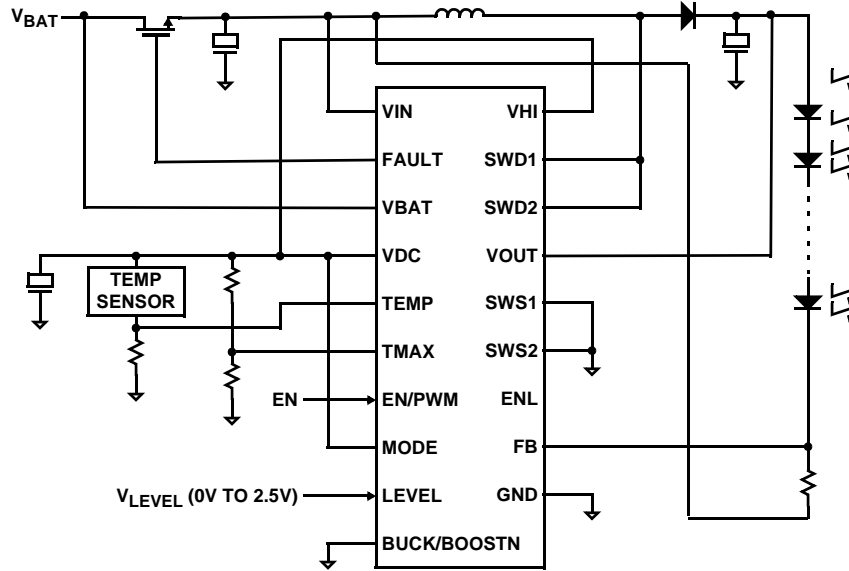
Typical Boost Application Diagram



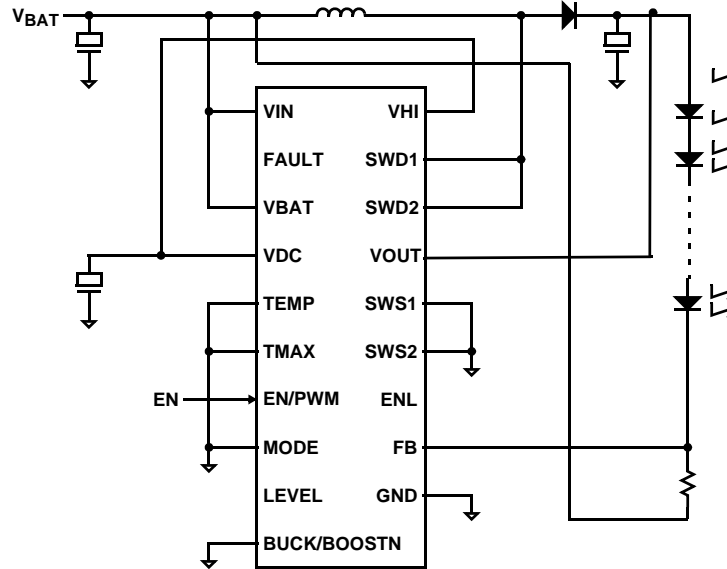
Minimum BOM Boost Application Diagram



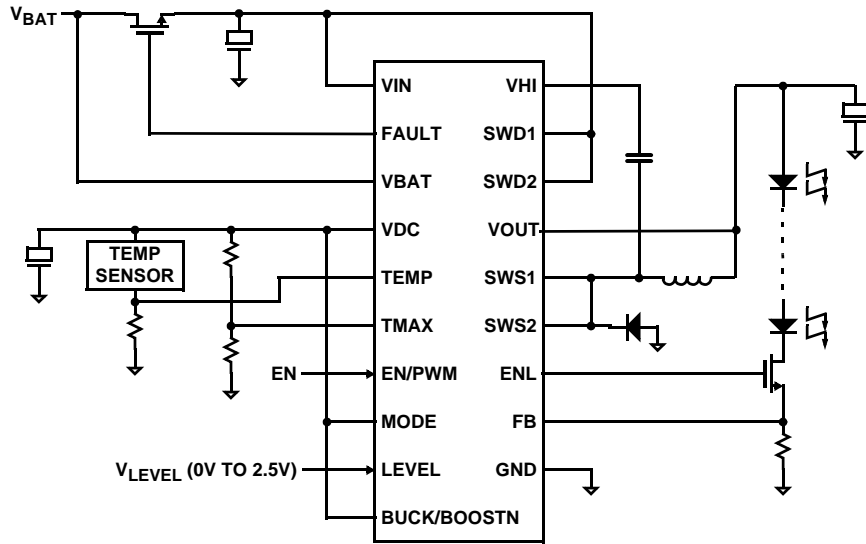
Typical Boost Application Diagram - Supply-Return Load



