

General Description

The SA33760 Buck-Boost controller can automatically operate in Buck, Boost, and Buck-Boost modes based on input and output voltages. It accepts a wide input voltage range from 4.5V to 55V and can accommodate LED voltages from 2.5V to 55V.

The SA33760 operates in constant frequency current mode, with a switching frequency range of 200 kHz to 700 kHz. It provides analog dimming when the voltage on the SET pin is adjusted, and direct pulse-width modulation (PWM) dimming when a dimming signal is applied to the PWM pin.

The SA33760 offers reliable protections against faults including overvoltage, LED open/short, overtemperature, input overcurrent, and additional single faults, and includes cycle-by-cycle current limiting.

Features

- AECQ-100 Qualified
- Input Voltage Range from 4.5 V to 55V
- Output Voltage Range from 2.5V to 55V
- Adaptive Switching between Pure Boost, Pure Buck, and Buck-Boost Modes
- Adjustable Switching Frequency 200kHz to 700kHz
- Spread Spectrum Operation
- Input current limit
- Input current and output current monitor
- Analog Dimming and Direct Dimming
- Adjustable Soft-Start Time
- Pre-Bias Startup
- Constant Frequency with Current Mode
- Overvoltage Protection, Open LED Protection, LED Short Protection, Overtemperature Protection
- Package: QFN7x7-48
- MSL Rating: MSL3

Applications

- Constant Current Buck-Boost for LED
- Constant Current Buck Controller for LED
- Constant Voltage Buck-Boost Controller

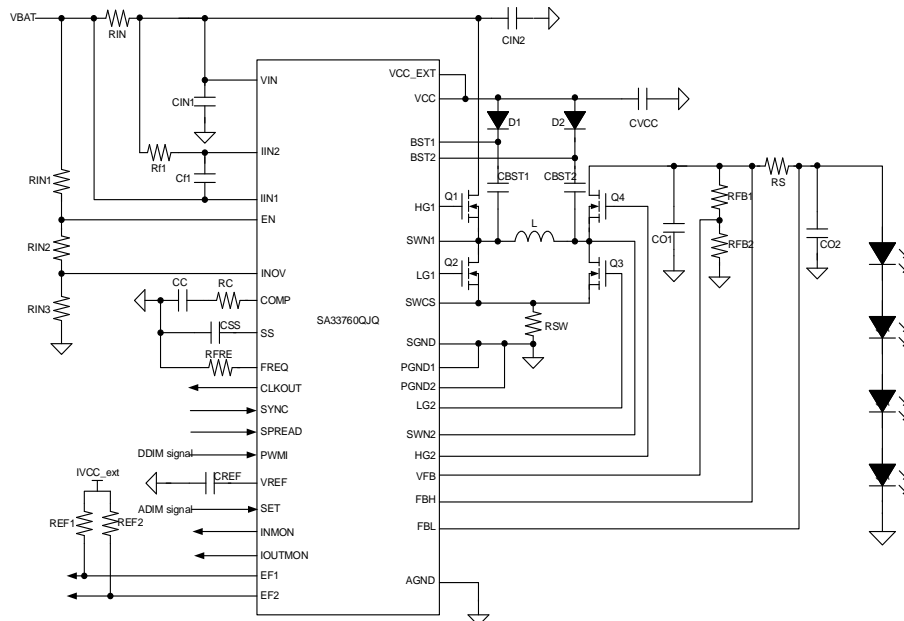


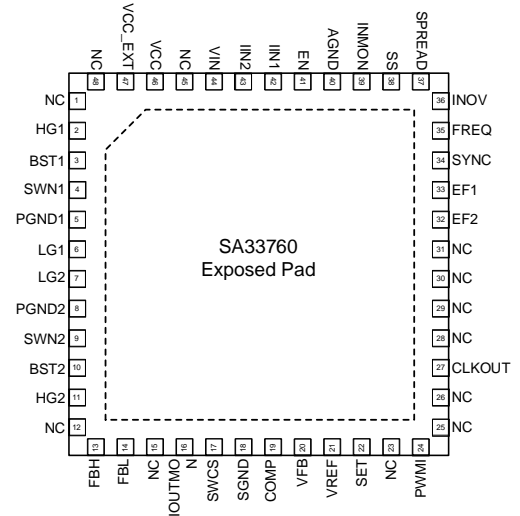
Figure 1. Typical Application Circuit

Ordering Information

Ordering Part Number	Package type	Top Mark
SA33760QJQ	QFN7x7-48 RoHS-Compliant and Halogen-Free	GEExyz

x = year code, y = week code, z = lot number code

Pinout (top view)



Pin Description

Pin Number	Pin Name	Pin Description
1,12,15,23 25,26,28,29 30,31,45,48	NC	No connect.
2	HG1	Buck MOSFET high side driver.
3	BST1	Buck bootstrap capacitor connection.
4	SWN1	Buck high side MOSFET and low side MOSFET connection.
5	PGND1	GND for BUCK MOS driver loop.
6	LG1	Buck low side MOSFET driver.
7	LG2	Boost low side MOSFET driver.
8	PGND2	GND for Boost MOS driver loop.
9	SWN2	Boost high side and low side MOSFET connection.
10	BST2	Boost bootstrap capacitor connect.
11	HG2	Boost high side MOSFET driver.
13	FBH	Output current sense positive.
14	FBL	Output current sense negative.
16	IOUTMON	Output current monitor pin, $V_{IOUTMON}=200mV+8 \times (V_{FBHV_FBL})$.
17	SWCS	Switching current sense.
18	SGND	GND switching current sense. Use a Kelvin connection.
19	COMP	Loop compensation.
20	VFB	Output voltage foldback.
21	VREF	Generate a 2V reference.
22	SET	Analog dimming signal input pin.

24	PWMI	Direct PWM dimming signal input pin.
27	CLKOUT	Generate a 180°phase shift PWM signal.
32	EF2	Open drain fault flag pin, pull low when open LED, overvoltage or over temperature happens.
33	EF1	Open drain fault flag pin, pull low short LED or over temperature happens.
34	SYNC	Input an external clock to synchronize the switching phase and frequency
35	FREQ	Switching frequency. Connect a resistor between this pin and GND to set the switching frequency.
36	INOV	Detect input voltage, stop switching when input over voltage.
37	SPREAD	Pull high to enable spread spectrum function.
38	SS	Soft-start pin. A current source of 25 μ A (typ.) is used to charge the C _{SS} capacitor.
39	INMON	Input current monitor pin.
40	AGND	Device GND pin.
41	EN	Device enable.
42	IIN1	Input current sense positive pin.
43	IIN2	Input current sense negative pin.
44	VIN	Device power supply pin
46	VCC	Internal LDO connected to VIN output. Connect a capacitor between VCC and GND close to the device.
47	VCC_EXT	Gate driver supply pin, connect to VCC or external power supply.
Exposed pad		Exposed pad. The exposed pad is on the bottom side of the device.

