Description

The AL3069Q is a high-efficiency 60V boost controller including four 80V high-precision current sink channels and fault diagnostics for LED backlight applications. Boost with built-in adaptive voltage control operates over a wide input-voltage range from 4.5V to 60V. Its operating frequency can be adjusted from 100kHz to 1MHz.

The four channel current is simply programmed with an external resistor. The current match between any channels is ±0.5% (typical).

Extensive fault diagnostic and robust protection features include cycle by cycle current limit, soft-start, UVLO, programmable OVP, OTP, open/short LED protection, Schottky diode short and open protection, inductor short-circuit protection, V_{OUT} short protection, and fault indicator (FAULTB) pin, which are designed for automotive applications to improve system robustness.

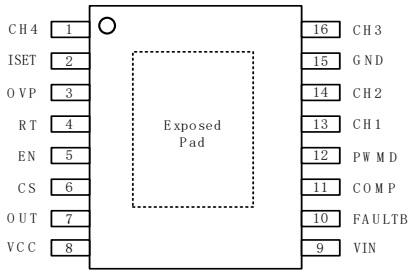
The AL3069Q is available in the TSSOP-16EP (Type DX) and U-QFN4040-16/SWP (Type UXB) packages. It is qualified to AEC-Q100 Grade 1 and is automotive grade to support PPAPs.

Features

- AEC-Q100 Grade 1 Qualified
- Boost or SEPIC DC/DC Controller
  - Input-Voltage Range: 4.5V to 60V
  - High-Voltage Pins CS and OVP for Safety Test
  - Switching Frequency 100kHz to 1MHz
  - Built-In Adaptive Voltage Feedback
- Four High-Precision Current Sinks
  - 250mA per String, 400mA Pulse Current
  - Typical ±0.5% Channel to Channel Current Matching
  - Supports Direct PWM Dimming
  - Minimum PWM Dimming Duty Cycle Achieved 1/5000 at 100Hz Dimming Frequency
- Extensive Fault Diagnostics
  - Open-Drain Fault Report Pin
  - LED Open/Short Protection
  - Schottky Diode/Inductor Short-Circuit Protection
  - Built-In OCP, OVP, OTP, UVLO
  - VOUT Short/Schottky Diode Open Protection
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**
- **The AL3069Q is suitable for automotive applications requiring specific change control; this part is AEC-Q100 qualified, PPAP capable, and manufactured in IATF 16949 certified facilities.**
  https://www.diodes.com/quality/product-definitions/

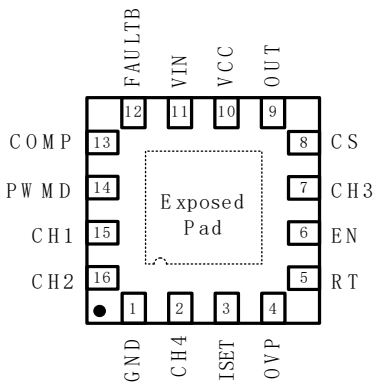
Pin Assignments

(Top View)



TSSOP-16EP (Type DX)

(Top View)



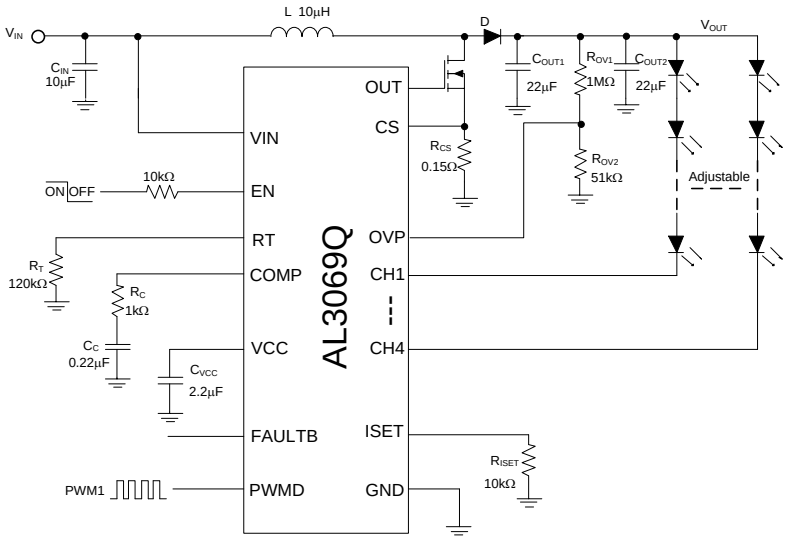
U-QFN4040-16/SWP (Type UXB)

Applications

- LED-backlight drivers for:
  - Automotive infotainment
  - Automotive instrument clusters
  - Smart mirrors
  - Heads-up displays (HUD)

Notes:
1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant.
2. See https://www.diodes.com/quality/lead-free/ for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.

