AL3158

HIGH EFFICIENCY 1x/2x CHARGE PUMP FOR WHITE LED APPLICATIONS

NEW PRODUCT

Description

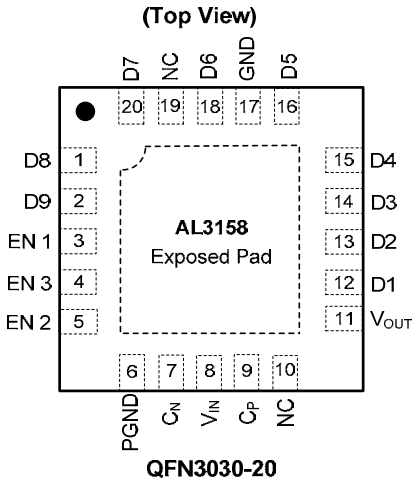
The AL3158 is a low noise, constant frequency charge pump DC/DC converter that uses a Dual mode load switch (1x), and (2x) conversion for white LED applications. The AL3158 is capable of driving three groups of three LED channels at 20mA from a 2.7V to 5.5V input. The current sinks may be operated using three simple PWM dimming inputs individually or in parallel for driving higher-current LEDs. Low external part counts (one 1µF flying capacitor and two 2.2µF capacitors at V_{IN} and V_{OUT}) make this part ideally suited for small, battery-powered applications.

AL3158 PWM dimming inputs are used to enable, disable device and dimming LED current with a fixed default current settings at 20mA or other factory programming options available.

Each output of the AL3158 is equipped with built-in protection for V_{OUT} short circuit and auto-disable for LED short conditions. Built-in soft-start circuitry prevents excessive inrush current during start-up and mode switching. A low-current shutdown feature disconnects the load from V_{IN} to reduce quiescent current less than 1µA.

The AL3158 is available in a lead-free, space-saving, thermally enhanced 20-pin 3 x 3mm QFN package.

Pin Assignments



QFN3030-20

Features

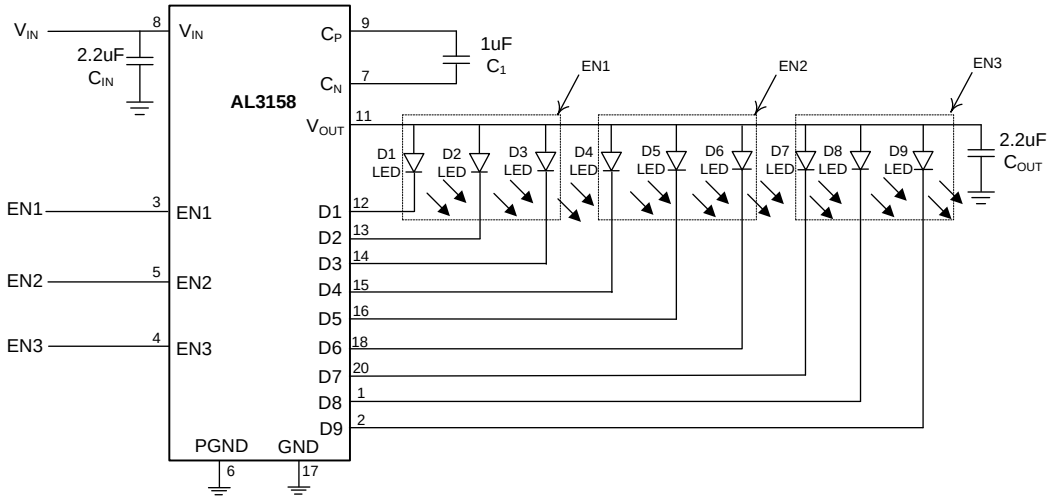
- V_{IN} Range: 2.7V to 5.5V
- Up to 93% Max Power Efficiency
- 1% Current Matching Accuracy Between Channels
- Three simple PWM dimming for RGB or WLED
- Low transition threshold voltage typical 150 mV
- Dual-Mode 1x and 2x Charge Pump
- Drives up to 3 + 3 + 3 Channels of LEDs
- 1.2 MHz Constant Switching Frequency
- V_{OUT} short circuit and Thermal Protections
- Soft Start for reducing inrush current
- Under Voltage Lockout Protection
- I_Q <1µA in Shutdown
- Thermally-Enhanced QFN3030-20 Package: Available in “Green” Molding Compound (No Br, Sb)
- Lead Free Finish/ RoHS Compliant (Note 1)

