Features

- 2.5V to 5.5V Input Voltage
- Up to 35V Output Voltage
- 1.2MHz Fixed Switching Frequency
- 0.1V Feedback Voltage
- Internal 1.6A Switch Current Limit
- Support Analog and PWM Dimming Mode
- Internal 35V Over Voltage Protection
- Internal Compensation
- Thermal Shutdown
- Driving Up to 10 White LEDS
- Dimming with wide Frequency Range
- Available in SOT23-5 package

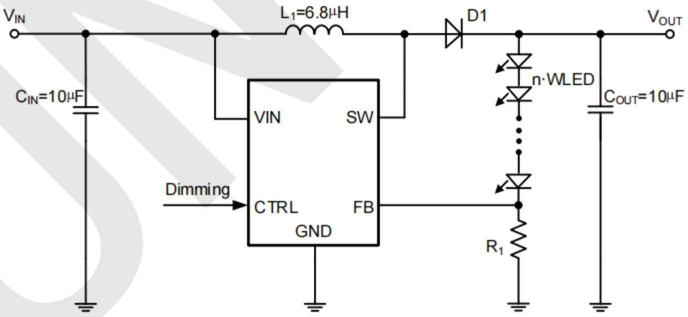
Applications

- Camera Flash White LED
- Digital still cameras
- PDA LED back light
- LCD Bias Supply

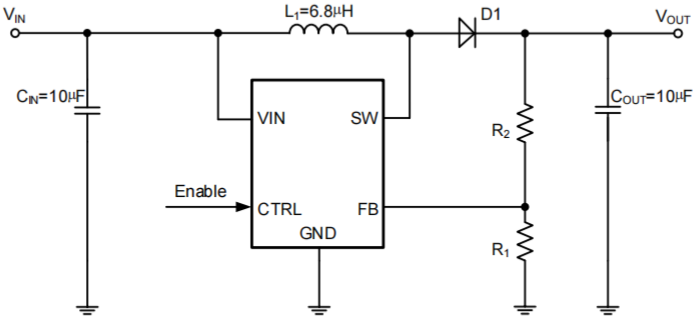
General Description

The MP3202 series is a step-up converter designed for driving up to 10 white LEDs or up to 35V output voltage from a single cell Lithium-Ion battery. The device features integrated overvoltage protection and feedback voltage is regulated to 100mV. Low feedback voltage helps to reduces power loss and improves efficiency.Customers can choose different FB voltages according to their application. Optimized operation frequency can meet the requirement of small LC filters value and low operation current with high efficiency. Internal soft start function can reduce the inrush current. SOT23-5package types provide the best solution for PCB space saving and total BOM cost.

Typical Application Circuit



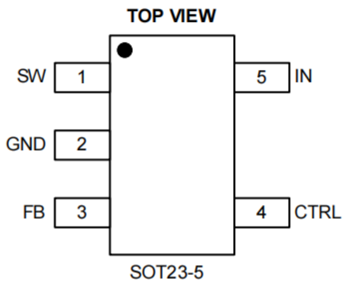
Typical White LED Application Circuit



Typical Boost Application Circuit

Package and Pin Description

Pin Configuration



Pin Description

SOT23-5 Pin No.	Name	Function
1	SW	Power Switch Output. SW is the drain of the internal MOSFET switch. Connect the power inductor and output rectifier to SW. SW can swing between GND and 35V.
2	GND	Ground Pin.
3	FB	Feedback Reference Voltage Pin. Series connect a resistor between WLED and ground as a current sense. Sense the current feedback voltage to set the current rating.
4	CTRL	CTRL pin of the boost converter. It is a multi-functional pin which can be used for enable control and PWMdimming. Should not be left floating.
5	IN	Input Supply Pin. Must be locally bypassed.
NA	NC	No Connection.

Order Information (1)

Marking(2)	Part No.	Model	Description	Package	T/R Qty
KaYLL	00390101	MP3202DJ	MP3202DJ Boost, VIN 2.5-5.5V, VOUT VIN-35V, 1.2MHz, VFB0.1V, SOT23-5	SOT23-5	3000PCS

Note (1): All SUNGOOD parts are Pb-Free and adhere to the RoHS directive.