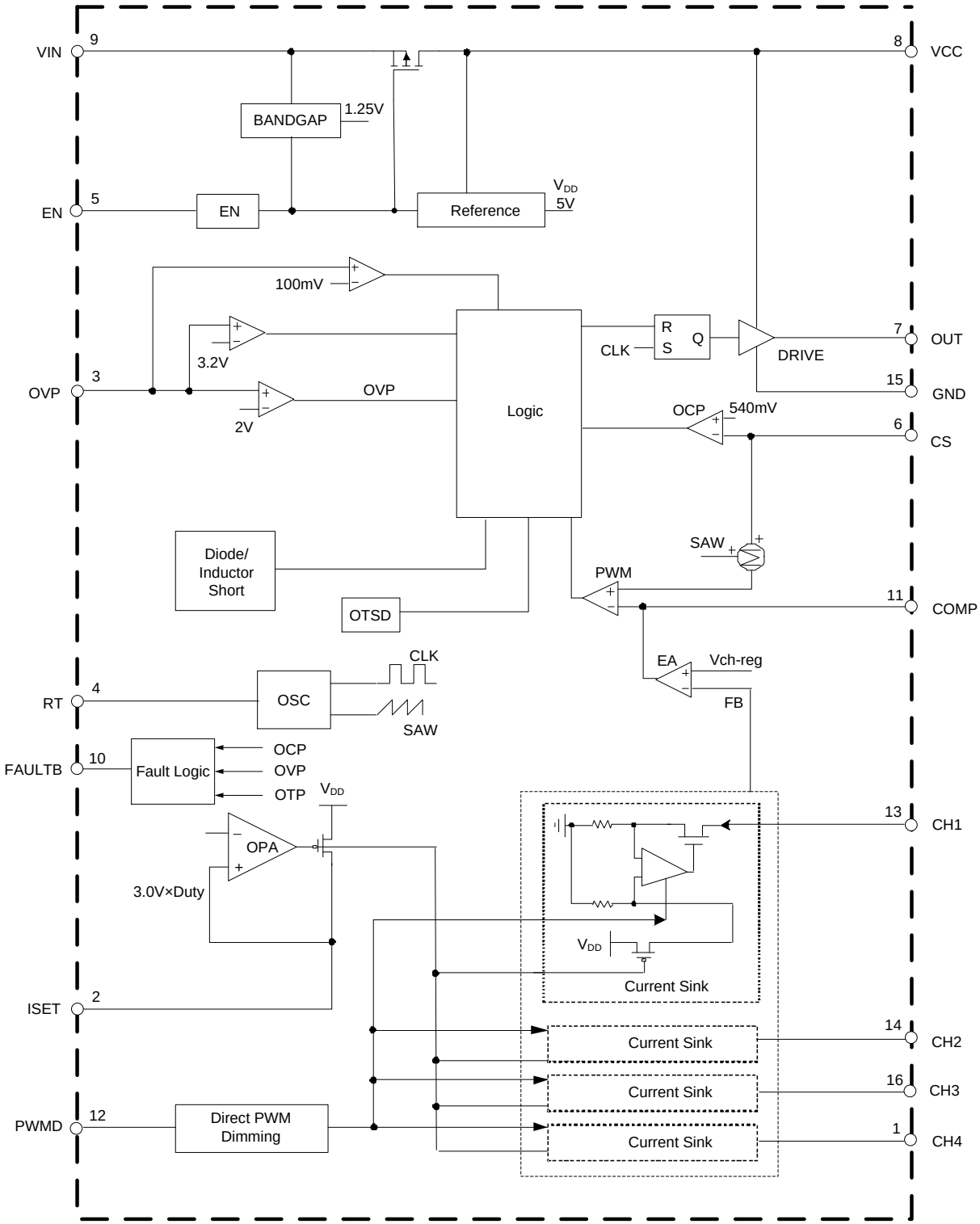
Typical Applications Circuit



Pin Descriptions

Pin Number		Pin Name	Function
TSSOP-16EP (Type DX)	U-QFN4040-16/SWP (Type UXB)		
1	2	CH4	LED current sink 4. Leave the pin open directly if not used.
2	3	ISET	LED current set pin. The corresponding maximum current of all four strings is set through connecting a resister from this pin to GND.
3	4	OVP	Overvoltage protection pin. When the OVP pin voltage exceeds 2.0V, the OVP is triggered, and the power switch is turned off. When the OVP pin voltage drops below hysteresis voltage, the OVP is released, and the power switch will resume normal operation.
4	5	RT	Frequency control pin.
5	6	EN	ON/OFF control pin. Forcing this pin voltage above 2.4V enables the IC while below 0.5V shuts down the IC. When the IC is in shutdown mode, all functions are disabled to reduce the supply current below 3µA.
6	8	CS	Power switch current-sense input.
7	9	OUT	Boost converter power switch gate output. This pin outputs high voltage (5V) to drive the external nMOSFET.
8	10	VCC	5V linear regulator output pin. This pin should be bypassed to GND with a ceramic capacitor.
9	11	VIN	Supply input pin. A capacitor (typical 10µF) should be connected between the VIN and GND to keep the DC input voltage constant.
10	12	FAULTB	Fault indication. Asserted low to report faulty conditions.
11	13	COMP	Soft-start and control loop compensation.
12	14	PWMD	Apply a low frequency PWM signal to this pin to get directive PWM dimming function.
13	15	CH1	LED current sink 1. Leave the pin open directly if not used.
14	16	CH2	LED current sink 2. Leave the pin open directly if not used.
15	1	GND	Ground
16	7	CH3	LED current sink 3. Leave the pin open directly if not used.
Exposed Pad	Exposed Pad	Exposed Pad	Exposed pad. Internally connected to GND. It should be externally connected to GND and thermal mass for enhanced thermal impedance. It should not be used as electrical conduction path.

Functional Block Diagram



Function Block Diagram

Absolute Maximum Ratings (@T_A = +25°C, unless otherwise specified.) (Notes 4, 5)

Symbol	Parameter	Rating	Unit
V_{CH}	CH1 to CH4 Pins Voltage	-0.3 to 80	V
V_{IN}, V_{CS}, V_{OVP}	Voltage on VIN, CS and OVP pin	-0.3 to 60	V
V_{EN}	EN Pin Voltage	-0.3 to 7	V
V_{CC}	VCC Output Pin Voltage	-0.3 to 7	V
V_{COMP}, V_{ISET}, V_{OUT}	COMP Pin Voltage, ISET Pin Voltage, OUT Pin Voltage	-0.3 to 7	V
V_{RT}	RT Pin Voltage	-0.3 to 7	V
V_{FAULTB}	FAULTB Pin Voltage	-0.3 to 7	V
V_{PWMD}	PWMD Pin Voltage	-0.3 to 7	V
V_{GND}	GND Pin Voltage	-0.3 to 0.3	V
T_J	Operating Junction Temperature	+150	°C
T_{STG}	Storage Temperature	-65 to +150	°C
T_{LEAD}	Lead Temperature (Soldering, 10sec)	+260	°C
—	ESD (Charged Device Model, CDM)	1000	V
—	ESD (Human Body Model, HBM)	2000	V

Notes: 4. Stresses greater than those listed under *Absolute Maximum Ratings* can cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions* is not implied. Exposure to *Absolute Maximum Ratings* for extended periods can affect device reliability.
5. For better performance, the AL3069Q should have high-voltage pins CS and OVP. If CS or OVP pin is added to 16V, the IC will not smoke or burn.

Package Thermal Information (Note 6)

Symbol	Parameter	TSSOP-16EP (Type DX)	U-QFN4040-16/SWP (Type UXB)	Unit
$R_{\theta JA}$	Junction-to-Ambient Thermal Resistance	31.5	30.8	°C/W
$R_{\theta JC(top)}$	Junction-to-Case (Top) Thermal Resistance	42.0	27.3	°C/W
$R_{\theta JB}$	Junction-to-Board Thermal Resistance	12.2	10.8	°C/W
ψ_{JT}	Junction-to-Top Characterization Parameter	1.2	0.16	°C/W
ψ_{JB}	Junction-to-Board Characterization Parameter	12.4	10.7	°C/W
$R_{\theta JC(bot)}$	Junction-to-Case (Bottom) Thermal Resistance	1.5	1.0	°C/W

Note: 6. The device is mounted on JEDEC standard 4 layers (2s2p) PCB test board with minimum recommended pad layout.

Recommended Operating Conditions

Symbol	Parameter	Min	Max	Unit
V_{IN}	Input Voltage	4.5	60	V
f_{SW}	Operating Switching Frequency	0.1	1	MHz
I_{CH}	LED Channel Current	20	400	mA
f_{PWMD}	Direct PWM Dimming Frequency	0.1	2	kHz
T_A	Operating Ambient Temperature	-40	+125	°C

Electrical Characteristics (@T_A = -40°C to +125°C, V_{IN} = 12V, V_{EN} = 5V, unless otherwise specified.)

Symbol	Parameter	Condition	Min	Typ	Max	Unit
Input Supply						
I_Q	Quiescent Current	No Switching	—	3	—	mA
I_{SHDN}	Shutdown Supply Current	V_{EN} = 0	—	1	—	μA
V_{UVLO}	Undervoltage Lockout Voltage	V_{IN} Rising	3.7	4.0	4.3	V
V_{HYS}	UVLO Hysteresis	—	—	200	—	mV
V_{CC} Regulator						
V_{CC}	V_{CC} Voltage	V_{IN} ≥ 5.5V	—	5	—	V
		V_{IN} < 5.5V	—	V_{IN}-0.5	—	V
—	Load Regulation	Load = 0 to 30mA	—	5	—	mV/mA
—	Line Regulation	V_{IN} = 12V to 33V	—	0.3	—	mV/V
Boost Gate Drive						
t_{RISE}	OUT Pin Rise Time (Note 7)	OUT Pin Load = 1nF	—	30	—	ns
t_{FALL}	OUT Pin Fall Time (Note 7)	OUT Pin Load = 1nF	—	30	—	ns
High-Frequency Oscillator						
f_{OSC1}	Switch Frequency	R_T = 100kΩ	—	500	—	kHz
—	Switch Frequency Range	—	0.1	—	1	MHz
D_{MAX}	Max Duty Cycle	R_T = 100kΩ	80	90	—	%
t_{ON_TIME}	Minimum On-Time (Note 7)	—	—	100	—	ns
Enable Logic and Dimming Logic						
V_{EN_H}	EN High Voltage	—	2.4	—	—	V
V_{EN_L}	EN Low Voltage	—	—	—	0.5	V
V_{PWMD_H}	PWM Logic for External Dimming	—	2.5	—	—	V
V_{PWMD_L}		—	—	—	0.3	V
Power Switch Drive						
V_{LIMIT}	Current-Limit Threshold Voltage	—	480	540	600	mV
V_{LIMIT2}	D/L Short Threshold Voltage	—	720	800	880	mV
t_{LEB}	Current-Sense LEB Time (Note 7)	—	—	100	—	ns
Compensation and Soft-Start (COMP Pin)						
I_{O_H}	Sourcing Current	V_{COMP} = 0.5V	—	120	—	μA
I_{O_L}	Sinking Current	V_{COMP} = 2V	—	120	—	μA

Note: 7. Guaranteed by design.

Electrical Characteristics (continued) (@T_A = -40°C to +125°C, V_{IN} = 12V, V_{EN} = 5V, unless otherwise specified.)