Applications

- Mobile Phone White LED Backlighting and Indicators
- PDA White LED Backlighting
- Battery-operated Phone Main and Sub Screen White LED Backlighting

Notes: 1. EU Directive 2002/95/EC (RoHS). All applicable RoHS exemptions applied. Please visit our website at http://www.diodes.com/products/lead_free.html

Typical Application Circuit



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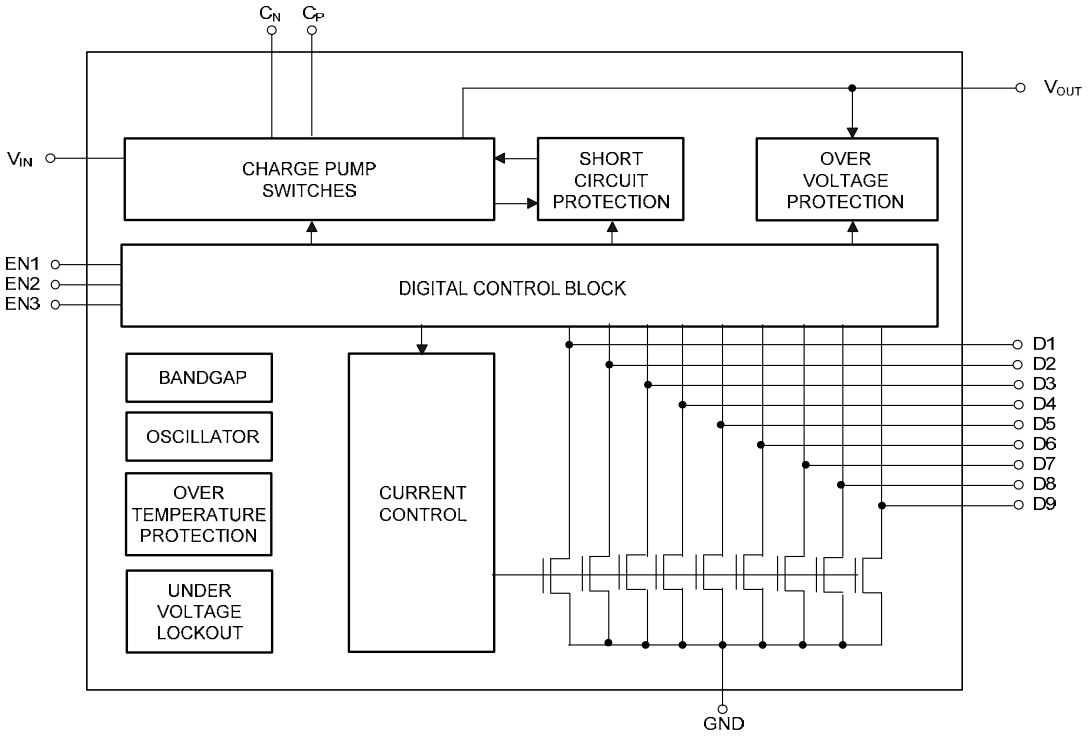
Pin Descriptions

Pin Name	Pin Number	Description
D8	1	Current sink input #8. Connected to VOUT when un-used.
D9	2	Current sink input #9. Connected to VOUT when un-used.
EN1	3	Enable Pin 1
EN3	4	Enable Pin 3
EN2	5	Enable Pin 2
PGND	6	Charge Pump Switch Ground
CN	7	Negative Terminal of Flying Capacitor
VIN	8	Input Power Supply. Requires 2.2µF capacitor between this pin and ground.
CP	9	Positive Terminal of Flying Capacitor
NC	10,19	No-Connect
V_{OUT}	11	Charge pump output to drive load circuit. Requires 2.2µF capacitor between this pin and ground.
D1	12	Current sink input #1. Connected to V_{OUT} when un-used.
D2	13	Current sink input #2. Connected to V_{OUT} when un-used.
D3	14	Current sink input #3. Connected to V_{OUT} when un-used.
D4	15	Current sink input #4. Connected to V_{OUT} when un-used.
D5	16	Current sink input #5. Connected to V_{OUT} when un-used.
D6	18	Current sink input #6. Connected to V_{OUT} when un-used.
GND	17	Ground
D7	20	Current sink input #7. Connected to V_{OUT} when un-used.
GND	EP PAD	Exposed Pad (bottom). Connected to GND directly underneath the package.