Note (2): Top Marking: KxYLL [device code: Kx (x=a, b, c, d, e, r, q), Y=year code, LL= lot number code)

Specifications

Absolute Maximum Ratings (1) (2)

Item	Min	Max	Unit
V_{IN}, V_{CTRL} voltage	-0.3	6	V
V_{SW}, V_{OVP} voltage	-0.3	37	V
V_{SW}, V_{OVP} voltage (10ns transient)	-5	38	V
All Other Pins	–0.3	6	V
Power dissipation (3)	Internally Limited		
Operating junction temperature, T_J	-40	150	°C
Storage temperature, T_{stg}	–65	150	°C
Lead Temperature (Soldering, 10sec.)		260	°C

Note (1): Exceeding these ratings may damage the device.

Note (2): The device is not guaranteed to function outside of its operating conditions.

Note (3): The maximum allowable power dissipation is a function of the maximum junction temperature, $T_{J(MAX)}$, the junction-to-ambient thermal resistance, $R_{\theta JA}$, and the ambient temperature, T_A. The maximum allowable power dissipation at any ambient temperature is calculated using: $P_{D(MAX)} = (T_{J(MAX)} - T_A)/R_{\theta JA}$. Exceeding the maximum allowable power dissipation causes excessive die temperature, and the regulator goes into thermal shutdown. Internal thermal shutdown circuitry protects the device from permanent damage. Thermal shutdown engages at T_J=160°C (typical) and disengages at T_J= 130°C (typical).

ESD Ratings

Item	Description	Value	Unit
$V_{(ESD-HBM)}$	Human Body Model (HBM) ANSI/ESDA/JEDEC JS-001-2014 Classification, Class: 2	±2000	V
$V_{(ESD-CDM)}$	Charged Device Mode (CDM) ANSI/ESDA/JEDEC JS-002-2014 Classification, Class: C0b	±200	V
$I_{LATCH-UP}$	JEDEC STANDARD NO.78E APRIL 2016 Temperature Classification, Class: I	±150	mA

Recommended Operating Conditions

Item	Min	Max	Unit
Operating junction temperature (1)	–40	125	°C
Operating temperature range	-40	85	°C
Input voltage V_{IN}	2.5	5.5	V
Output voltage V_{OUT}	V_{IN}	34	V

Note (1): All limits specified at room temperature (T_A = 25°C) unless otherwise specified. All room temperature limits are 100% production tested. All limits at temperature extremes are ensured through correlation using standard Statistical Quality Control (SQC) methods. All limits are used to calculate Average Outgoing Quality Level (AOQL).

Thermal Information

Item	Description	SOT23-5	Unit
$R_{\theta JA}$	Junction-to-ambient thermal resistance (1)(2)	180	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	130	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	45	°C/W
ψ_{JT}	Junction-to-top characterization parameter	35	°C/W
ψ_{JB}	Junction-to-board characterization parameter	45	°C/W
$R_{\theta JC}$	Junction-to-case (Bottom) thermal resistance	NA	°C/W

Note (1): The package thermal impedance is calculated in accordance to JESD 51-7.

Note (2): Thermal Resistances were simulated on a 4-layer, JEDEC board

Electrical Characteristics (1) (2)

V_{IN}=5V, T_A=25°C, unless otherwise specified.

Parameter	Test Conditions	Min	Typ.	Max	Unit
Input voltage range		2.5		5.5	V
Output voltage range				34	V
Supply Current (Quiescent)	V_{FB} =110%		200	250	µA
Supply Current (Shutdown)	V_{CTRL} =0 or C_{TRL} = GND		0.1	1	µA
Feedback Voltage		(1-2.5%) Typ.	Typ.	(1+2.5%) Typ.	mV
SW On Resistance			400	650	mΩ
Internal SW Current Limit			1.6		A
OVP Protection Threshold			35		V
Switching Frequency			1.2		MHz
Maximum Duty Cycle	V_{FB}=90%		85		%
Minimum On-Time			80		ns
EN Rising Threshold		1.1			V
EN Falling Threshold				0.6	V
Under-Voltage Lockout Threshold	Wake up V_{IN} Voltage		2.3	2.5	V
	Shutdown V_{IN} Voltage	1.7	1.9		V
	Hysteresis V_{IN} voltage		400		mV
Soft Start			600		µS
Thermal Shutdown			160		℃
Thermal Hysteresis			30		℃

Note (1): MOSFET on-resistance specifications are guaranteed by correlation to wafer level measurements.