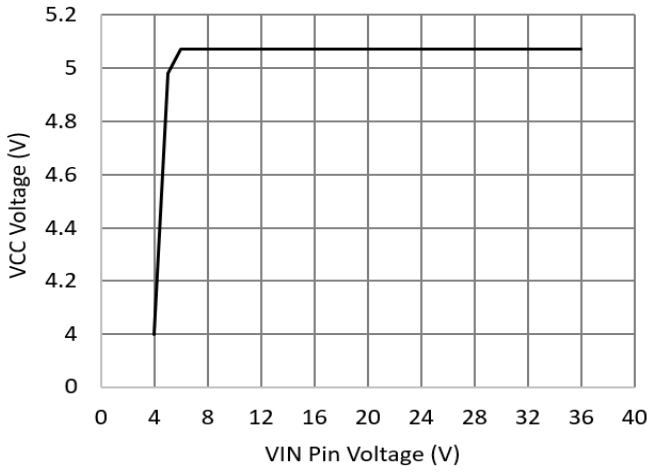
Symbol	Parameter	Condition	Min	Typ	Max	Unit
Overvoltage Protection						
V_{OVP}	OVP Threshold Voltage	V_{OUT} Rising	1.9	2.0	2.1	V
V_{OVP_HYS}	OVP Hysteresis	—	—	200	—	mV
V_{OVP_SH}	Shutdown Under Abnormal Condition	—	3.0	3.2	3.4	V
Current Source						
I_{CH}	Regulation Current per Channel	R_{ISET} = 21.8kΩ I_{CH} = 55mA Analog Dimming PWM Duty Cycle = 100%	52.3	55	57.7	mA
I_{CH_MATCH}	LED Current Matching Between Each String (Note 8)		—	0.5	1	%
I_{CH}	Regulation Current per Channel	Analog Dimming PWM Duty Cycle = 10%	4	5.5	7	mA
I_{CH_MATCH}	LED Current Matching Between Each String (Note 8)		-0.1	1.5	5	%
V_{LED_REG}	Minimum LED Regulation Voltage (Note 7)	I_{CH} = 120mA	—	500	—	mV
I_{LED_LEAK}	CH1 to CH4 Leakage Current	V_{EN} = 0, V_{LED} = 37V	—	0.1	1	μA
V_{LED_S}	LED Short Protection Threshold	—	8.0	8.7	9.5	V
Fault Indicator						
V_{FOL}	FAULTB Output Low Voltage	—	—	10	—	mV
I_{F_LKG}	FAULTB Leakage Current	—	—	—	0.15	μA
Overtemperature Protection						
T_{OTSD}	Thermal Shutdown Temperature (Note 7)	—	—	+160	—	°C
T_{HYS}	Thermal Shutdown Temperature Hysteresis (Note 7)	—	—	+30	—	°C

Notes: 7. Guaranteed by design.

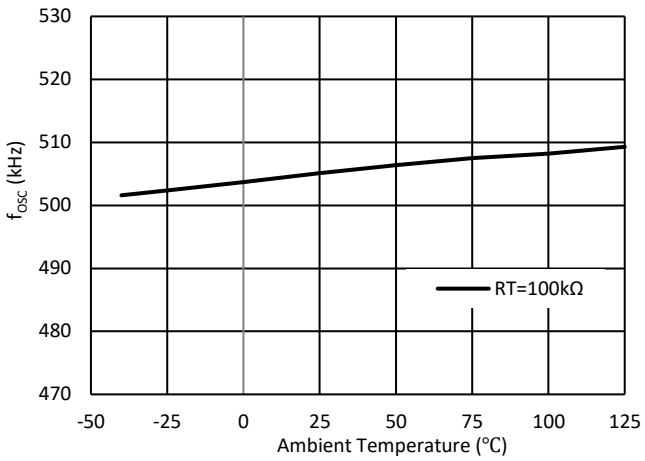
8. $$I_{CH\_MATCH} = \frac{I_{MAX} - I_{MIN}}{2 \times I_{AVG}} \times 100\%$$

Performance Characteristic (@T_A = +25°C, V_{IN} = 12V, V_{EN} = 5V, unless otherwise specified.)

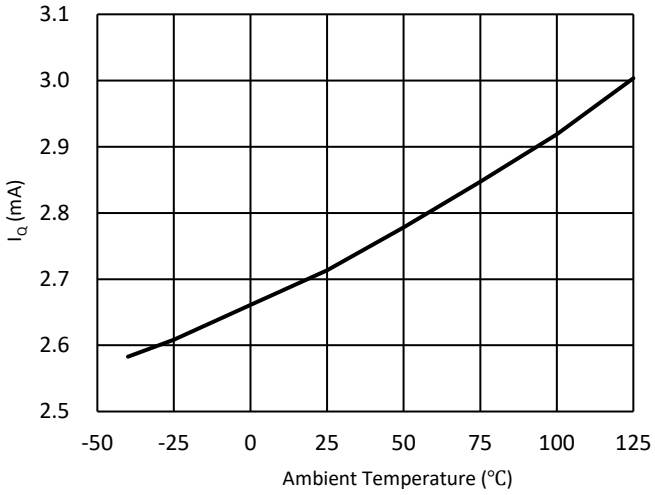
VCC Voltage vs. VIN Pin Voltage



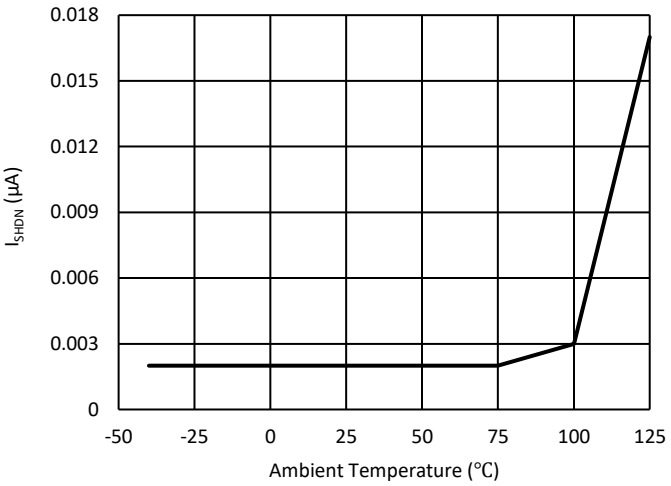
Switch Frequency vs. Ambient Temperature



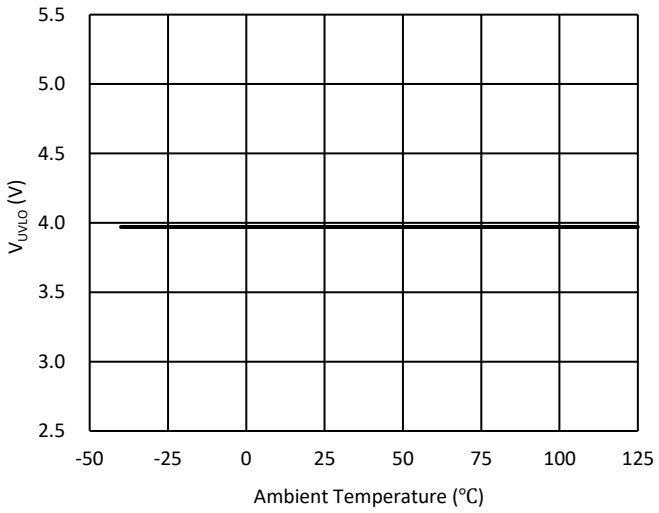
Quiescent Current vs. Ambient Temperature



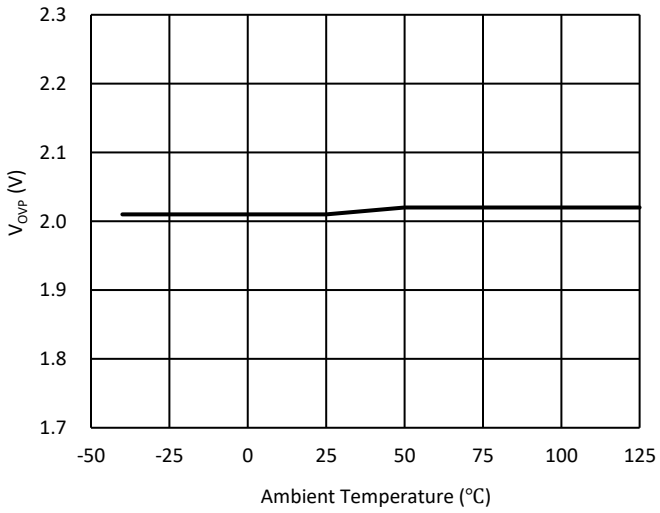
Shutdown Current vs. Ambient Temperature