Functional Block Diagram



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Absolute Maximum Ratings (Note 2)

Symbol	Description	Rating	Unit
ESD HBM	Human Body Model ESD Protection	2	KV
ESD MM	Machine Model ESD Protection	200	V
V_{IN}	Input Voltage	-0.3 to 6	V
$V_{EN1,2,3}$	EN1, EN2, EN3 to GND Voltage	-0.3 to V_{IN} +0.3	V
I_{OUT}	Maximum DC Output Current	270	mA
T_J	Operating Junction Temperature Range	150	°C
T_{LEAD}	Maximum Soldering Temperature (at leads, 10 sec)	300	°C

Notes: 2. Exceeding Absolute Maximum Ratings will cause permanent damage to the device.

Recommended Operating Conditions

Symbol	Parameter	Min	Max	Unit
V_{IN}	Input Voltage	2.7	5.5	V
T_A	Operating Ambient Temperature	-40	85	°C

Electrical Characteristics (T_A = 25°C, Vin = 3.6V, C_{IN} = C_{OUT} = 2.2µF, C_1 = 1µF Unless otherwise noted)

Symbol	Parameter	Test Conditions	Min	Typ.	Max	Unit
I_Q	Quiescent Current	1x Mode, 3.0≤V_{IN}≤5.5, Active, No Load Current		0.3	0.6	mA
		2x Mode, 3.0≤V_{IN}≤5.5, Active, No Load Current		2	5	
I_{SHDN}	Shutdown Current	EN1, EN2, EN3 = 0			1	µA
I_{DX}	I_{SINK} Current Accuracy **(Note 3)**		19	20	21	mA
$I_{D-Match}$	Current Matching Between Any Two Current Sink Inputs **(Note 4)**	V_F: D1:D9 = 3.6V		1	2	%
R_{out}	Open Loop V_{OUT} Resistance	1x mode		0.5		Ω
		2 x mode		4.5		
V_{TH}	1x to 2x Transition Threshold at Any I_{SINK} Pin	I_{DX} = 20mA		150		mV
V_{HS}	Mode Transition Hysteresis			250		mV
T_{SS}	Soft-Start Time			100		µs
Fsw	Switching Frequency			1.2		MHz
$V_{EN1, 2,3 (L)}$	EN1,2,3 Threshold Low	V_{IN} = 2.7V			0.4	V
$V_{EN1,2,3(H)}$	EN1,2,3 Threshold High	V_{IN} = 5.5V	1.4			V
$T_{EN1,2,3}$	EN1,2,3 Off Timeout				20	ms
UVLO	V_{IN} Under-Voltage Lockout		1.8	2	2.2	V
$I_{EN1,2,3}$	EN1,2,3 Input Leakage		-1		1	µA
T_{SHDN}	Thermal shutdown Protection			160		°C
T_{HYS}	Thermal shutdown hysteresis			10		°C
θ_{JA}	Thermal Resistance Junction-to-Ambient	QFN3030-20 **(Note 5)**		52		°C/W

Notes: 3. Determined by the average current levels of all active channels.
4. Determined by the maximum sink current (MAX), the minimum sink current (MIN), and the average sink current (AVG). Two matching numbers are calculated as (MAX-AVG)/AVG and (AVG-MIN)/AVG. The largest number of the two (worst case) is considered as the matching data.
5. Device mounted on FR-4 substrate, 2"*2", 2oz copper, double-sided PC board, with minimum recommended pad on top layer and 4 vias to bottom layer.

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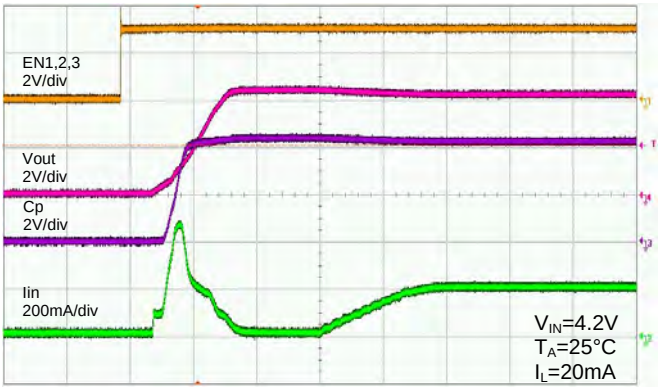
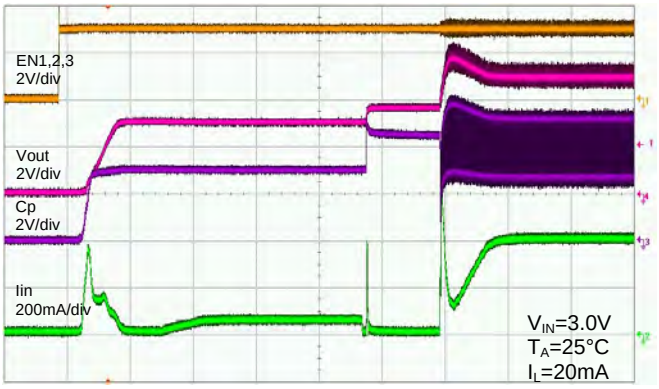
Typical Performance Characteristics

