Single channel LED Backlight Driver with Integrated Boost

General Description

The SN3948 is a PFM step-up DC-DC converter designed for driving the white LED arrays for large size LCD panel backlighting applications. It can deliver stable constant output current from 0mA to 700mA by adjusting the external resistor.

The SN3948 has a wide input voltage range from 3V to 100V with an external resistor. With internal OVP circuit, the chip and the system can be safe even if the load is not connected.

The device features external PWM dimming or DC dimming, which allows the flexible control of the backlighting luminance.

The SN3948 incorporates a proprietary FB scheme which automatically adjusts the integrated DC/DC converter to the optimum output voltage for the system, maximizing the efficiency. And since loop compensation is needless, the stability is improved.

Applications

TV Monitor Backlighting,
Notebook
Automotive
Street Lamp

Features

- Wide input voltage range <3V---100V>
- Constant Current Output up to 700mA
- Loop compensation needless
- Auto Optimized Boost output
- Internal over-voltage protection
- Over-temperture protection

Typical Operating Circuit

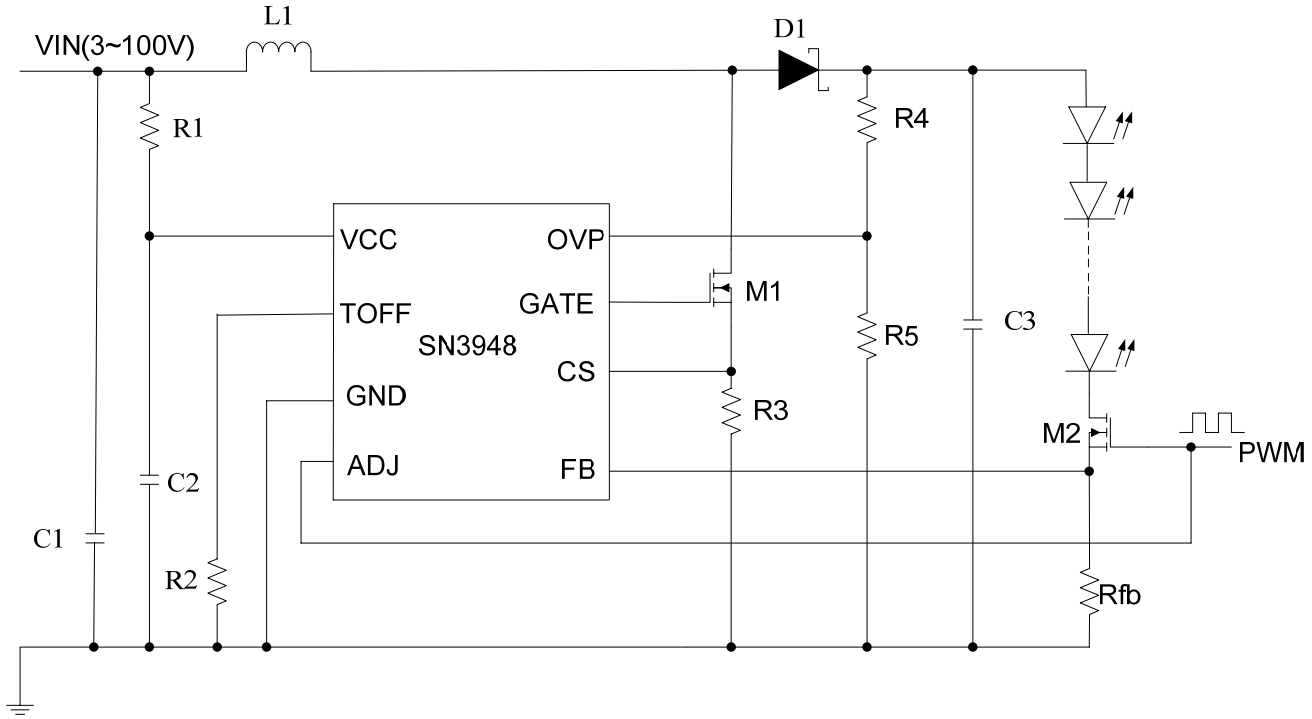
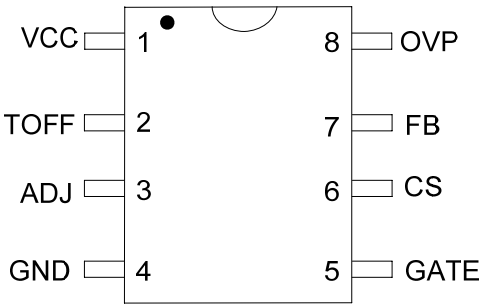