V_{UVLO} vs. Ambient Temperature

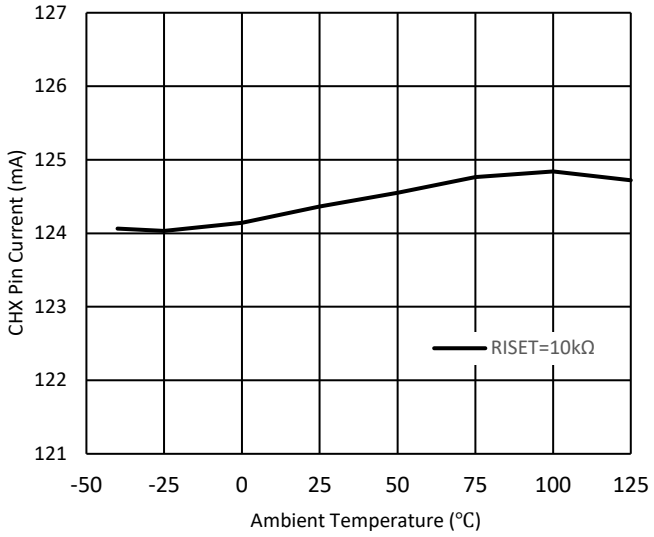


V_{OVP} vs. Ambient Temperature

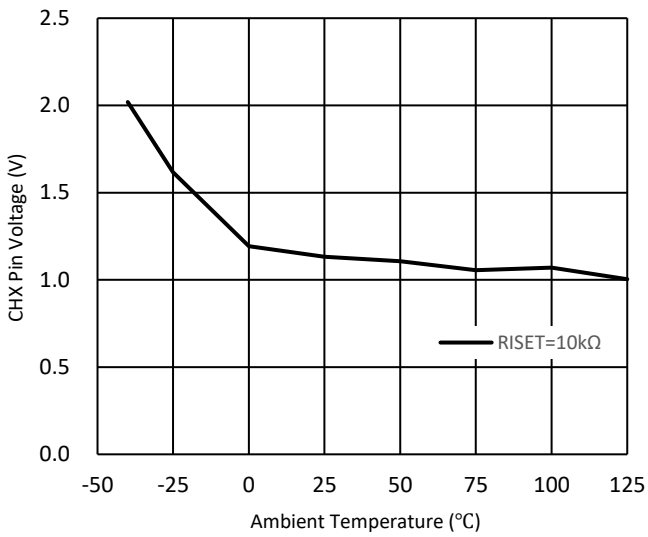


Performance Characteristic (continued) (@T_A = +25°C, V_{IN} = 20V, V_{EN} = 5V, unless otherwise specified.)

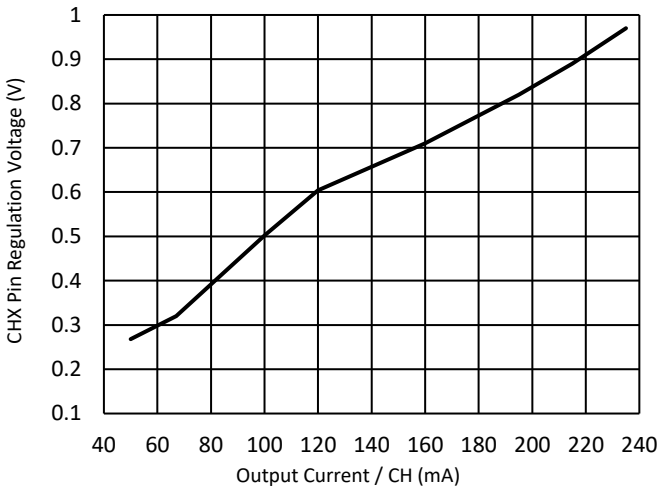
CHX Pin Current vs. Ambient Temperature



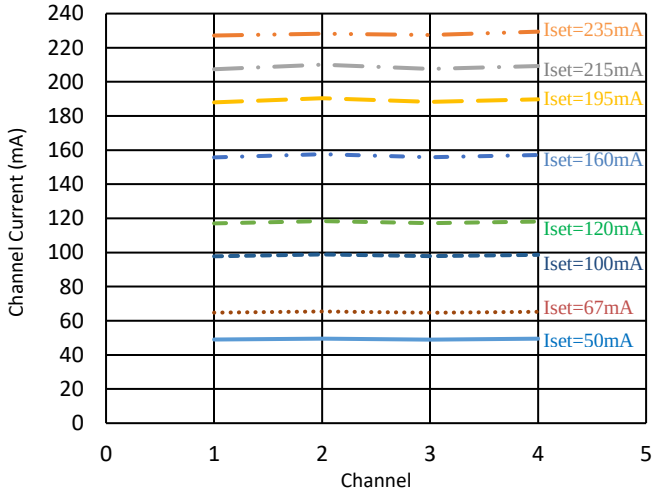
CHX Pin Voltage vs. Ambient Temperature



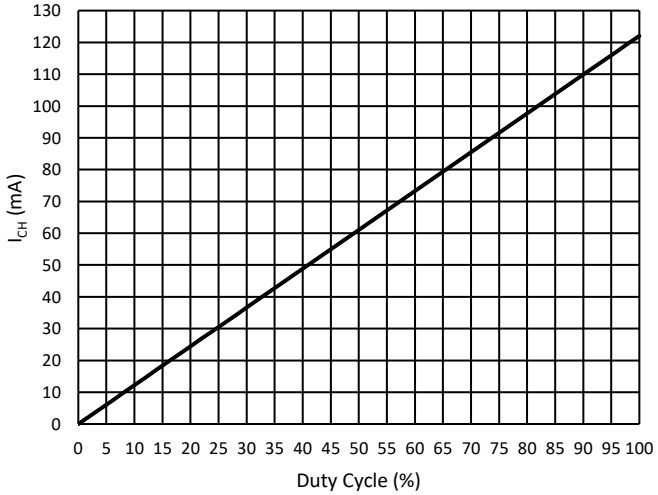
CHX Pin Regulation Voltage vs. Output Current / CH



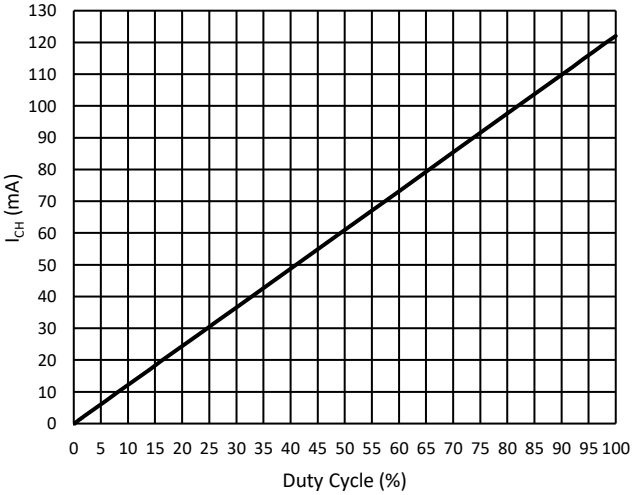
Channel Current vs. Channel



Direct PWM Dimming Curve @ f_{PWMD} = 100Hz
Channel Current vs. Duty Cycle

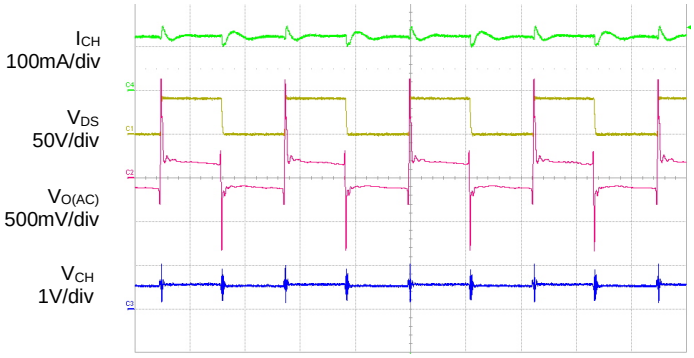


Direct PWM Dimming Curve @ f_{PWMD} = 2kHz
Channel Current vs. Duty Cycle



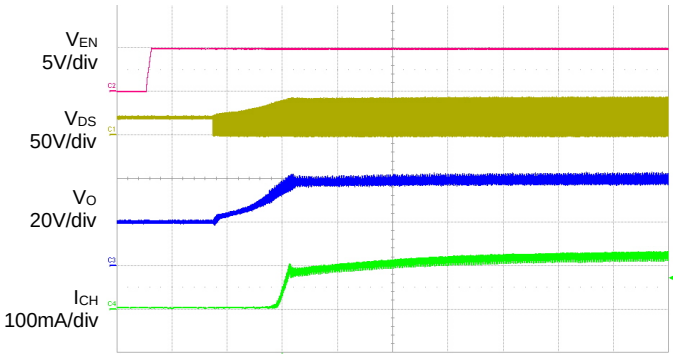
Performance Characteristic (continued) (@T_A = +25°C, V_{IN} = 20V, V_{EN} = 5V, unless otherwise specified.)