Block Diagram

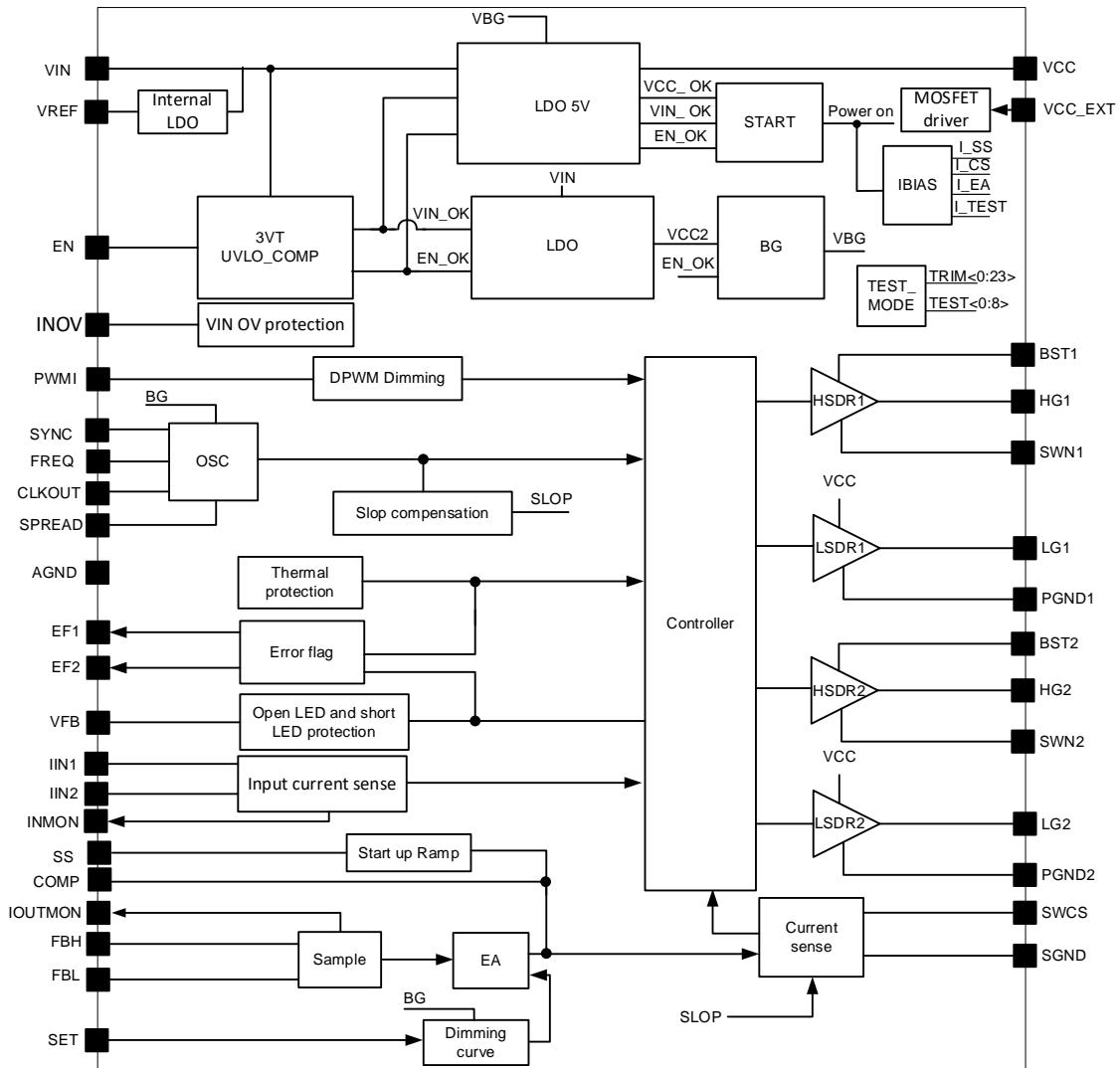


Figure 2. Block Diagram

Absolute Maximum Ratings

Parameter (Note 1)	Min	Max	Unit
VIN, SWN1, SWN2, IIN1, IIN2, FBH, FBL	-0.3	60	V
EN	-0.3	40	
BST1, BST2	-0.3	65	
VCC, VCC_EXT, BST1-SWN1, BST2-SWN2	-0.3	6	
LG1- PGND1, LG2 -PGND2, HG1 to SWN1, HG2 to SWN2, PWMI, FB, EF, SET, SYNC, CLKOUT, SPREAD, IOUTMON	-0.3	5.5	
COMP, SS, INMON, INOV	-0.3	3.6	
SWCS-SGND, IIN1-IIN2, FBH-FBL	-0.3	0.3	
SWCS, SGND, PGND	-0.3	0.3	
Junction Temperature, Operating		150	°C
Lead Temperature (Soldering, 10s)		206	
Storage Temperature Range	-65	150	

Thermal Information

Parameter (Note 2)	Typ	Unit
R _{θJA} Junction-to-Ambient Thermal Resistance	20.2	°C/W
R _{θJC} Junction-to-Case (Top) Thermal Resistance	3.4	°C/W

Recommended Operating Conditions

Parameter (Note 3)	Min	Max	Unit
VIN	4.5	55	V
VOUT	2.4	55	
Ambient Temperature Range	-40	125	°C

Electrical Characteristics

($V_{IN}=12V$, $V_{DD} = 5V$, $T_J = -40^{\circ}C$ to $+125^{\circ}C$, unless otherwise noted (Note 4))

Parameter	Symbol	Min	Typ	Max	Unit	
Functional Range	Supply Voltage	V_{VIN}	4.5	-	55	V
	Normal Operating T_J Range	T_J	-40	-	150	$^{\circ}C$
Power Supply V_{IN}	Input Voltage Startup	V_{VIN_ON}	4.0	4.2	4.4	V
	Input Voltage Startup Hysteresis	V_{VIN_HYS}	-	0.37	-	V
	IC Operating Current (without Driver Current when FS = 300KHz) PWMI = 0	I_Q		2.6	3.9	mA
	V_{IN} Sleep Mode Current	I_{SD}			20	μA
Regulator	V(FBH-FBL) Threshold (VSET = 2V)	$V_{REF_CURRENT}$	145.5	150	154.5	mV
	V(FBH-FBL) Threshold @ Analog Dimming 10%(VSET = 0.32V)	$V_{REF_CURRENT_10\%}$	10	15	20	mV
	g_m of Current Loop	g_m		1000		$\mu A/V$
	Saturation Output Current of G_m	g_{m_MAX}		80		μA
	Minimum Boost t_{ON}	t_{ONMIN_BST}		230		ns
	Minimum Buck t_{ON}	t_{ONMIN_BUCK}		230		ns
	SWCS Switch Peak Overcurrent Boost Threshold	$V_{S_LIM_BST}$	40	50	60	mV
	SWCS Switch Peak Overcurrent Buck Threshold	$V_{S_LIM_BUCK}$	-60	-50	-40	mV
	Soft-Start Pullup Current	I_{SS_CHAREG}		26		μA
	Soft-Star Pulldown Current	$I_{SS_DISCHARGE}$		2		μA
	Soft-Start Voltage during Regulation	V_{SS_REG}		2		V
	Soft-Start Done Threshold	V_{SS_DONE}		1.75		V
	Soft-Start Latch-Off Threshold	V_{SS_RESET}	0.1	0.2	0.3	V
	Enable Rising Threshold	V_{EN_ON}	1.65	1.75	1.85	V
	Enable Voltage Hysteresis	V_{EN_HYS}		200		mV
Gate Driver	Gate Driver Undervoltage ($V_{BST1} - V_{SWN1}$ and $V_{BST2} - V_{SWN2}$)	$V_{(VBSTx-VSWx)_UV}$		2.4		V
	HG1/HG2 MOS Driver Pullup Resistor	$R_{DSON_HG_UP}$		3.0		Ω
	HG1/HG2 MOS Driver Pulldown Resistor	$R_{DSON_HG_LOW}$		1.6		Ω
	LG1/LG2 MOS Driver Pullup Resistor	$R_{DSON_LG_UP}$		3.0		Ω
	LG1/LG2 MOS Driver Pulldown Resistor	$R_{DSON_LG_LOW}$		1.6		Ω
PWMI and VCC regulator	PWMI Turn-On Threshold	V_{PWMI_ON}		2.1		V
	PWMI Turn-Off Threshold	V_{PWMI_OFF}		0.8		V
	VCC Output Voltage	V_{VCC}	4.85	5	5.15	V
	VCC Output Current Limit	I_{LIM_VCC}		100		mA
	Dropout Voltage from V_{IN} to VCC when $I_{VCC} = 10mA$	V_{DR}		70		mV
	VCC On-Voltage	V_{CC_ON}		4.2	4.4	V
	VCC Undervoltage Hysteresis	V_{CC_HYS}		0.5		V
	VCC_EXT on-Threshold	$V_{CC_EXT_ON}$		4.2		V
VCC_EXT Undervoltage Hysteresis	$V_{CC_EXT_HYS}$		0.5		V	
Oscillator	Switch Frequency for $R_{FREQ} = 36k\Omega$, $T_J = 25^{\circ}C$	f_{sw}	270	310	350	kHz