Note (2): Thermal shutdown specifications are guaranteed by correlation to the design and characteristics analysis.

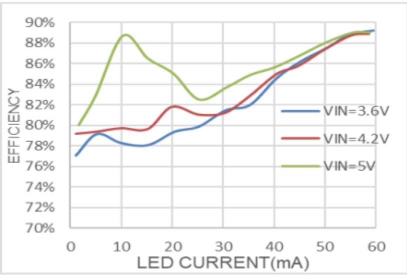
Typical Performance Characteristics (1) (2)

Note (1): Performance waveforms are tested on the evaluation board.

Note (2): V_{IN} =5V, V_{OUT}=18V, 5 LEDs, T_A = +25ºC, unless otherwise noted.

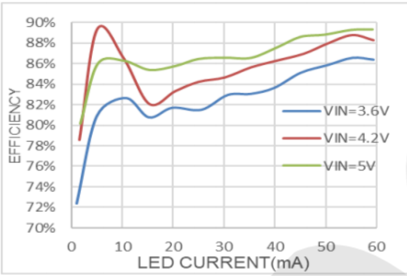
Efficiency vs. LED Current

V_{OUT}=9V, 3 LEDs



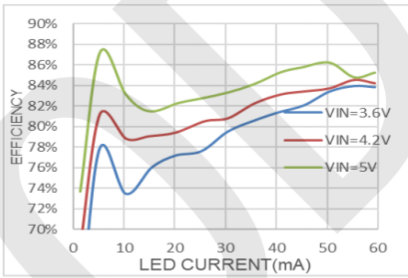
Efficiency vs. LED Current

V_{OUT}=18V, 5 LEDs



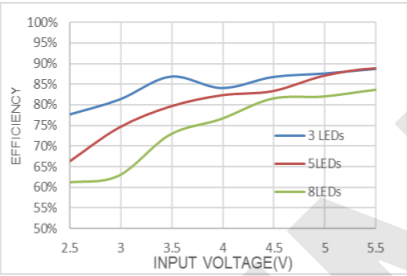
Efficiency vs. LED Current

V_{OUT}=36V, 10 LEDs



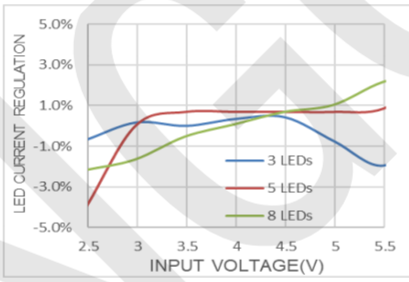
Efficiency vs. Input Voltage

Typical ILED=11.5mA



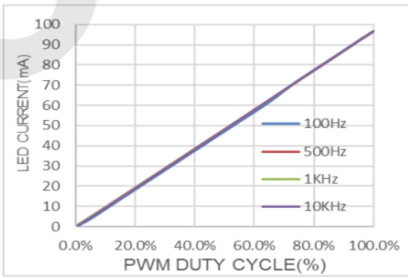
LED Current Regulation vs. Input Voltage