Steady State



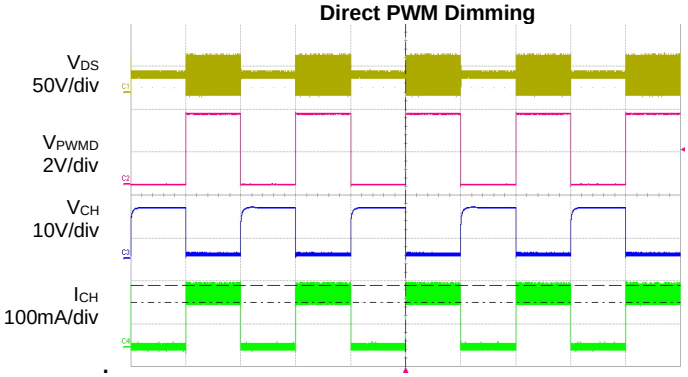
Time: 1µs/div

System Startup



Time: 1ms/div

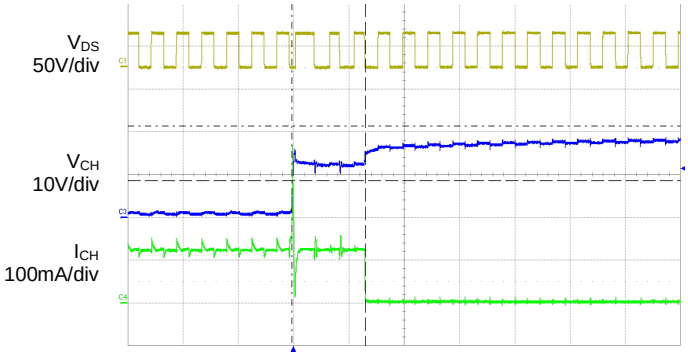
Direct PWM Dimming



Time: 5ms/div

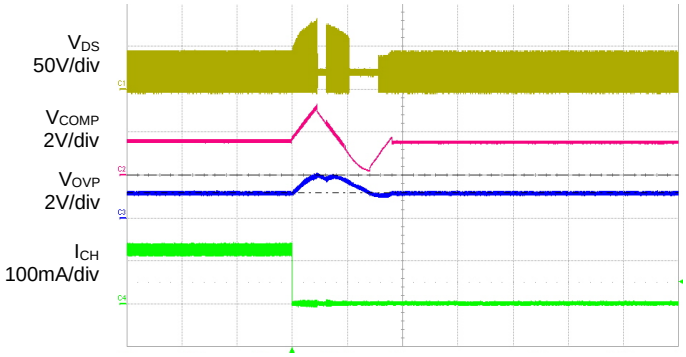
Performance Characteristic (continued) (@T_A = +25°C, V_{IN} = 20V, V_{EN} = 5V, unless otherwise specified.)

LED Short Protection



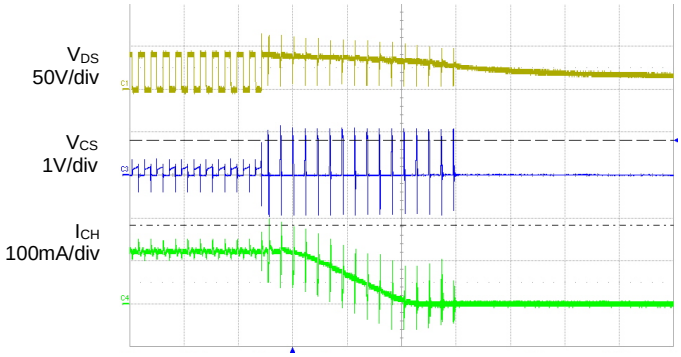
Time: 5µs/div

LED Open Protection



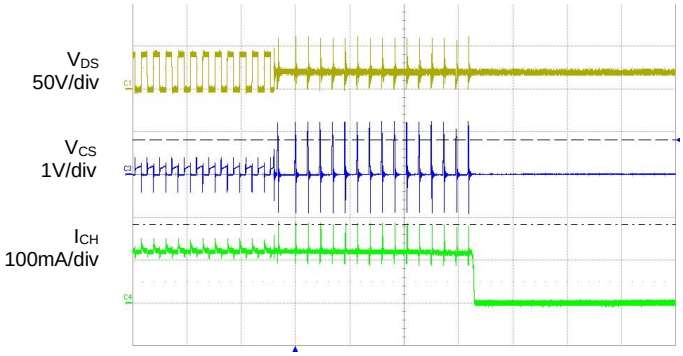
Time: 5ms/div

Schottky Short Protection



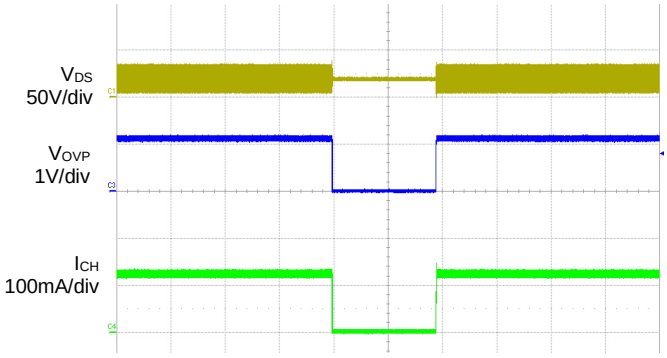
Time: 10µs/div

Inductor Short Protection



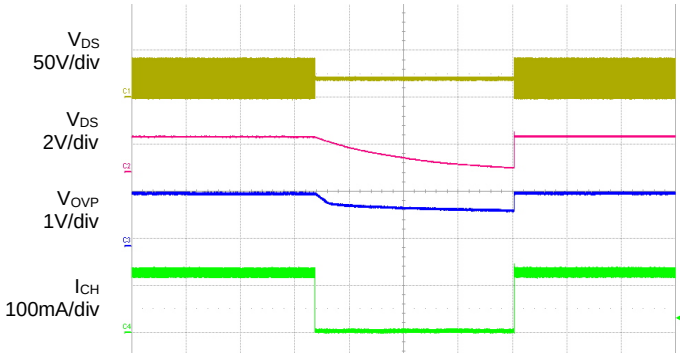
Time: 10µs/div

OVP Short to GND Protection



Time: 200ms/div

Overtemperature Protection



Time: 1s/div

Application Information

Enable

The AL3069Q is enabled when the voltage at EN pin is greater than approximately 2.4V, and disabled when lower than 0.5V.

Frequency Selection

An external resistor R_T, placed between RT pin and GND, can be used to set the operating frequency. The operating frequency ranges from 100kHz to 1MHz. The high-frequency operation optimizes the regulator for the smallest-sized component application, while low-frequency operation can help to reduce switch loss. The approximate operating frequency can be expressed as below:

$$f_{OSC}[MHz] = \frac{52}{R_T[k\Omega]}$$

LED Current Setting

The maximum LED current per channel can be adjusted up to 400mA via ISET pin. When ≥ 400mA current is needed in application, two or more channels can be paralleled to provide larger drive current. A resistor R_{ISET} is connected between ISET pin and GND to set the reference current I_{SET}. The LED current can be expressed as below:

$$I_{LED}[mA] = \frac{1200}{R_{ISET}[k\Omega]}$$

Dimming Control

Direct PWM Dimming Control

Compared to analog dimming, PWM dimming offers superior dimming resolution and reduced LED color shift. The PWM signal is applied to the PWMD pin. The LED current of all enabled channels can be adjusted at the same time and the LED brightness can be adjusted from 1%×I_{CH_MAX} to 100%×I_{CH_MAX}.

During the “high level” period of PWM signal, the LED is turned on, while during the “low level” period of the PWM signal, the LED is turned off and almost no current flows through the LED. Changing the average current through the LED can adjust the LED brightness.