Figure 1 Typical Operating Circuit

Pin Configurations

Package	Top View
SOP-8	

Pin Descriptions

Pin	**Name**	**Function**
1	VCC	Internally clamped Positive Power supply input pin
2	TOFF	An external resistor connect to this PIN to form a RC discharge path to generate a constant TOFF of MOSFET
3	ADJ	Input pin for PWM/DC control
4	GND	Ground
5	GATE	Driver's output to an external MOSFET
6	CS	Current sense input for the control loop
7	FB	Feedback voltage to set the current of LEDs
8	OVP	Overvoltage protection, if the voltage of OVP exceed 1.25V,Gate will always shutdown

Ordering Information

Order Number	**Package Type**	**QTY/Reel**	**MSL (J-STD-020D)**	**Green Status**	**Operating Temperature Range**
SN3948ID08E	SOP-8	2500 units	3	RoHS	−40 °C to 85°C

SN3948 ---------- I D 08 E

- E: Environmental Code — E: Lead Free
- 08: Pin Code — 08: 8pins
- D: Package Type — D: SOP
- I: Temperature Code

I: Industrial, -40°C to +85°C

Absolute Maximum Ratings

Parameter	Value
VCC to GND	-0.3V to 6V
CS, ADJ,GATE,TOFF,OVP,FB	-0.3V to 6V
VCC Max. Input Current*(note1)*	10mA
Junction Temperature Range	-40°C to +150°C
Storage Temperature Range	-65°C to +150°C
ESD Human Model	3000V

Operating Conditions

- Input Voltage ---------- 3V~100V
- Ambient Temperature ---------- -40 °C~85°C

Electronic Characteristics (Unless otherwise specified, Vin=12V, T_{amb}=25°C.)

Parameter	Conditions	spec			Unit
		Min	Typ	Max	
Input Voltage	with a Rexternal *(note2)*	3		100	V
Vcc Clamp Voltage	Rexternal=10KOhm		5		V
Undervoltage Thresold	VCC falling		2.5		V
Undervoltage Thresold hyteresis			200		mV
Quiescent supply current	VCC=5V		300		uA
Quiescent supply current when VIN undervoltage	VCC=2.5V		70		uA
Current Sense threshold voltage	ADJ=5V		250		mV
Current Sense blank interval	Vcs=Vcs_th+50mV		500		ns
Fixed turn-off interval	Rext=300KΩ		10		us
Analog DIM control range		0.5		2.5	V
Thermal shutdown threshold			125		°C
Thermal shutdown hysteresis			20		°C
Feedback voltage thresold			0.3		V
Overvoltage input thresold			1.25		V

*Note1:*If Icc>10mA, Vcc will not be clamped at 5V precisely
*Note2:*If Vin<5V, connect Vin to VCC directly; if Vin>5V, connect Vin to VCC with a resistor