Typical ILED=11.5mA



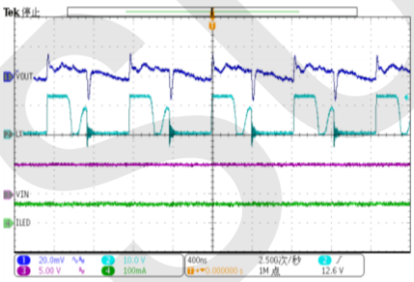
LED Current vs. PWM Duty Cycle

V_{IN}=5V, V_{OUT}=18V, 5 LEDs



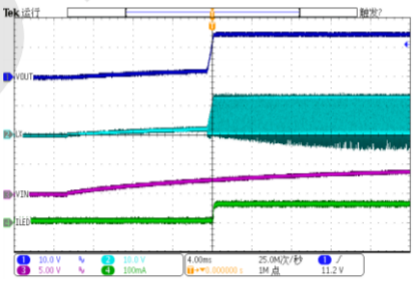
Steady State Operation

V_{IN}=5V, V_{OUT}=18V, 5LEDs, ILED=60mA



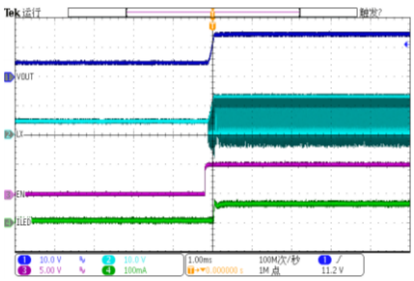
V_{IN} Startup

V_{IN}=5V, V_{OUT}=18V, 5 LEDs, ILED=60mA



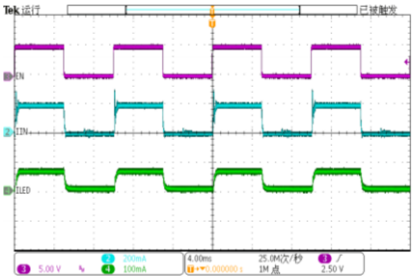
Enable Startup

V_{IN}=5V, V_{OUT}=18V, 5 LEDs, ILED=60mA



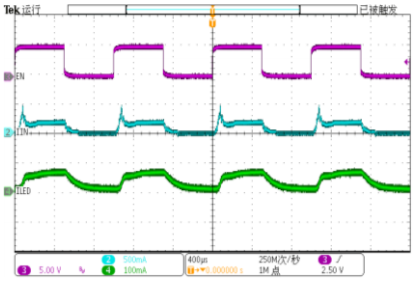
Dimming Operation

V_{IN}=5V, V_{OUT}=18V, 5LEDs, f=100Hz



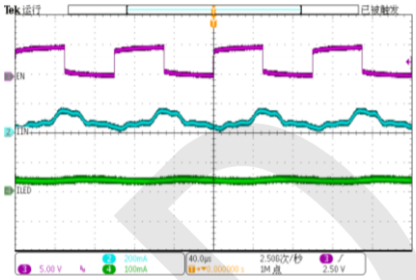
Dimming Operation

V_{IN}=5V, V_{OUT}=18V, 5LEDs, f=1KHz



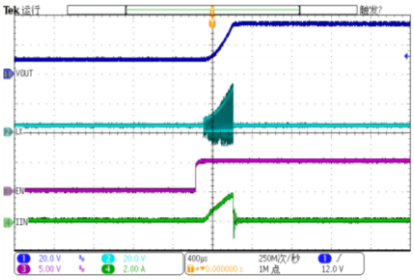
Dimming Operation

V_{IN}=5V, V_{OUT}=18V, 5LEDs, f=10KHz



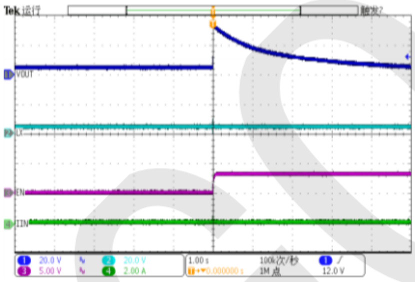
Open Load Protection

V_{IN}=5V, V_{OUT} Open

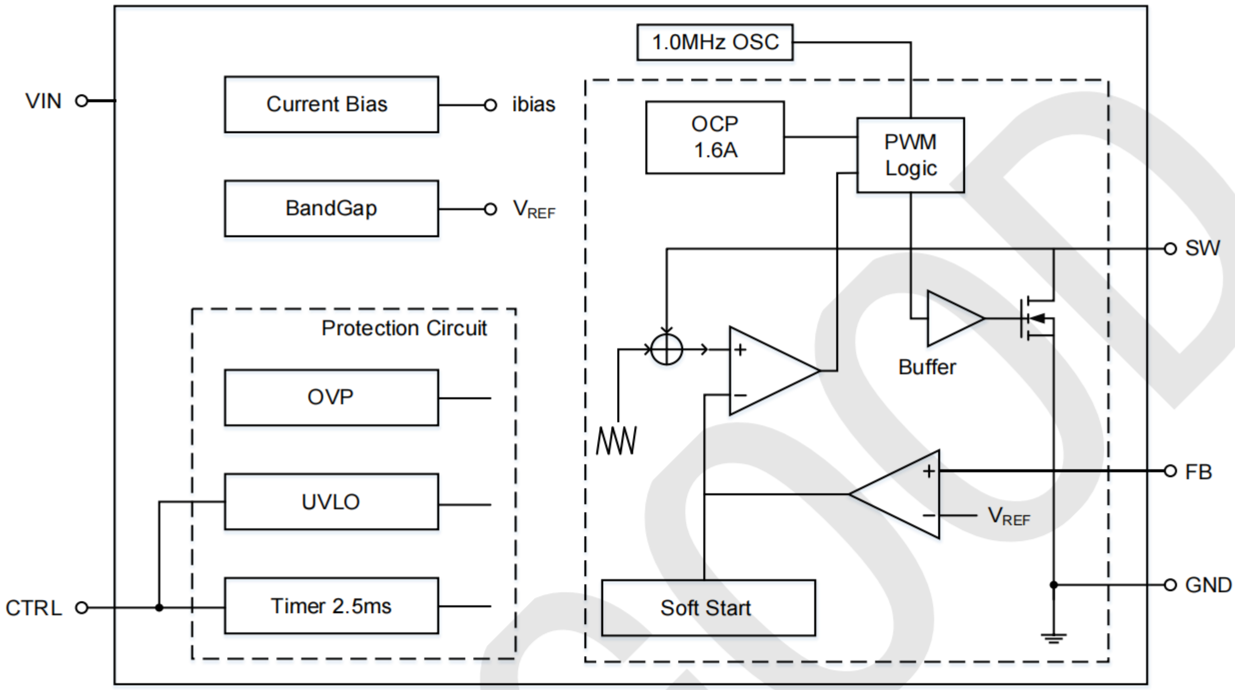


Open Load Protection

V_{IN}=5V, V_{OUT} Open



Functional Block Diagram



Block Diagram

Functions Description

Under-Voltage Lockout (UVLO)

Under-voltage lockout (UVLO) protects the chip from operating at an insufficient supply voltage. UVLO protection monitors the internal regulator voltage. When the voltage is lower than UVLO threshold voltage, the device is shut off. When the voltage is higher than UVLO threshold voltage, the device is enabled again.

Enable and PWM Dimming