Parameter	Symbol	Min	Typ	Max	Unit	
	SYNC Frequency	F _{SYNC}	200		700	KHz
	SYNC Turn on Threshold	V _{SYNC_ON}		2.1		V
	SYNC Turn off Threshold	V _{SYNC_OFF}		0.8		V
	Spread Function Turn on Threshold	V _{SYNC_ON}		2.1		V
	Spread Function Turn off Threshold	V _{SYNC_OFF}		0.8		V
	Frequency Deviation	F _{DEV}	-8		+8	%
	High Level of CLKOUT Output Voltage	V _{CLKOUTH}	VCC-0.4		VCC	V
	Low Level of CLKOUT Output Voltage	V _{CLKOUTL}	0		0.4	
Protection	FB Detect Threshold for Short LED Protection	V _{FB_SLP}		0.16		V
	FB Detect Threshold for Overvoltage Protection	V _{FB_OVP}	1.38	1.46	1.54	V
	Output Overvoltage Hysteresis	V _{FB_OV_HYS}		50		mV
	Open Load Rising Threshold	V _{FB_OPL_RISE}	1.27	1.34	1.41	V
	Open Load Hysteresis	V _{FB_OPL_HYS}		50		mV
	Open Load Reference Threshold on V _{FBH} - V _{FBL}	V _{FBHL_LOW}		20		mV
	Input over Voltage Rising Threshold	V _{IN_OV_TH}	1.8	2	2.2	V
	Input over Voltage Threshold Hysteresis	V _{IN_OV_HYS}	20	40	60	mV
	Input Current Sense Threshold V(IIN1-IIN2)	V(IIN1-IIN2)	46	50	54	mV
	Input Current Sense Amplifier	I _{IN_GM}		2.5		mA/V
	Saturation Output Current Input Current Sense Amplifier	I _{IN_GM_max}		80		μA
	Input Current Monitor Voltage	V _{INMON}	0.85	1	1.15	V
	EF1/EF2 Output Impedance (1mA)	R _{EF}		2.7		kΩ
	Overtemperature	T _{SD}	150	160		°C
Overtemperature Protection Hysteresis	T _{SD_HYS}		15		°C	

Note 1: Stresses beyond the “Absolute Maximum Ratings” may cause permanent damage to the device. These are stress ratings only. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Note 2: θ_{JA} is measured in the natural convection at $T_A = 25^\circ\text{C}$ on a 2oz two-layer Silergy evaluation board. Case temperature θ_{JC} is measured at pin 4.

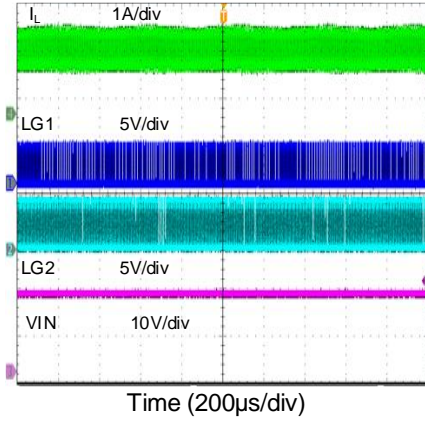
Note 3: The device is not guaranteed to function outside its operating conditions.

Note 4: Unless otherwise stated, limits are 100% production tested under pulsed load conditions such that $T_A \cong T_J = -40^\circ\text{C} - 125^\circ\text{C}$. Limits over the operating temperature range (see recommended operating conditions) and relevant voltage range(s) are guaranteed by design, test, or statistical correlation.