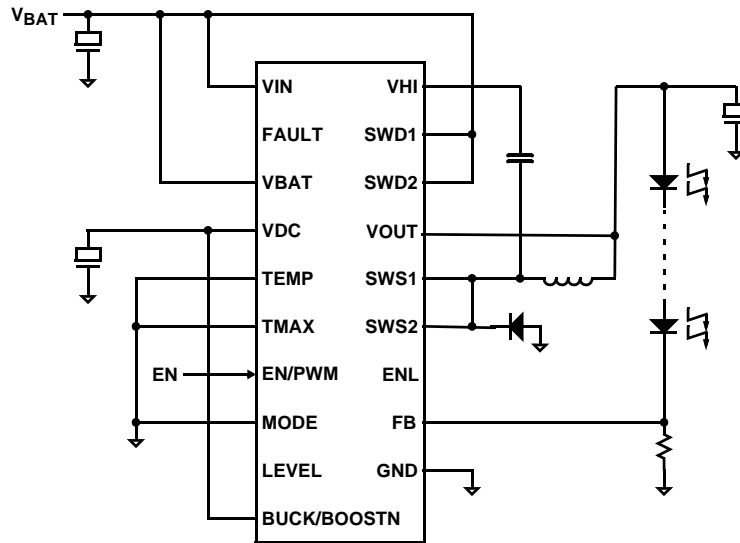
Minimum BOM Boost Application Diagram - Supply-Return Load



Typical Buck Application Diagram



Minimum BOM Buck Application Diagram



Automotive Applications

The LED load and EL7801 may be protected against load dumps and other electrical faults in automotive supplies with a minor addition to the standard application schematic:

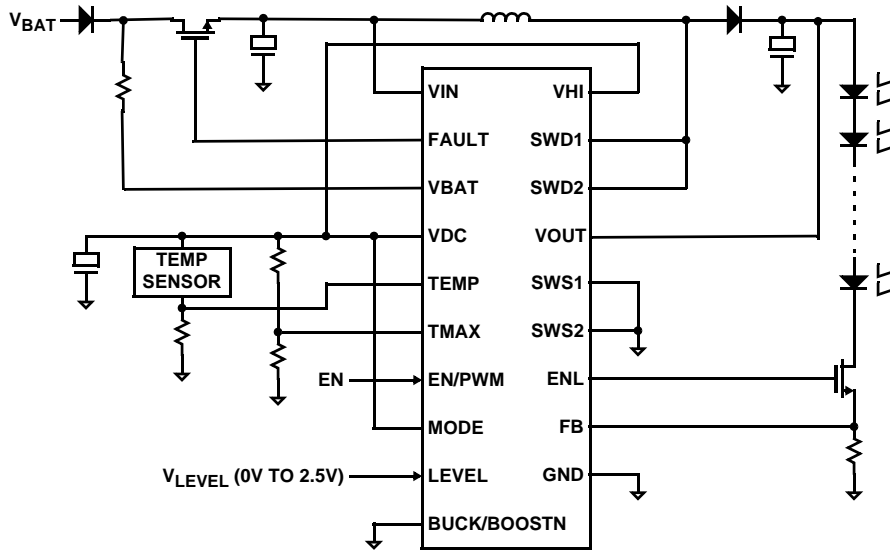
- A reverse transient automotive-rated protection power schottky must be added in series with the input supply
- A 500Ω current limit resistor must be inserted in series with the V_{BAT} pin
- The fault protection NFET must be specified to handle 100V VDS conditions.