The external PWM signal frequency applied to PWMD pin can be 100Hz or higher and the minimum duty PWM duty can be 1/5000 at 100Hz dimming frequency.

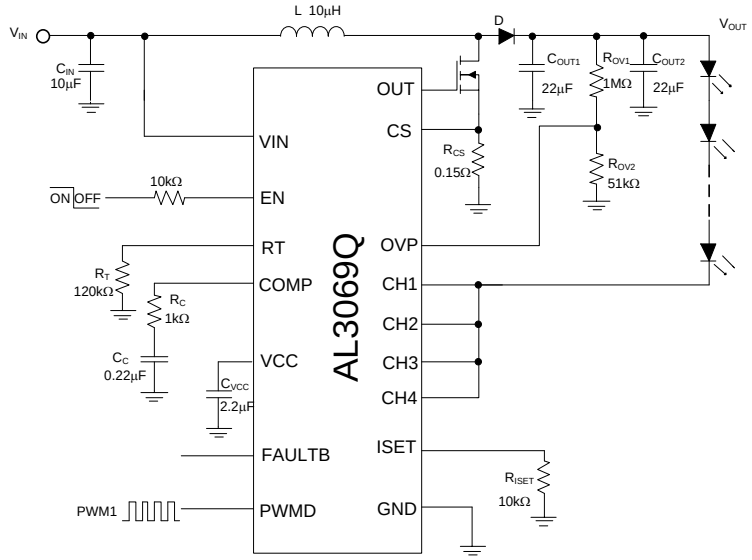
1- to 3-Channel Recommended Connections

For applications using fewer than four LED strings, one option is to leave the unused channels open. However, LED open-circuit protection is triggered at each startup to disable the unused channels.

To avoid LED open-circuit protection at each startup, use the following recommended connections.

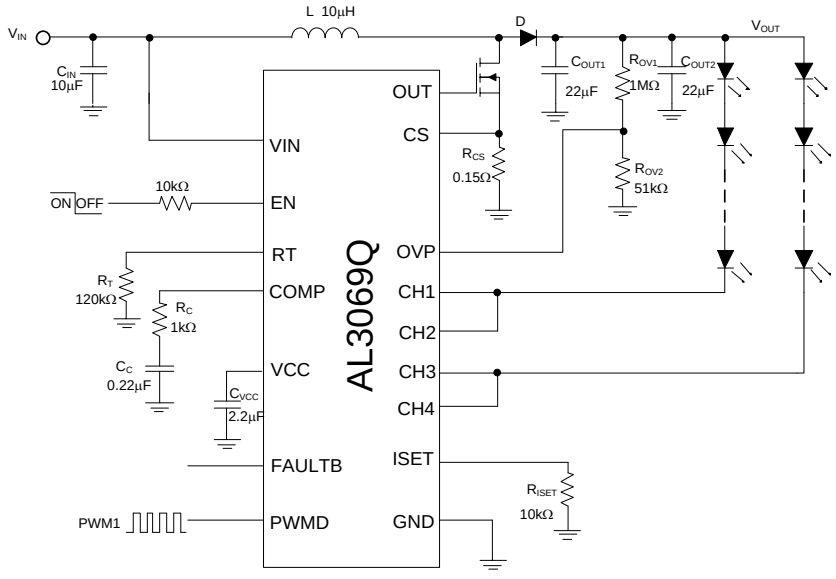
For applications using only one LED string, all four channels must be tied together, and the current setting for each channel is one quarter of the desired output current.

Application Information (continued)



One Channel Recommended Connection

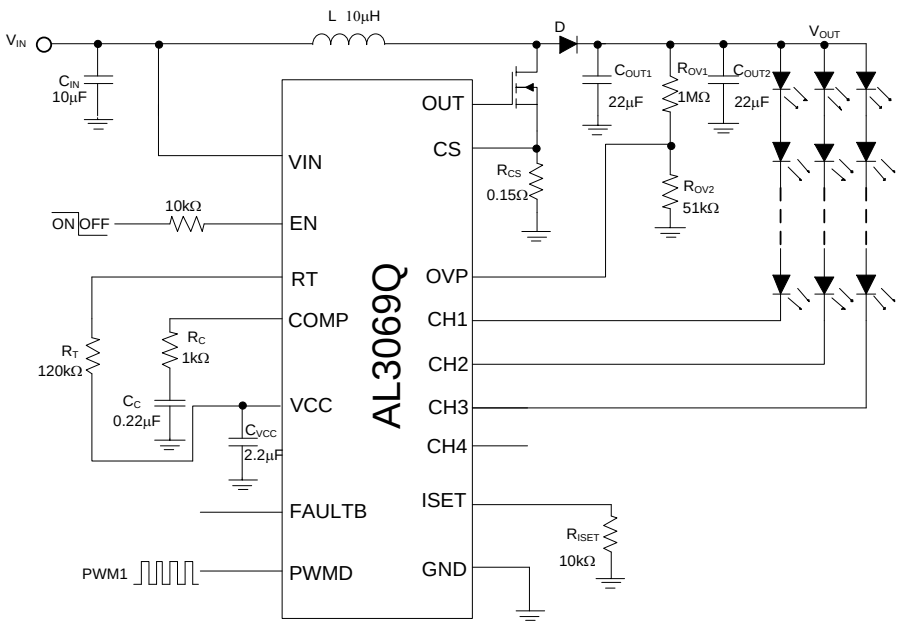
For applications using two LED strings, every two channels must be tied together (CH1 & CH2, CH3 & CH4), and the current setting for each channel is half of the desired output current of each LED string.



Two Channels Recommended Connection

For applications using three LED strings, the AL3069Q provides design flexibility by disabling the fourth channel, CH4 opened. A resistor RT is required to be connected between RT pin and VCC pin instead of connecting between RT pin and GND pin. The three LED strings must be connected to CH1, CH2, and CH3 correspondingly.

Application Information (continued)



Three Channels Recommended Connection

Protection

1) Overvoltage Protection

The AL3069Q integrates an OVP circuit. The OVP pin is connected to the center tap of voltage-divider (R_{OV1} and R_{OV2}) connected between high-voltage output and GND.

If the voltage at OVP pin exceeds 2.0V, which may result from open loop or excessive output voltage, all the functions of the AL3069Q will be disabled with output voltage falling. The OVP hysteresis is 200mV.

2) Overcurrent Protection

The AL3069Q integrates an OCP circuit. The CS pin is connected to the voltage-sensor (R_{CS}) placed between the source of the MOSFET and GND. If the voltage at CS pin exceeds 0.54V, the MOSFET is turned off immediately and will not turn on until the next cycle begins.

3) LED Short-Circuit Protection

The AL3069Q integrates an LED short-circuit protection circuit. If the voltage at any of the CH1 to CH4 pins exceeds a threshold of approximately 8.7V and 7µs delay time during normal operation, the corresponding channel is latched off. Toggle V_{IN} or EN to reset the latch. LED short detecting logic priority is lower than open LED and OVP logic. The LED short detecting is triggered when 0.1V < V_{LED_MIN} under dimming on mode, and disabled when LED open occurs until output voltage resumes to the regulated voltage.

4) LED Open-Circuit Protection

The AL3069Q integrates an LED open-circuit protection circuit. When any LED string is open, V_{OUT} will boost up until the voltage at OVP pin reaches an approximate threshold of 2.0V. The IC will automatically ignore the open string whose corresponding pin voltage is less than 100mV and the remaining string will continue operation. If all the strings are open and the voltage at OVP pin reaches a threshold of 2.0V, the MOSFET drive gate will turn off and the IC will shut down and latch.

5) V_{OUT} Short/Open Schottky Diode Protection

The AL3069Q monitors the OVP pin. If the OVP pin voltage is less than 0.1V, MOSFET drive output will turn off. This protects the converter if the output Schottky diode is open or V_{OUT} is shorted to ground.

Application Information (continued)

6) Undervoltage Lockout

The AL3069Q provides an undervoltage lockout circuit to prevent it from undefined status when it starts up. The UVLO circuit shuts down the device when V_{CC} drops below 3.8V. The UVLO circuit has 200mV hysteresis, which means the device starts up again when V_{CC} rises to 4.0V.