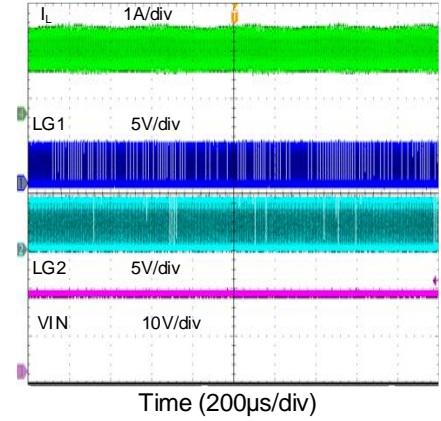
Typical Performance Characteristics

$V_{IN}=16V$, $V_{LED}=20V$, $I_{LED}=1A$, Buck-Boost mode

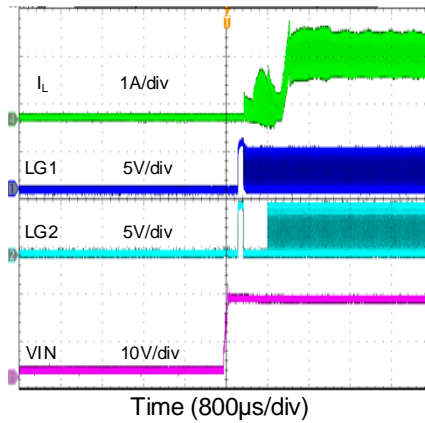
Steady State



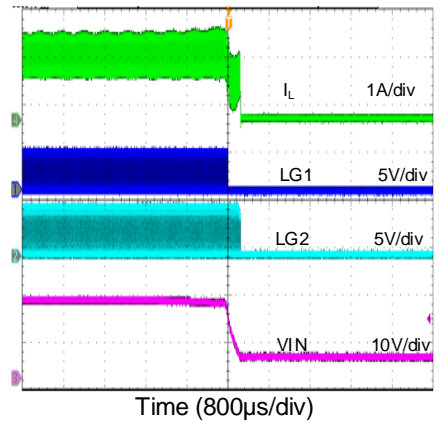
Steady State



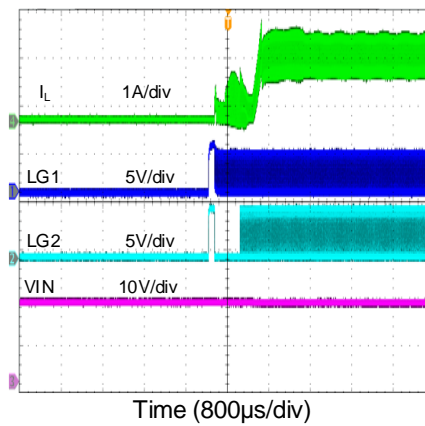
VIN ON



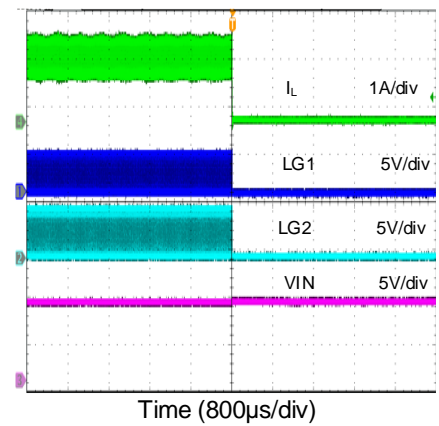
VIN OFF



EN ON

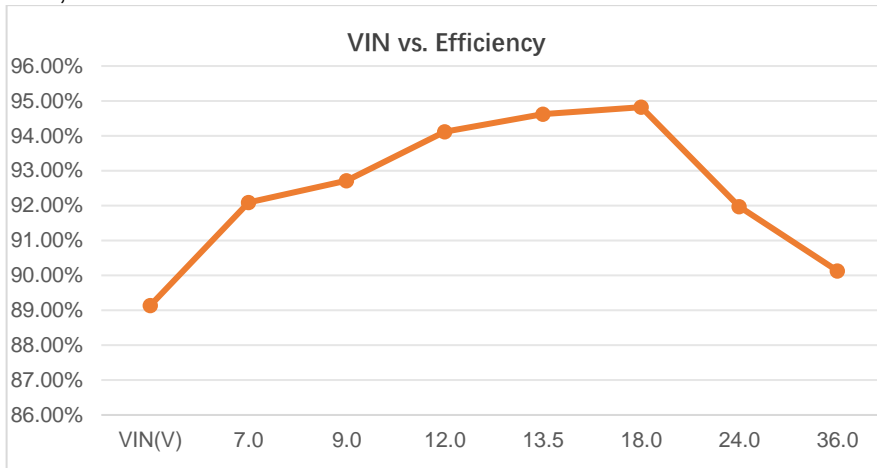


EN OFF



Efficiency Performance

Constant current V_{LED}=20V, I_{LED}=0.95A



V _{IN} (V)	I _{IN} (A)	V _{LED} (V)	I _{LED} (A)	Efficiency
7.0	3.013	19.81	0.949	89.14%
9.0	2.272	19.8	0.95	92.09%
12.0	1.66	19.57	0.946	92.71%
13.5	1.46	19.56	0.947	94.12%
18.0	1.09	19.56	0.947	94.62%
24.0	0.817	19.62	0.948	94.82%
36.0	0.562	19.65	0.948	91.97%

Functional Description

The SA33760 Buck-Boost controller can automatically operate in Buck, Boost, and Buck-Boost modes based on the input and output voltages.

VIN Startup/Shutdown

Startup: When V_{VIN} exceeds V_{VIN_ON} , the SA33760 will charge V_{CC} . When V_{CC} exceeds V_{CC_ON} and V_{CC_EXT} exceeds $V_{CC_EXT_ON}$, both low side MOSFETs are turned ON for approximately 100 μ s to charge C_{BST} . After this charge time, the device will operate normally.

Shutdown: When V_{VIN} falls below $V_{VIN_ON} - V_{VIN_HYS}$, the device will enter shut down state and stop switching both the high side and low side MOSFETs.

The V_{CC} is regulated to the V_{VCC} target value. When $I_{VCC} = 10mA$, the dropout voltage from V_{IN} to V_{CC} is V_{DR} .

When the device exits shut down mode, the internal current source I_{SS_CHARGE} will begin charging the capacitor C_{SS} connected between the SS pin and GND. Additionally, the rate at which the LED current increases can be adjusted by C_{SS} .

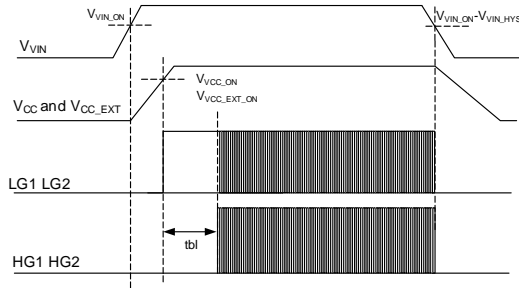
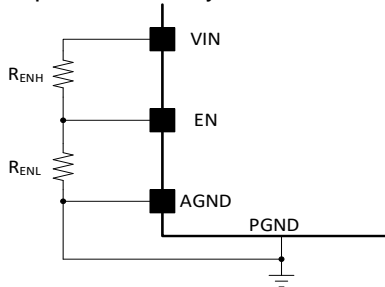


Figure 3. VIN Startup and Shutdown

EN ON/EN OFF

EN ON condition: When $V_{EN} > V_{EN_ON}$, V_{CC} starts ramping. $LG1$ and $LG2$ remain on for approximately 100 μ s to charge C_{BSTx} after $V_{CC} > V_{CC_ON}$. Once $V_{CBST} > V_{(VBSTx-VSWx)_UV}$, all MOSFETs will operate normally.



$$V_{EN} = V_{IN} \times \frac{R_{ENL}}{R_{ENL} + R_{ENH}}$$

EN OFF condition: When $V_{EN} < V_{EN_ON} - V_{EN_HYS}$, V_{IN} stops supplying V_{CC} and all MOSFETs are turned off.

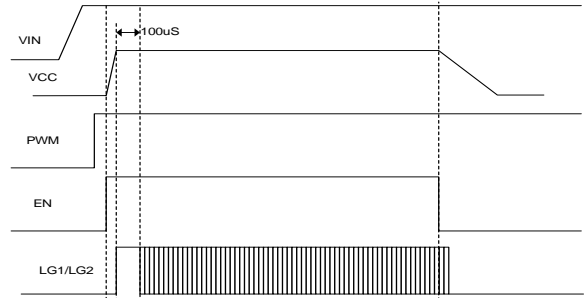


Figure 4. EN ON/OFF

PWM ON/PWM OFF

$LG1$ and $LG2$ are both turned ON before PWM to charge C_{BSTx} . When PWM is ON, the SA33760 operates normally. When PWM is OFF, the SA33760 will not detect open LED or short LED conditions, and C_{SS} will not be charged during soft-start.

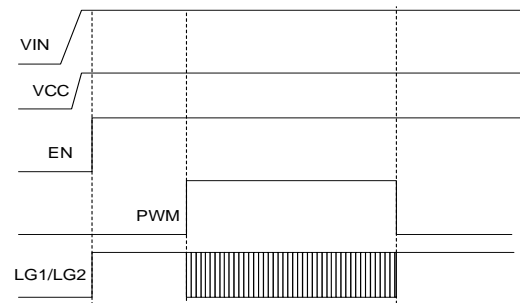


Figure 5. PWM ON/OFF

Switching Frequency

The switching frequency f_{sw} is set using the $FREQ$ pin. The resistor value can be determined using the curve in Figure 6 or the following equation:

$$R_{FREQ} = e^{\frac{\ln(9735) - \ln(f_{sw})}{0.95}}$$

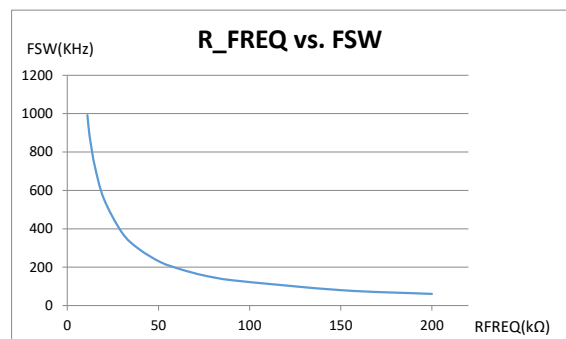


Figure 6. R_{FREQ} vs. f_{SW}

When the detected R_{FREQ} is abnormal, indicating that the $FREQ$ pin is either open or shorted, the default f_{sw} of 300KHz is used.