Typical Performance Characteristics

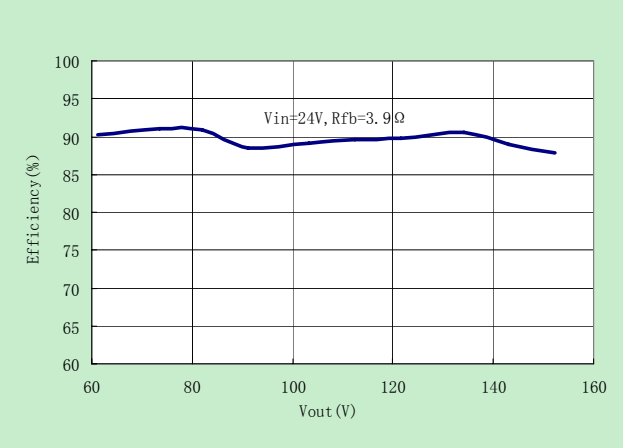


Figure 2. Voutt vs efficiency

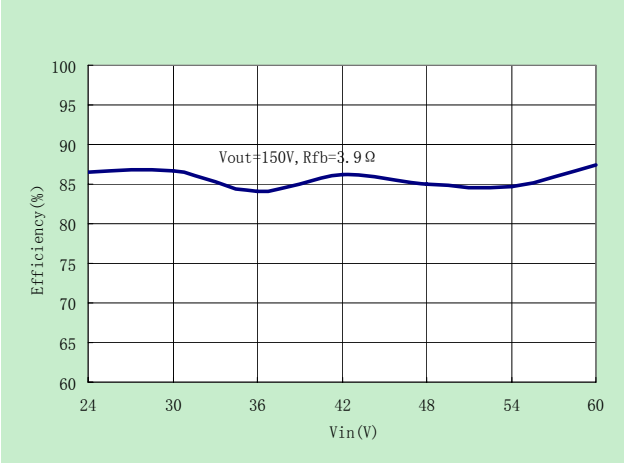


Figure 3. Vin vs efficiency

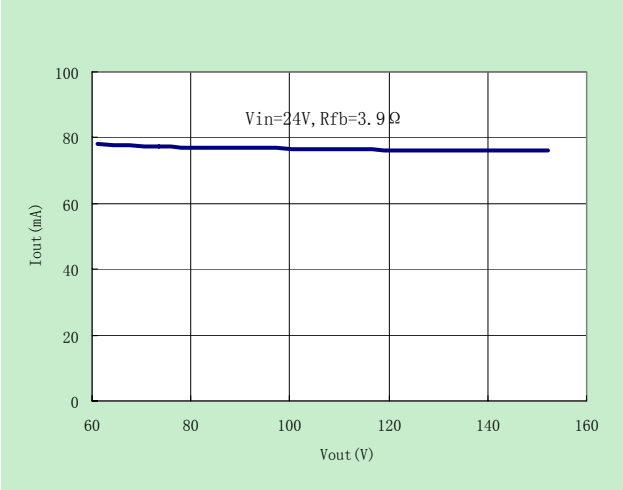


Figure 4. Vout vs Iout

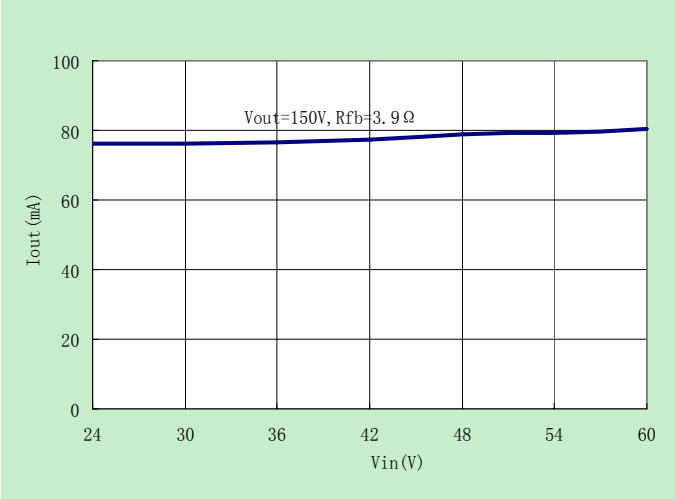


Figure 5. Vin vs Iout

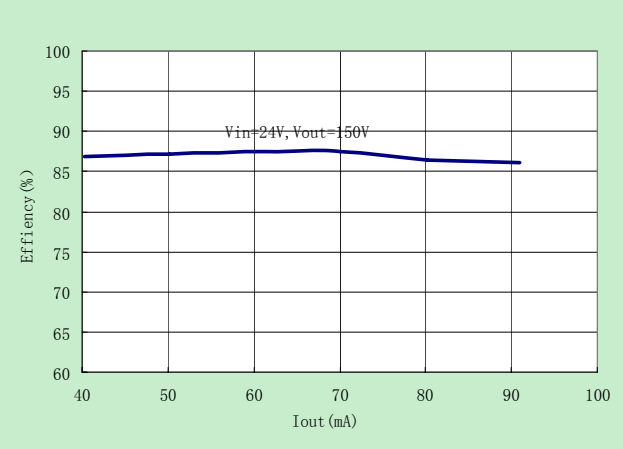


Figure 6. Iout vs efficiency

Application Information

Internal 5V Regulator

The SN3948 includes an internal linear regulator (VCC). When the input voltage is higher than 5V, this regulator offers a 5V power supply for the internal MOSFET switch gate driver and the internal control circuitry.
In the application of input voltage lower than 5V, tie VCC and input voltage together.
The SN3948 features Under Voltage Lockout. The chip is disabled until VCC exceeds the UVLO threshold. And the hysteresis of UVLO is approximately 200mV.