7) Overtemperature Protection

The AL3069Q features overtemperature protection. If the junction temperature exceeds approximately +160°C, the IC will shut down until the junction temperature is less than approximately +140°C. When the IC is released from overtemperature shutdown, it will start a soft-start process.

8) Schottky Diode/Inductor Short-Circuit Protection

The AL3069Q features Schottky diode/inductor short-circuit protection circuit. When CS pin voltage exceeds 0.8V for greater than 16 switching clocks, the IC will latch off. The voltage of CS pin is monitored after a short delay of t_{LEB}.

9) Shutdown Under Abnormal Condition

The AL3069Q features shutdown under abnormal condition protection circuit. When the OVP pin voltage exceeds 3.2V, the IC will latch off. Toggle EN pin to restart the IC. This feature can be used to shut down the IC under any defined abnormal condition.

10) Fault Indicator (FAULTB)

The AL3069Q includes an active low, fault indicator (FAULTB). The FAULTB pin goes low when one of the following conditions occurs:

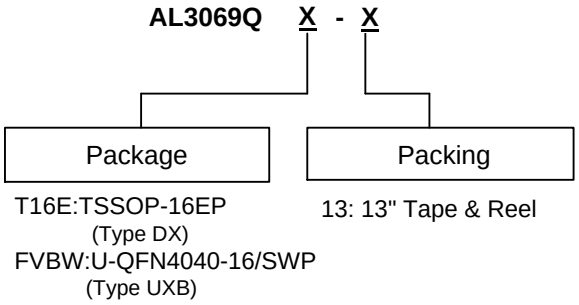
1) Overvoltage across the LED string
2) Undervoltage across the LED string
3) Overvoltage across the CHx
4) Short circuit across current-sense resistor
5) Short circuit across Schottky diode or inductor
6) Overtemperature condition

Fault	Detection	Action
Overvoltage across the LED string	V_{OVP} > 2V	When any channel is open, OVP pin exceeds 2V, OVP is triggered and then ignore the opened channel, the other channels are still working normally. If all channels are open, the system will latch off. Whatever, the FAULTB pin will go low.
Overvoltage across the OVP pin	V_{OVP} > 3.2V	When OVP pin exceeds 3.2V, the system will latch off and the FAULTB pin will go low.
Undervoltage across the LED string	V_{OVP} < 0.1V	When OVP pin drops below 0.1V, the FAULTB pin will go low.
Overvoltage across the CHx	V_{CHx} > 8.7V last for 7µs	When the voltage at any of the CH1 to CH4 pins exceeds 8.7V and last for 7µs, the corresponding channel is latched off and the FAULTB pin goes low.
Short circuit across current-sense resistor	V_{CS} > 0.54V	When the CS pin voltage exceeds 0.54V, OCP is triggered and the FAULTB pin goes low.
Short circuit across Schottky diode or inductor	V_{CS} > 0.8V switching cycle > 16	When CS pin voltage exceeds 0.8V for greater than 16 switching clocks, the Schottky diode or Inductor short is detected, the IC will latch off and the FAULTB pin goes low.
Overtemperature condition	T_J > +160°C	When the junction temperature exceeds approximately +160°C, the AL3069Q is forced to shut down and FAULTB goes low. A startup sequence is initiated and FAULT resumes high when the junction temperature is less than approximately +140°C

Design Tools (https://www.diodes.com/design/tools/)

- Evaluation Board User Guides
- Spice Models (PSPICE Digital Simulation)
- Design Calculators

Ordering Information (Note 9)



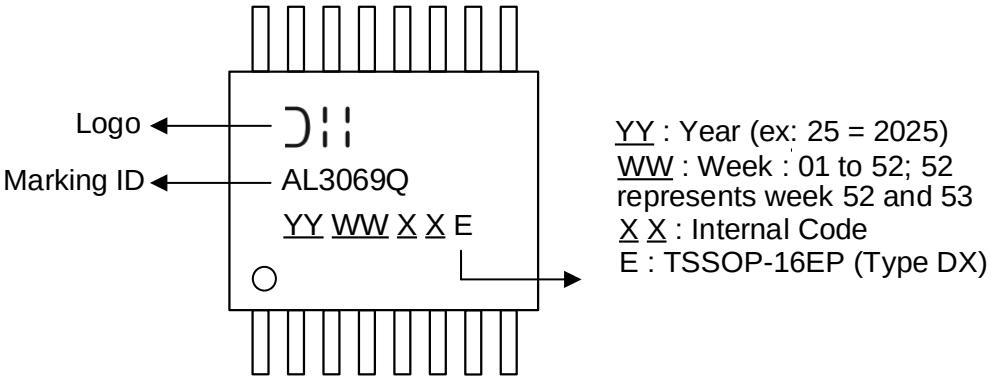
Orderable Part Number	Package Code	Package	Packing	
			Qty.	Carrier
AL3069QT16E-13	T16E	TSSOP-16EP (Type DX)	2,500	13” Tape and Reel
AL3069QFVBW-13	FVBW	U-QFN4040-16/SWP (Type UXB)	3,000	13” Tape and Reel

Note: 9. For packaging details, go to our website at https://www.diodes.com/design/support/packaging/diodes-packaging/.

Marking Information

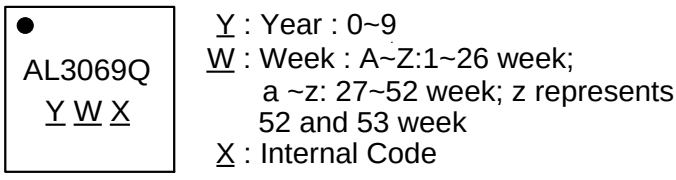
Package Type: TSSOP-16EP (Type DX)

(Top View)



Package Type: U-QFN4040-16/SWP (Type UXB)

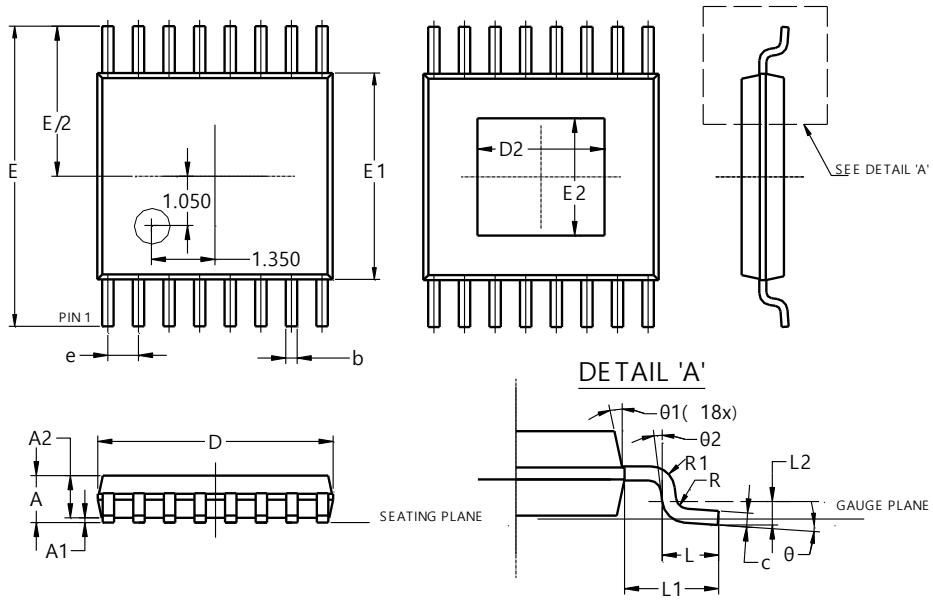
(Top View)



Package Outline Dimensions

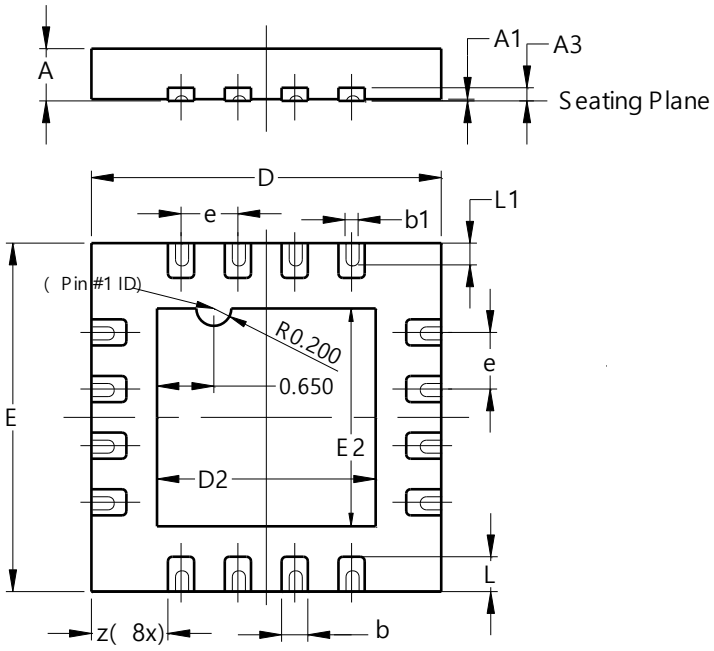
Please see http://www.diodes.com/package-outlines.html for the latest version.