Spread Spectrum

The SA33760 features Spread Spectrum operation to improve EMC performance. It varies the switching frequency by $\pm 8\%$ of f_{sw} over a triangle sequence of 128 switching cycles when pull SPREAD pin high, as shown in Figure 7.

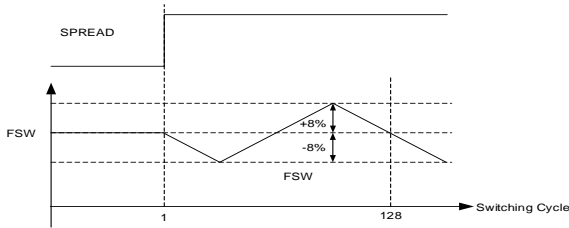


Figure 7. Spread Function

Loop Control

The SA33760 operates in constant frequency current mode, sensing the average LED current from FBH and FBL, and regulating I_{LED} through the COMP voltage. The COMP voltage controls the on-time (t_{ON}) of LG1 and LG2.

The suggested typical value for C_{COMP} is 22nF, R_{comp} is 510 Ω for constant current application.

$$C_{comp} = \frac{R_S \times g_m}{f_{GBW} \times 2\pi \times K \times R_{SW}}$$

$$R_{comp} = \frac{R_{LED} \times C_{OUT}}{C_{comp}}$$

(K is current sense coefficient, the value is 10, GBW is suggested about 10KHz; $C_{OUT} = C_{O1} + C_{O2}$, R_{LED} is the equivalent LED internal resistor)

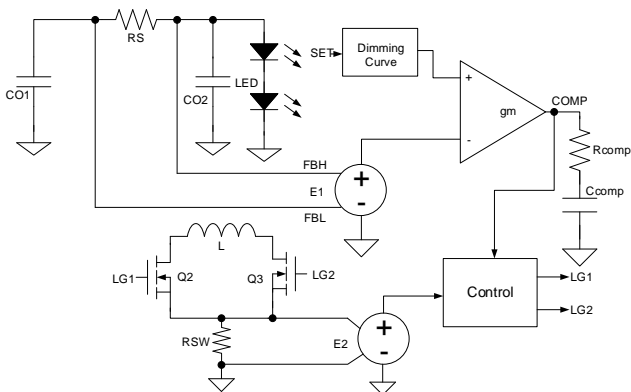


Figure 8. Loop Control

Operating Modes

The SA33760 has three operating modes: Buck, Boost, and Buck-Boost. The device automatically switches to the appropriate mode by detecting the input and output voltages:

- When V_{IN} is much less than V_{OUT} , the device operates in Boost mode, as shown in Figure 9.
- When V_{IN} is much greater than V_{OUT} , the device operates in Buck mode, as shown in Figure 10.
- When V_{IN} is close to V_{OUT} , the device operates in Buck-Boost mode, as shown in Figure 11.

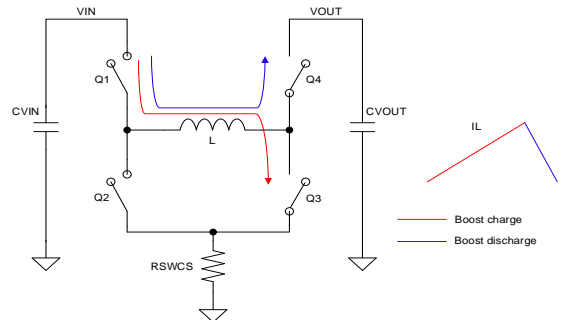


Figure 9. $V_{IN} \ll V_{OUT}$: Boost Mode

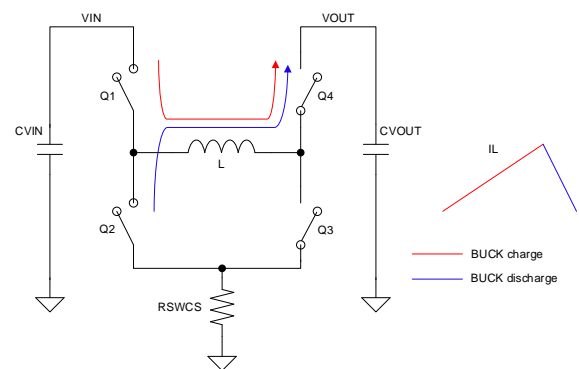


Figure 10. $V_{IN} \gg V_{OUT}$: Buck Mode

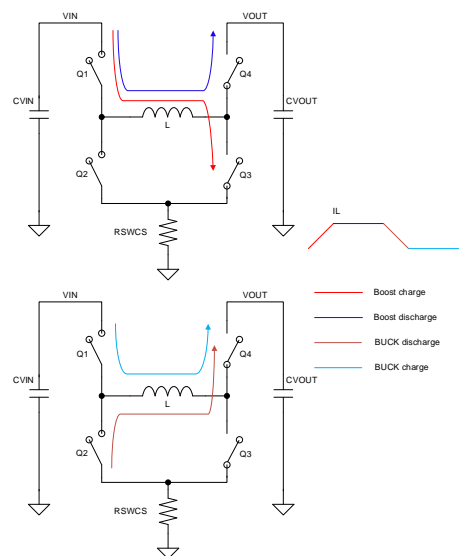


Figure 11. $V_{IN} = V_{OUT}$: Buck-Boost Mode

Analog Dimming

The SA33760 features an analog dimming function that allows the internal I_{LED} reference to be adjusted by changing V_{SET}, as shown in Figure 12 and Figure 13.

$$I_{LED} = \frac{V_{SET} - 200mV}{R_{FB} \times 8}$$

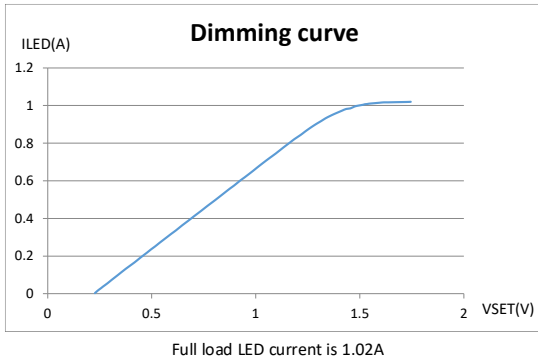


Figure 12. Dimming Curve

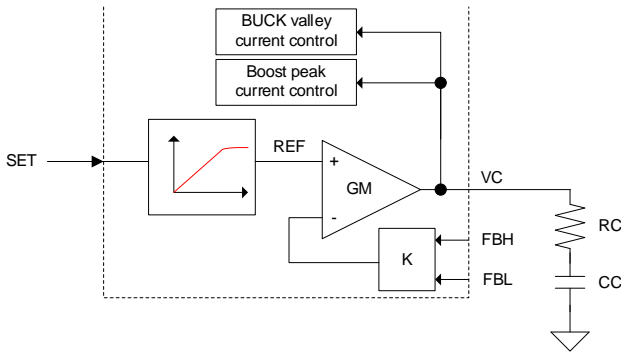


Figure 13. Analog Dimming

Direct Dimming

The SA33760 also supports direct PWM dimming. Connect the PWM dimming signal to the PWMI pin to control dimming as follows:

- When PWM = 1, the VC regular output LED current and all power MOSFETs operate normally
- When PWM = 0, COMP is held, both LG1 and LG2 are ON to charge C_{BSTx} while HG1 and HG2 are OFF

The supported PWM frequency range is 100Hz to 1kHz.