When the input voltage is above maximal UVLO rising threshold and the CTRL pin is pulled high, the MP3202 series is enabled. When the CTRL pin is pulled low, the MP3202 series goes into shutdown mode. In shutdown mode, less than 1μA input current is consumed. Because there is a conductive path from the input to the output through the inductor and Schottky diode, the output voltage is equal to the input voltage during shutdown. The CTRL pin allows disabling and enabling of the device as well as brightness control of the LEDs by applying a PWM signal up to typically 1kHz. When a PWM signal is applied, the LED current is turned on when the CTRL is high and off when CTRL is pulled low. Changing the PWM duty cycle therefore changes the LED brightness.

Soft-Start

The MP3202 series begins soft start when the CTRL pin is pulled high. At the beginning of the soft start period, the isolation FET is turned on slowly to charge the output capacitor. After the pre-charge phase, the MP3202 series starts switching. This is called switching soft start phase. An internal soft start circuit limits the peak inductor current according to the output voltage. The switching soft start phase is about 600μs typically. The soft start function reduces the inrush current during startup.

Over-Voltage Protection

As with any current source, the output voltage rises when the output gets high impedance or disconnected. To prevent the output voltage exceeding the maximum switch voltage rating of the main switch, an over voltage protection circuit is integrated. As soon as the output voltage exceeds the OVP threshold, the converter stops switching and the output voltage falls.