TSSOP-16EP (Type DX)



TSSOP-16EP (Type DX)			
Dim	**Min**	**Max**	**Typ**
A	--	1.08	--
A1	0.05	0.15	--
A2	0.80	0.93	--
b	0.19	0.30	--
c	0.09	0.20	--
D	4.90	5.10	--
D2	2.70	--	--
E	6.40 BSC		
E1	4.30	4.50	--
E2	2.50	--	--
e	0.65 BSC		
L	0.45	0.75	--
L1	1.00 REF		
L2	0.25 BSC		
R	0.09	--	--
R1	0.09	--	--
θ	0°	8°	--
θ1	5°	15°	--
θ2	0°	--	--
All Dimensions in mm			

U-QFN4040-16/SWP (Type UXB)

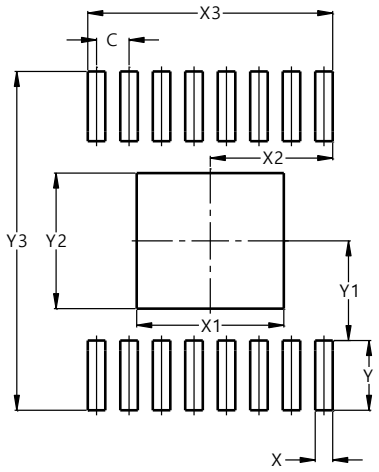


U-QFN4040-16/SWP (Type UXB)			
Dim	**Min**	**Max**	**Typ**
A	0.57	0.63	0.60
A1	0.00	0.05	0.02
A3	--	--	0.15
b	0.25	0.35	0.30
b1	--	--	0.15
D	3.95	4.05	4.00
D2	2.40	2.60	2.50
E	3.95	4.05	4.00
E2	2.40	2.60	2.50
e	--	--	0.65
L	0.35	0.45	0.40
L1	--	--	0.25
z	0.850	0.900	0.875
All Dimensions in mm			

Suggested Pad Layout

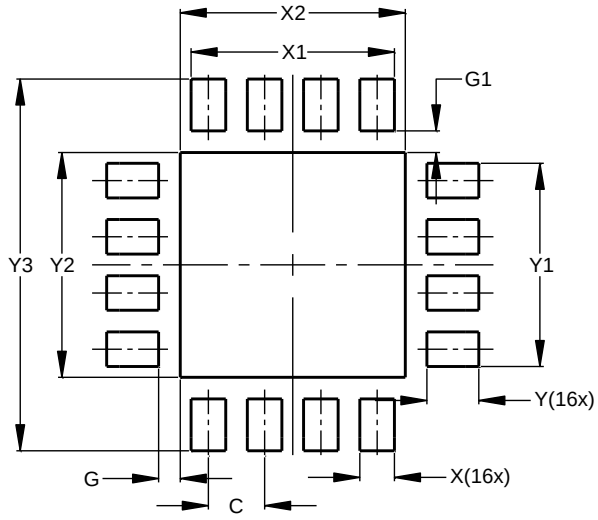
Please see http://www.diodes.com/package-outlines.html for the latest version.

TSSOP-16EP (Type DX)



Dimensions	Value (in mm)
C	0.65
X	0.35
X1	2.94
X2	2.45
X3	4.90
Y	1.40
Y1	2.00
Y2	2.72
Y3	6.80

U-QFN4040-16/SWP (Type UXB)



Dimensions	Value (in mm)
C	0.65
G	0.25
G1	0.25
X	0.40
X1	2.35
X2	2.60
Y	0.60
Y1	2.35
Y2	2.60
Y3	4.30

Mechanical Data

TSSOP-16EP (Type DX)

- Moisture Sensitivity: Level 1 per J-STD-020
- Terminals: Finish – Matte Tin Plated Leads, Solderable per M2003 JESD22-B102 e3
- Weight: 0.055 grams (Approximate)

U-QFN4040-16/SWP (Type UXB)

- Moisture Sensitivity: Level 1 per J-STD-020
- Terminals: Finish – Matte Tin Plated Leads, Solderable per MIL-STD-202, Method 208 e3
- Weight: 0.03 grams (Approximate)

IMPORTANT NOTICE

1. DIODES INCORPORATED (Diodes) AND ITS SUBSIDIARIES MAKE NO WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, WITH REGARDS TO ANY INFORMATION CONTAINED IN THIS DOCUMENT, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION).

2. The Information contained herein is for informational purpose only and is provided only to illustrate the operation of Diodes' products described herein and application examples. Diodes does not assume any liability arising out of the application or use of this document or any product described herein. This document is intended for skilled and technically trained engineering customers and users who design with Diodes' products. Diodes' products may be used to facilitate safety-related applications; however, in all instances customers and users are responsible for (a) selecting the appropriate Diodes products for their applications, (b) evaluating the suitability of Diodes' products for their intended applications, (c) ensuring their applications, which incorporate Diodes' products, comply the applicable legal and regulatory requirements as well as safety and functional-safety related standards, and (d) ensuring they design with appropriate safeguards (including testing, validation, quality control techniques, redundancy, malfunction prevention, and appropriate treatment for aging degradation) to minimize the risks associated with their applications.

3. Diodes assumes no liability for any application-related information, support, assistance or feedback that may be provided by Diodes from time to time. Any customer or user of this document or products described herein will assume all risks and liabilities associated with such use, and will hold Diodes and all companies whose products are represented herein or on Diodes' websites, harmless against all damages and liabilities.

4. Products described herein may be covered by one or more United States, international or foreign patents and pending patent applications. Product names and markings noted herein may also be covered by one or more United States, international or foreign trademarks and trademark applications. Diodes does not convey any license under any of its intellectual property rights or the rights of any third parties (including third parties whose products and services may be described in this document or on Diodes' website) under this document.

5. Diodes' products are provided subject to Diodes' Standard Terms and Conditions of Sale (https://www.diodes.com/about/company/terms-and-conditions/terms-and-conditions-of-sales/) or other applicable terms. This document does not alter or expand the applicable warranties provided by Diodes. Diodes does not warrant or accept any liability whatsoever in respect of any products purchased through unauthorized sales channel.

6. Diodes' products and technology may not be used for or incorporated into any products or systems whose manufacture, use or sale is prohibited under any applicable laws and regulations. Should customers or users use Diodes' products in contravention of any applicable laws or regulations, or for any unintended or unauthorized application, customers and users will (a) be solely responsible for any damages, losses or penalties arising in connection therewith or as a result thereof, and (b) indemnify and hold Diodes and its representatives and agents harmless against any and all claims, damages, expenses, and attorney fees arising out of, directly or indirectly, any claim relating to any noncompliance with the applicable laws and regulations, as well as any unintended or unauthorized application.

7. While efforts have been made to ensure the information contained in this document is accurate, complete and current, it may contain technical inaccuracies, omissions and typographical errors. Diodes does not warrant that information contained in this document is error-free and Diodes is under no obligation to update or otherwise correct this information. Notwithstanding the foregoing, Diodes reserves the right to make modifications, enhancements, improvements, corrections or other changes without further notice to this document and any product described herein. This document is written in English but may be translated into multiple languages for reference. Only the English version of this document is the final and determinative format released by Diodes.

8. Any unauthorized copying, modification, distribution, transmission, display or other use of this document (or any portion hereof) is prohibited. Diodes assumes no responsibility for any losses incurred by the customers or users or any third parties arising from any such unauthorized use.

9. This Notice may be periodically updated with the most recent version available at https://www.diodes.com/about/company/terms-and-conditions/important-notice

www.diodes.com