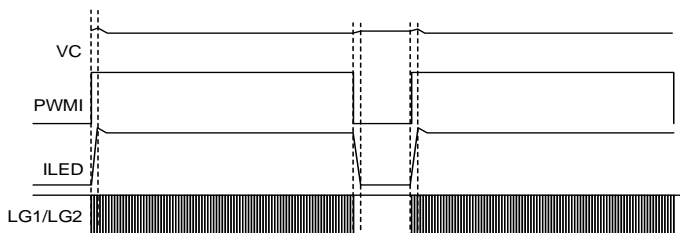
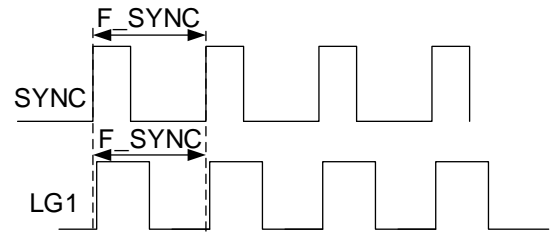


Figure 14. Direct Dimming

SYNC Function:

The SA33760 possesses the synchronization function, which inputs a clock to the SYNC pin to force the switching frequency to vary the 50% to 150% ratio of the frequency set by FREQ. SYNC function is not suggested when the SPREAD function is enable. SYNC floating or connect to AGND if SYNC function is not used.



CLKOUT Function

CLKOUT has a 180° phase shift with the current device, applied for dual device situation to decrease the EMC noise. CLKOUT floating or connect to AGND if CLKOUT function is not used.

IIN Monitor

The INMON pin is applied to detect the input average current. Connect a 100nF MLCC from INMON to GND. The result is showed in IINMON with the relational expression:

$$V_{INMON} = 20 \times (V_{IIN1} - V_{IIN2})$$

The maximum voltage of IIN1-IIN2 is 50mV, and V_{IINMON} is 1.0V.

IOUT Monitor

The IOUTMON pin is applied to detect the ILED average current. Connect a 100nF MLCC from IOUTMON to GND. The result is showed in IOUTMON with the relational expression:

$$V_{IOUTMON} = 200mV + 8 \times (V_{FBH} - V_{FBL})$$

Fault Protection

Short LED Protection

The SA33760 detects the LED voltage from the FB pin after V_{SS} exceeds V_{SS_DONE}. When V_{FB} is less than V_{FB_SLP} for 8 cycles, the device will stop switching and pull SS low with I_{SS_DISCHARGE} until V_{SS} falls below V_{SS_RESET}. The fault signal EF1 will be pulled low when short LED protection (SLP) is activated, as shown in Figure 15.

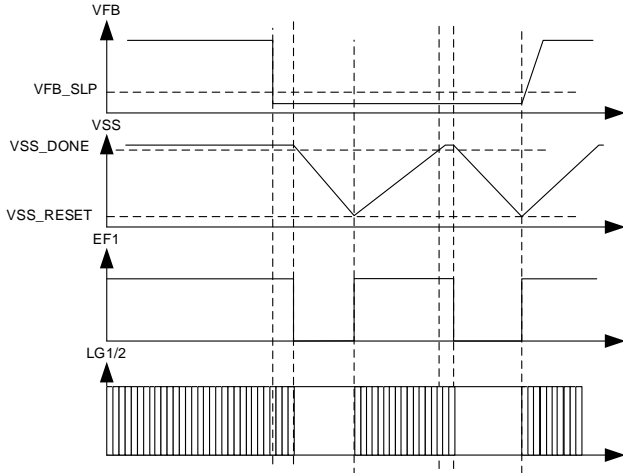


Figure 15. Short LED Protection

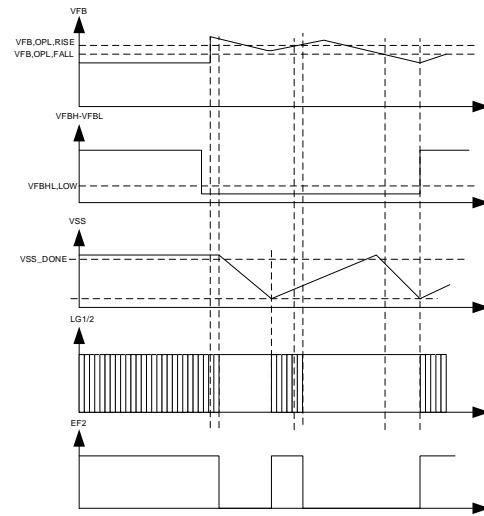


Figure 17. Open LED Protection

Output Overvoltage Protection

To prevent output overvoltage, when VFB exceeds V_{FB_OVP} , the SA33760 will pull HG1 and HG2 low and turn LG1 and LG2 ON to charge the C_{BST} until $VFB < V_{FB_OVP} - V_{FB_OVP_HYS}$. The EF2 signal is pulled low during overvoltage protection (OVP), as shown in Figure 16.

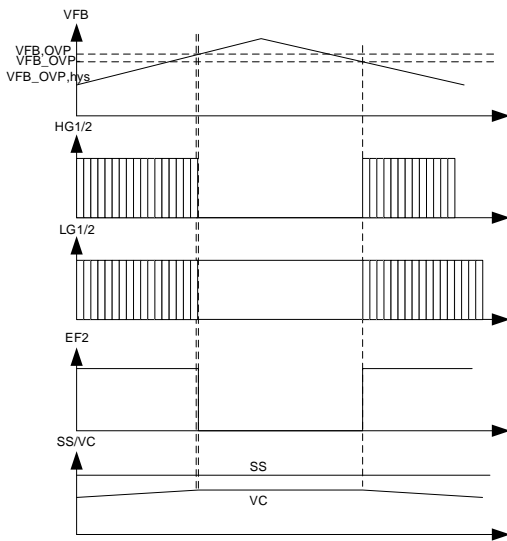


Figure 16. Output Overvoltage Protection

Open LED Protection

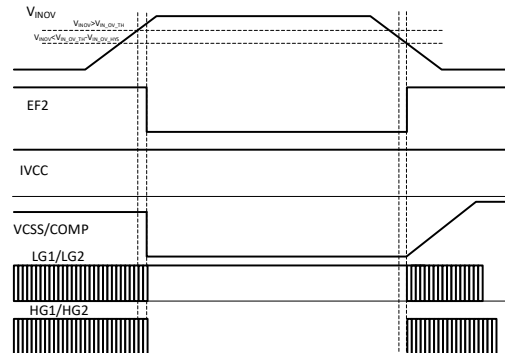
The SA33760 detects an LED open circuit by monitoring VFB and the difference between V_{FBH} and V_{FBL} . When VFB exceeds V_{FB_OLP} and $V_{FBH} - V_{FBL} < V_{FBHL_LOW}$, the device will disable HG1 and HG2, discharge C_{SS} , and pull EF2 low, as shown in Figure 17.

Figure 18. Input over voltage Protection

Layout Design

Input over voltage protection

The SA33760 detects input voltage from INOV to avoid the input over voltage, the IC detects V_{INOV} from INOV pin, when $V_{INOV} > V_{IN_OV_TH}$, the IC will stop the high-side MOS and pull high the low-side MOS, EF2 is pulled low until $V_{INOV} < V_{IN_OV_TH} - V_{IN_OV_TYS}$.