Efficiency and Feedback Voltage

The feedback voltage has a direct effect on the converter efficiency. Because the voltage drop across the feedback resistor does not contribute to the output power (LED brightness), the lower the feedback voltage, the higher the efficiency. Especially when powering only three or less LEDs, the feedback voltage impacts the efficiency around 2% depending on the sum of the forward voltage of the LEDs.

Thermal Shutdown

Thermal shutdown prevents the chip from operating at exceedingly high temperatures. When the silicon die temperature exceeds 160°C, it shuts down the whole chip. When the temperature falls below its lower threshold (Typ. 130°C) the chip is enabled again.

LED Applications Information (1)

Note (1): The following dimming methods are based on the MP3202C 250mV FB voltage value. Different FB need to choose different resistors and external DC voltage signals to get the desired ILED value.

Setting the LED Current

The LED current is controlled by the feedback resistor, R_1. The current through the LEDs is given by the equation $V_{FB}/R1$. I_{LED} is average LED current. According to the Superposition Theorem, we can implement the analog dimming function, and we provide a variety of different FB voltage to choose from, which can help customers more easily adapt to their application needs.

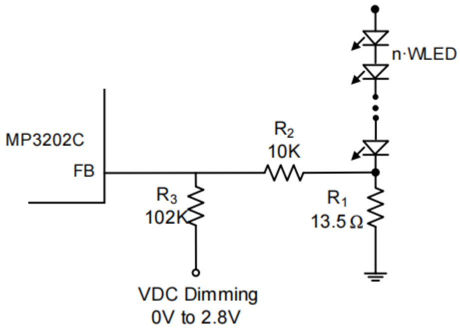
Dimming Control

1. Using a PWM Signal to CTRL Pin

For controlling the LED brightness, the MP3202 series can perform the dimming control by applying a PWM signal to CTRL pin. The internal soft start and the wide range dimming frequency can eliminate inrush current and audio noise when dimming. The average LED current is proportional to the PWM signal duty cycle. The magnitude of the PWM signal should be higher than the minimum enables voltage of CTRL pin, in order to let the dimming control perform correctly for preventing the flicker issue, the selected PWM frequency is ⩾100Hz and ⩽10KHz.

2. Using a DC Voltage

When CTRL remains high level, using a variable DC voltage to adjust the brightness is a popular method in some applications. According to the Superposition Theorem, as the DC voltage increases, the voltage contributed to VFB increases and the voltage drop on R2 decreases, i.e. the LED current decreases. For example, the 250mV FB voltage MP3202C can use a DC voltage ranging from 0V-2.8V to adjust the LED current, the selection of resistors sets dimming control of LED current from 20mA to 0mA.

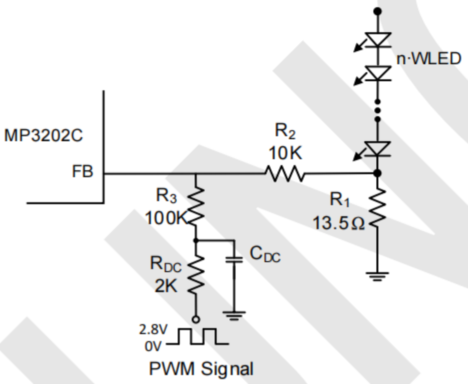


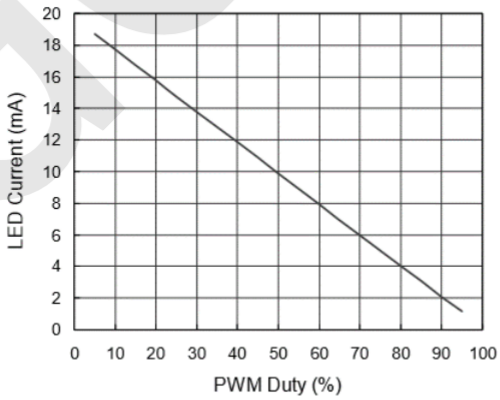
The LED current can be calculated by the following Equation:

$$I_{LED} = \frac{V_{FB} - \frac{R_2 \times (V_{DC} - V_{FB})}{R_3}}{R_1}$$

3. Using a Filtered PWM signal

Another common application is using a filtered PWM signal as an adjustable DC voltage for LED dimming control. A filtered PWM signal acts as the DC voltage to regulate the output current. In this circuit, the output ripple depends on the frequency of PWM signal. For smaller output voltage ripple (<100mV), the recommended frequency of 2.8V PWM signal should be above 2kHz. To fix the frequency of PWM signal and change the duty cycle of PWM signal can get different output current.