Step-up Converter

The SN3948 step-up converter uses a current mode topology, the CS pin voltage determines the peak current in the inductor of the converter and hence the duty cycle of the GATE switching waveform. The basic loop uses a pulse from an internal oscillator to set an RS flip-flop and turn on the external power MOSFET. Current increases in the MOSFET and inductor until the VC commanded peak switch current is exceeded and the MOSFET is then turned off. Inductor current is sensed during the GATE on period by a sense resistor RCS in the source of the external N-channel power MOSFET. Once the MOSFET is turned off, the current of inductor decrease until the FB pin voltage drops below internal reference voltage and the MOSFET is then turned on again.

LED Current Control

The SN3948 regulates the LED current by setting the external resistor connecting to feedback and ground. The internal feedback reference voltage is 0.3V. The LED current can be set from following equation easily.
ILED*R = 0.3V
In order to have an accurate LED current, precision resistors are preferred (1% is recommended).

Setting the Over Voltage Protection

The open string protection is achieved through the over voltage protection (OVP). In some cases, an LED string failure results in the feedback voltage always zero. The part then keeps boosting the output voltage higher and higher. If the output voltage reaches the programmed OVP threshold, the protection will be triggered. To make sure the chip functions properly, the OVP setting resistor divider must be set with a proper value. The recommended OVP point is about 1.1 times higher than the output voltage for normal operation.
V_{OVP}=1.25V*(R4+R5)/R5

Dimming Control

The SN3948 allows for LED dimming (brightness reduction) by analog dimming or by PWM dimming. Analog dimming uses the ADJ pin voltage range from 2.5V to 0.5V to reduce LED brightness by reducing LED current.
Many applications require an accurate control of the brightness of the LED(s). In addition, being able to maintain a constant color over the entire dimming range can be just as critical. This is achieved by operating the LED at its setting current and then controlling the on time of that LED current. For maximum PWM dimming ratios (low PWM duty cycles) it is important to be able to turn LED currents on/off as quickly as possible.

Input Peak Current control

Through the feedback of R3 connected from Source of MOSFET to ground, the input Ipeak can be controlled.
Gernerally, setting Ipeak(in)=1.6*Iavg(in), and Iavg(in)=Vout*Iout/Vin*(efficiency)

Input Capacitor

The input capacitor of the SN3948 will supply the transient input current of the power inductor.

Values of 220 μ F is recommended to prevent excessive input voltage ripple.

Inductor Selection

Ferrite cores should be used to obtain the best efficiency. Choose an inductor that can handle the necessary peak current without saturating. Also ensure that the inductor has a low DCR (copper-wire resistance) to minimize I^2R power loss.

Output Capacitor

Low ESR capacitors should be used at the SN3948 converter output to minimize output ripple voltage. For most applications, a 22μF capacitor will be sufficient.