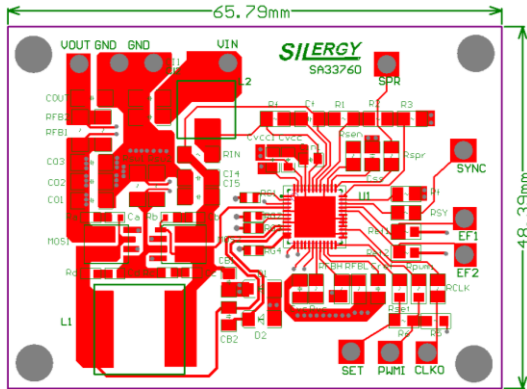
Input over current limit

SA33760 detects input current from IIN1 and IIN2, when $V_{IIN1} - V_{IIN2} > V_{(IIN1-IIN2)}$, COMP will be discharged to limit the input current to $V_{(IIN1-IIN2)} \cdot I_{IN_LIMIT}$. I_{IN_LIMIT} is the input current limit.

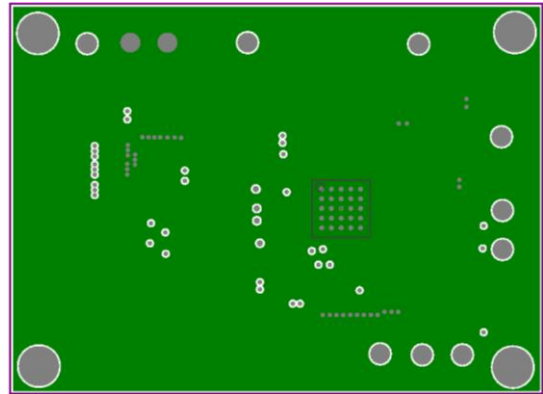
$$I_{IN_LIMIT} = \frac{V_{(IIN1-IIN2)}}{R_{IN}}$$

Thermal Shutdown Protection

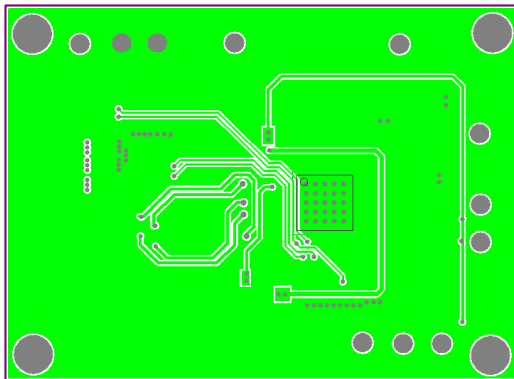
To prevent the device junction temperature T_J from becoming excessively high and damage the device, the SA33760 enters shut down when T_J exceeds the temperature threshold T_{SD} , when T_J falls below $T_{SD} - T_{SD_HYS}$, the device will restart.



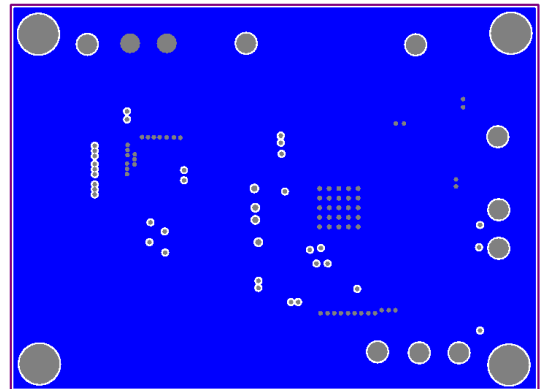
Top Layer



M2 Layer



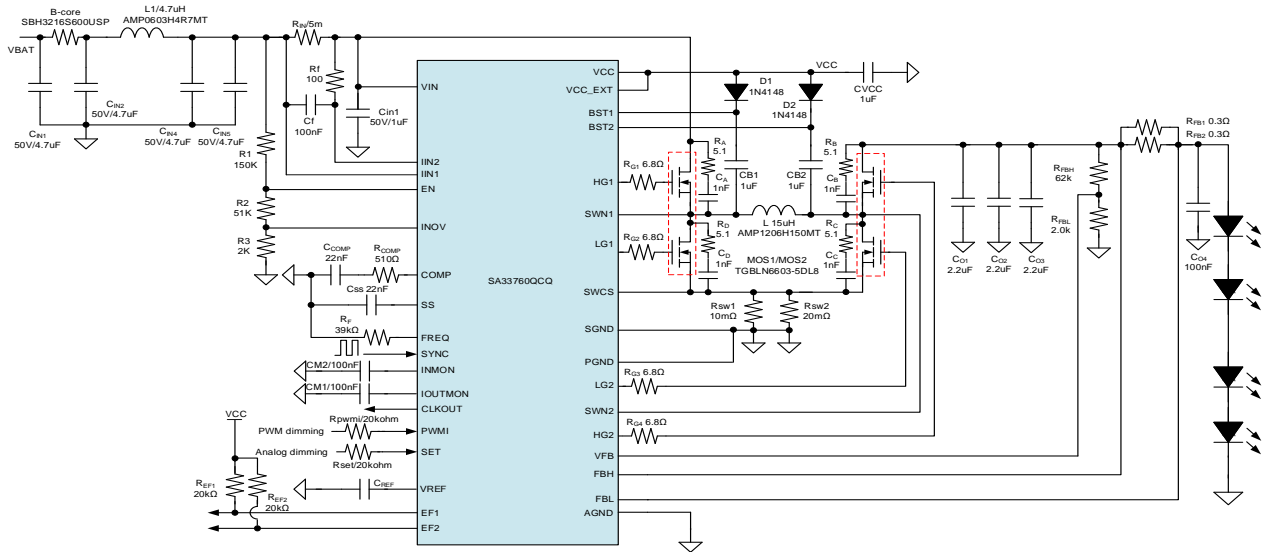
M3 Layer



Bottom Layer

Design Example 1 (Buck-Boost LED Application)

$V_{IN} = 13.5V$, $V_{LED} = 36V$, $I_{LED} = 1.0A$



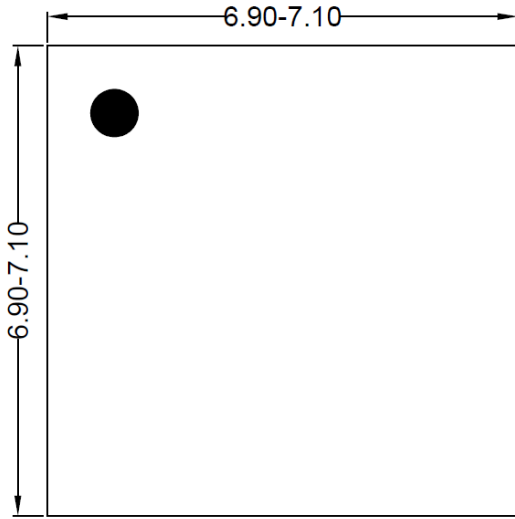
BOM List

Reference Designator	Description	Part Number	Manufacturer
CIN1 , CIN2, CIN4, CIN5	4.7μF/50V	MLCC	TDK
CIN1	1μF/50V	MLCC	TDK
CVCC, CB1, CB2, CREF	1μF/16V	MLCC	TDK
Rf	100Ω/0805		
Cf,CO4,CM1,CM2	100nF/0805	MLCC	TDK
R1	150kΩ/0805		
R2	51kΩ/0805		
R3,RFB1	2kΩ/0805		
RIN	5mΩ/1210		
CCOMP,CSS	22nF/0603	MLCC	TDK
RCOMP	510Ω/0805		
RF	39kΩ/0805		
Rpwmi, Rset, REF1, REF2	20kΩ/0805		
RG1,RG2,RG3,RG4	6.8Ω/0805		
RA,RB,RC,RD	5.1Ω/0805		
CA,CB,CC,CD	1nF/0805	MLCC	TDK
Rsw1	10mΩ/1210		
Rsw2	20mΩ/1210		
D1,D2	1N4148		
L	15μH/AMP1206H150MT		
MOS1/MOS2	TGBLN6603-5DL8		
RFBH	62kΩ/0805		
RFB1,RFB2	0.3Ω/1206		
CO1,CO2,CO3,CO4	2.2μF/0805	MLCC	TDK
L1	4.7μF/AMP0603H4R7MT		
B-core	SBH3216S600USP		
IC	SA33760		Silergy