The protection circuit is applicable to buck, boost, and supply-return load applications.

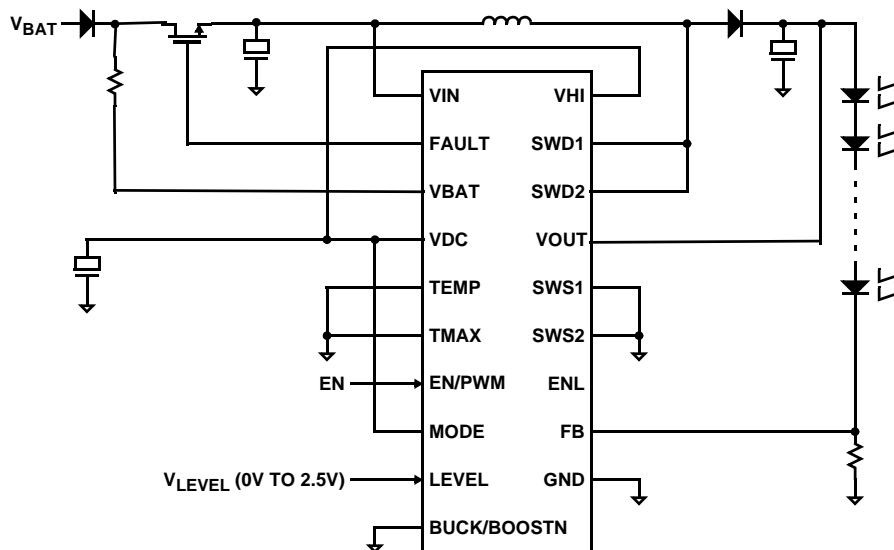
A small reduction in efficiency is caused by the drop in the power schottky.

Unless alternative transient protection is provided, minimum BOM automotive applications must include the circuit changes noted above.

Automotive Boost Application Diagram



Automotive Minimum BOM Boost Application Diagram



Camera Flash Application

Typical camera flash applications use a single Li-Ion battery:

- The load must be returned to the positive rail since $V_{LED} > V_{BAT}$

EL7801 includes a Flash Mode which:

- Increases the power switch current limit to 6A
- Uses an internal timer to enable the regulator for 16ms only
- Disables temperature compensation and maximum temperature operation
- Sets V_{FB} to 400mV

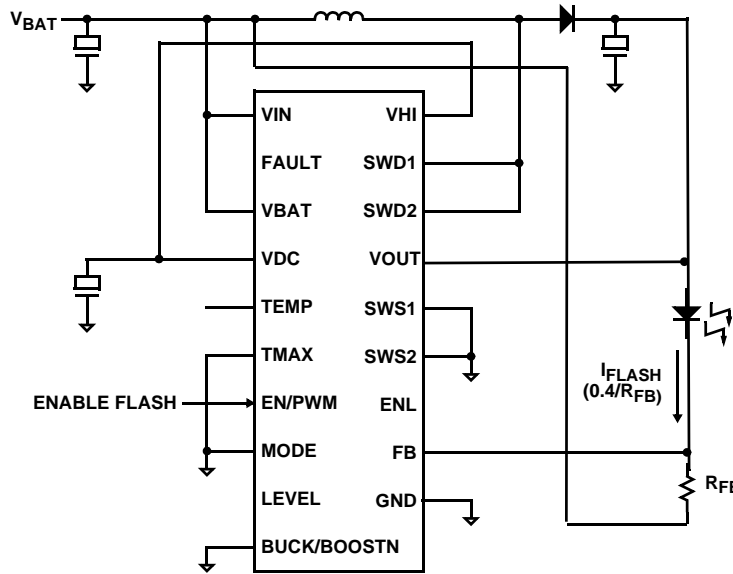
To configure EL7801 in Flash Mode:

- Choose an appropriate R_{FB} value ($I_{FLASH} = 400mV/R_{FB}$)
- Connect TEMP to V_{DC}

Enable the part using EN/PWM for the required flash duration:

- T_{FLASH} is limited to 16ms max after which the part will disable

Li-Ion Camera Flash Application Diagram



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