Schottky Rectifier

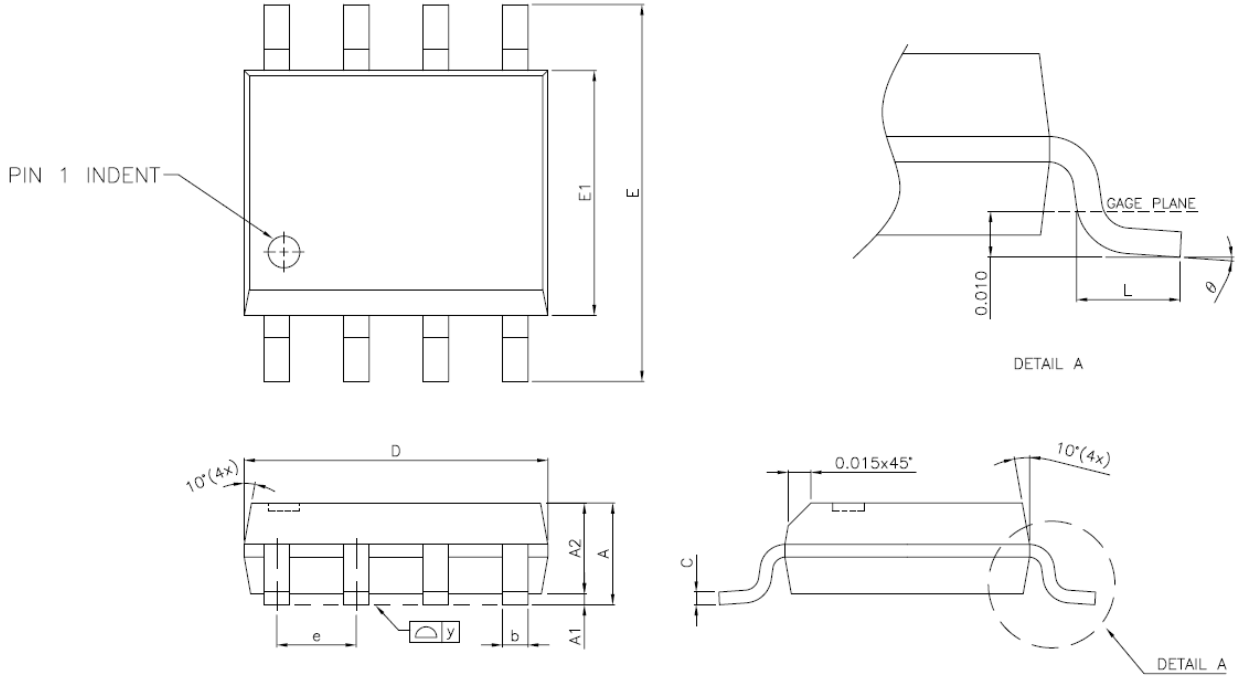
The external diode for the SN3948 must be a Schottky diode, with low forward voltage drop and fast switching speed. The diode's average current rating must exceed the application's average output current. The diode's maximum reverse voltage must exceed the maximum output voltage of the application. For PWM dimming applications be aware of the reverse leakage of the Schottky diode. Lower leakage current will drain the output capacitor less during PWM low periods, allowing for higher PWM dimming ratios.

Power MOSFET Selection

The power MOSFET selected should have a VDS rating which exceeds the maximum over voltage protection (OVP) level programmed for the application. The $R_{DS\ (ON)}$ of the MOSFET will determine d.c. power loss. The d.c power loss could be calculated by setting the number of LEDs as n, so the output voltage $Vout=n*V_F=n*3.5V$ and the current of M1 $I_{M1}=Vout*I_{LED}*Duty/Vin$ $=n*3.5*I_{LED}*Duty/Vin$, thus get the d.c power loss of M1 as $P_{loss}=I_{M1}^2*R_{DS\ (ON)}$. Be aware of the power dissipation within the MOSFET and deciding if the thermal resistance of the MOSFET package causes the junction temperature to exceed maximum ratings.

Package information

SOP-8



Note:

1. *Controlling dimension: inch*
2. *Lead frame material: copper 194*
3. *Dimension "D" does not include mold flash, tie bar burrs and gate burrs shall not exceed 0.006"(0.15mm) per end. Dimension "E1" does not include interlead flash. Interlead flash shall not exceed 0.010"(0.25mm) per side.*
4. *Dimension "b" does not include dambar protrusion. Allowable dambar protrusion shall be 0.003"(0.08mm) total in excess of the "b" dimension at maximum material condition. Dambar cannot be located on the lower radius or the foot. Minimum space between protrusion and an adjacent lead to be 0.0028"(0.07mm)*
5. *Tolerance: ±0.010"(0.25mm) unless otherwise specified.*
6. *Otherwise dimension follow acceptable spec.*
7. *Reference document: JE DEC SPEC MS-01*

Symbol	Dimension (mm)		
	MIN	NOM	MAX
A	1.35	1.50	1.75
A1	0.10	——	0.25
A2	——	1.45	——
b	0.33	0.41	0.51
C	0.17	0.20	0.25
D	4.80	4.85	5.00
E	5.80	6.00	6.24
E1	3.80	3.90	4.00
e	——	1.27	——
L	0.40	0.71	1.27
y	——	——	0.076
θ	0^o	——	8^o