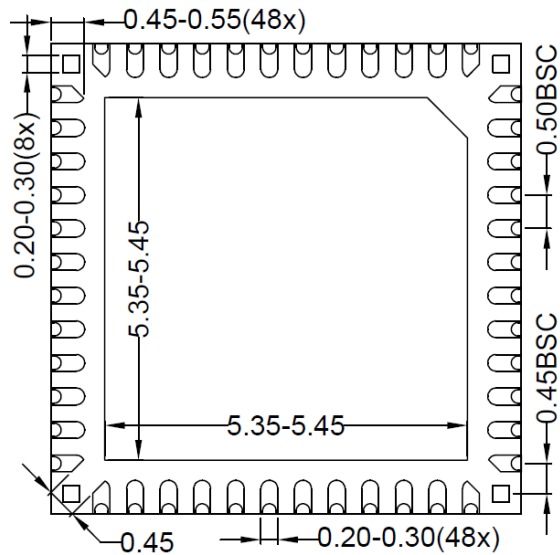
Table 1. Example 1 Efficiency

$V_{IN}(V)$	$I_{IN}(A)$	$V_{LED}(V)$	$I_{LED}(A)$	Efficiency
7	3.013	19.81	0.949	89.14%
8.99	2.272	19.8	0.95	92.09%
12.03	1.66	19.57	0.946	92.71%
13.48	1.46	19.56	0.947	94.12%
17.96	1.09	19.56	0.947	94.62%
24.01	0.817	19.62	0.948	94.82%
36.04	0.562	19.65	0.948	91.97%
50	0.414	19.68	0.948	90.13%
7	6.3	37.7	0.94	80.36%
9.07	4.4	37.69	0.941	88.87%
12	3.24	37.57	0.942	91.03%
13.5	2.863	37.63	0.944	91.91%
17.98	2.13	37.54	0.946	92.73%
24.01	1.576	37.57	0.947	94.02%
36.01	1.041	37.54	0.948	94.94%
50.1	0.756	37.59	0.948	94.09%

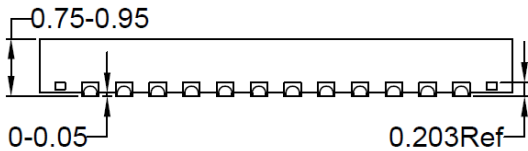
QFN7x7-48 Package Outline Drawing



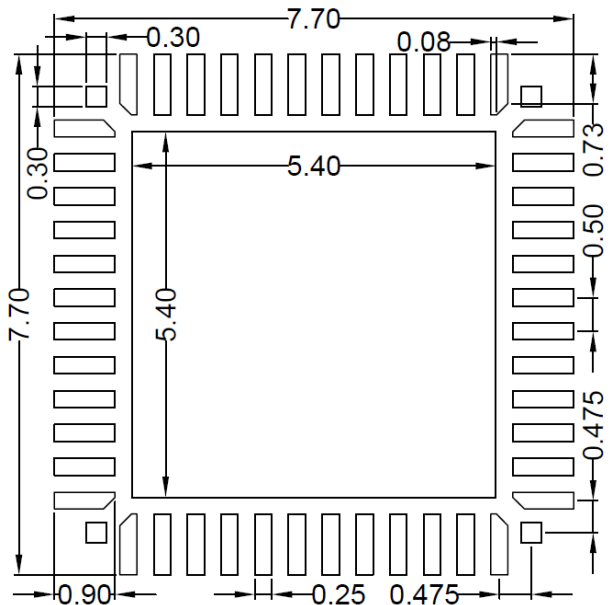
Top View



Bottom View



Front View

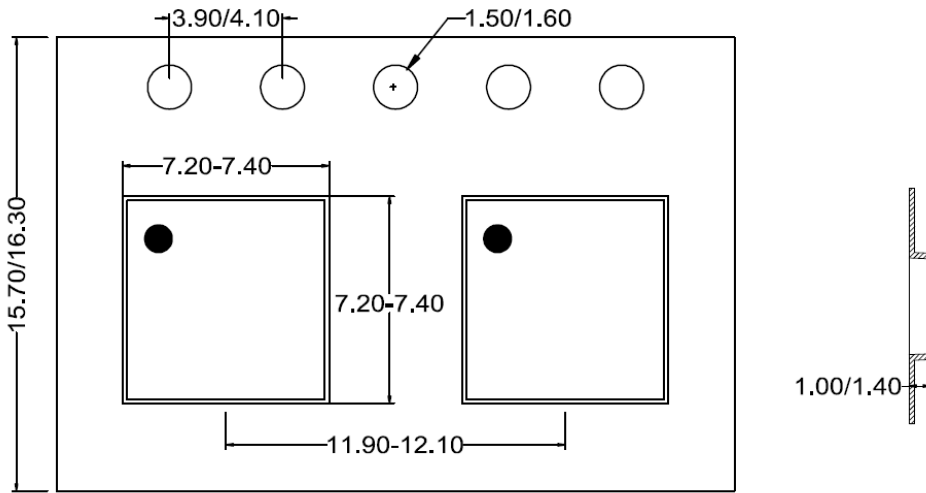


Recommended PCB Layout
(Reference only)

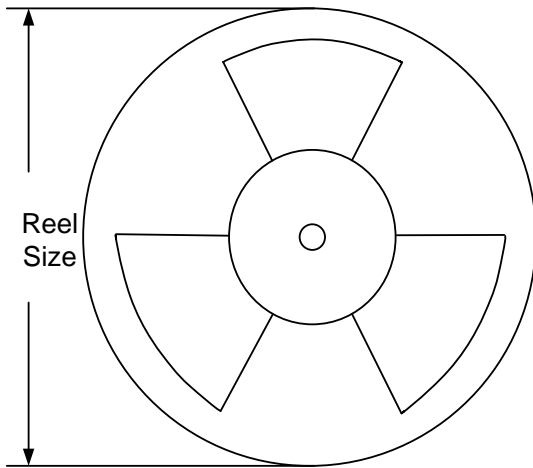
Notes: All dimension in millimeter and exclude mold flash & metal burr.

Tape and Reel Specification

Taping Orientation



Reel dimensions



Package types	Tape width (mm)	Pocket pitch(mm)	Reel size (Inch)	Trailer * length(mm)	Leader * length (mm)	Qty per reel (pcs)
QFN7x7	16	12	13"	400	400	3000

Revision History

The revision history provided is for informational purpose only and is believed to be accurate, however, not warranted. Please make sure that you have the latest revision.

Date	Revision	Change
December 10,2025	Revision 1.0	Initial Release

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