The LED current can be calculated by the following Equation:

$$I_{LED} = \frac{V_{FB} - \frac{R_2 \times (V_{PWM} \times Duty - V_{FB})}{R_3 + R_{DC}}}{R_1}$$

Inductor Selection

The recommended value of inductor for most applications are 4.7 to 22μH. Small size and better efficiency are the major concerns for portable device, such as MP3202 series used for mobile phone. When selecting the inductor, the inductor saturation current should be rated as high as the peak inductor current at maximum load, and respectively, maximum LED current.

Output Capacitor Selection

The device is designed to operate with a wide selection of ceramic output capacitors. The selection of the output capacitor value is a trade-off between output voltage ripple and capacitor cost and form factor. In general, capacitor values of 10µF can be used. For better voltage filtering, ceramic capacitors with low ESR are recommended. X5R and X7R types are suitable because of their wider voltage and temperature ranges.

Input Capacitor Selection

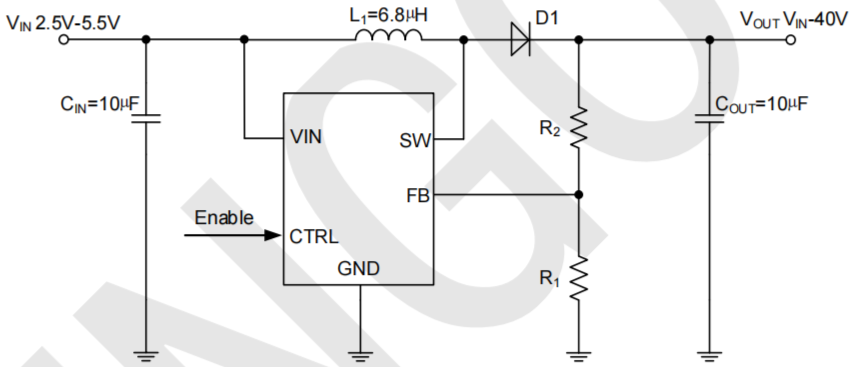
For good input voltage filtering, low ESR ceramic capacitors are recommended. A 10µF ceramic input capacitor is sufficient for most of the applications. For better input voltage filtering and EMI reduction, this value can be increased. The input capacitor should be placed as close as possible to the input pin of the converter.

Diode Selection

A Schottky diode should be used for the output diode. The forward current rating of the diode should be higher than the load current, and the reverse voltage rating must be higher than the output voltage. Do not use ordinary rectifier diodes, since slow switching speeds and long recovery times cause the efficiency and the load regulation to suffer.

Boost Applications Information

Typical Application



Setting the Output Voltage

The MP3202 Series can also be used for boost converter dedicated for small to medium LCD bias supply. Set different voltage divider resistors to get the desired output according to FB. The output voltage can be programmed by resistor divider, as shown in Equation:

$$V_{OUT} = V_{FB} \times (1 + \frac{R2}{R1})$$

The MP3202 Series operates with an input voltage range of 2.5V to 5.5V and can generate output voltages up to 35V. The device operates in a pulse-frequency-modulation (PFM) scheme with constant peak current control. This control scheme maintains high efficiency over the entire load current range, and with a switching frequency up to 1 MHz, the device enables the use of very small external components.

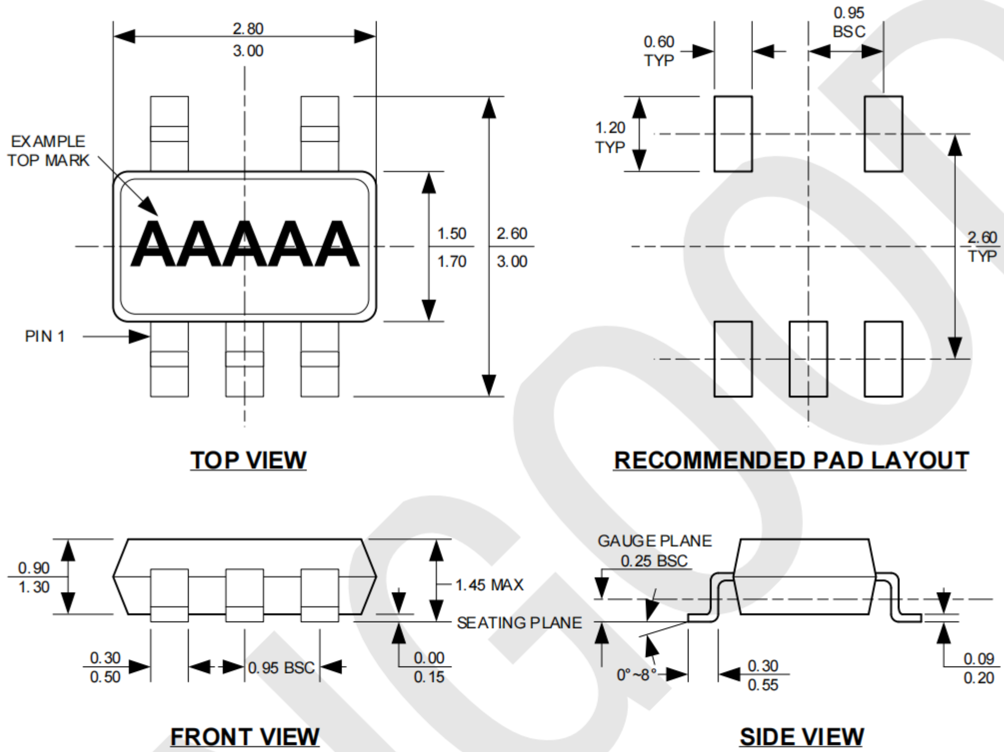
Layout Guidelines

PC board layout is an important part of DC-DC converter design. Poor board layout can disrupt the performance of a DC-DC converter and surrounding circuitry by contributing to EMI, ground bounce, and resistive voltage loss in the traces. These can send erroneous signals to the DC-DC converter resulting in poor regulation or instability. Good layout can be implemented by following a few simple design rules.

1. Minimize area of switched current loops. Input capacitor should be placed as close as possible to the VIN terminal. Grounding for both the input and output capacitors should consist of a small localized topside plane that connects to GND. The inductor should be placed as close as possible to the SW pin and output capacitor.
2. Minimize the copper area of the switch node. The SW terminals should be directly connected with a trace that runs on top side directly to the inductor. To minimize IR losses this trace should be as short as possible and with an enough width. However, a trace that is wider than 100 mils will increase the copper area and cause too much capacitive loading on the SW terminal. The inductors should be placed as close as possible to the SW terminals to further minimize the copper area of the switch node.
3. Have a single point ground for all device analog grounds. The ground connections for the feedback components should be connected then routed to the GND pin of the device. This prevents any switched or load currents from flowing in the analog ground plane. If not properly handled, poor grounding can result in degraded load regulation or erratic switching behavior.
4. Minimize trace length to the FB terminal. The feedback trace should be routed away from the SW pin and inductor to avoid contaminating the feedback signal with switch noise.
5. Make input and output bus connections as wide as possible. This reduces any voltage drops on the input or output of the converter and can improve efficiency. If voltage accuracy at the load is important make sure feedback voltage sense is made at the load. Doing so will correct for voltage drops at the load and provide the best output accuracy.

Package Description

SOT23-5



NOTE:
1. CONTROL DIMENSION IS IN INCHES. DIMENSION IN BRACKET IS IN MILLIMETERS.
2. PACKAGE LENGTH DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS.
3. PACKAGE WIDTH DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSIONS.
4. LEAD COPLANARITY (BOTTOM OF LEADS AFTER FORMING) SHALL BE 0.004" INCHES MAX.
5. DRAWING CONFORMS TO JEDEC MS-012, VARIATION BA.
6. DRAWING IS NOT TO SCALE.