Turn-On to 1x Mode



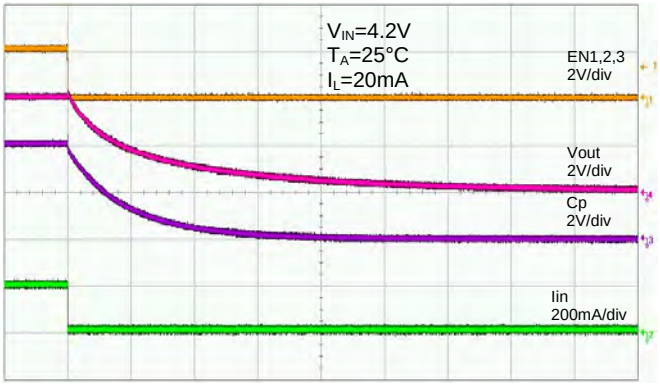
50us/div

Turn-On to 2x Mode



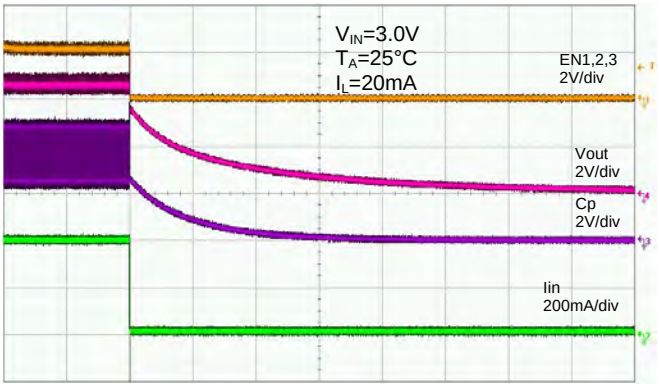
100us/div

Turn-Off from 1x Mode



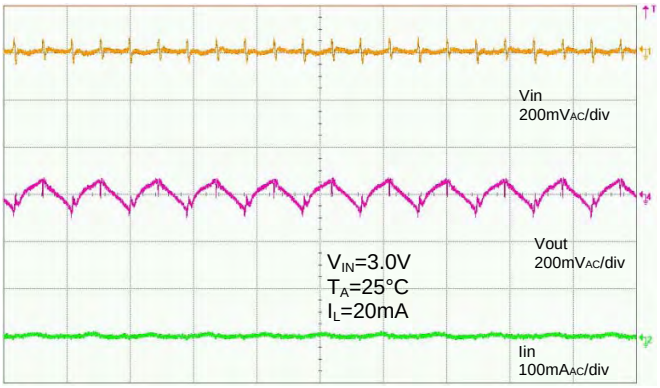
200ms/div

Turn-Off from 2x Mode



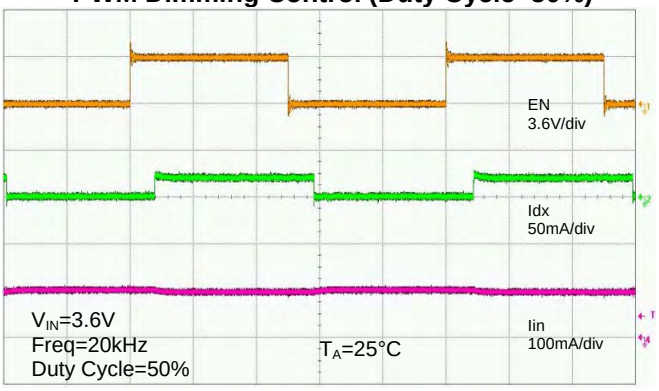
200ms/div

Load Characteristics in 2x Mode



1us/div

PWM Dimming Control (Duty Cycle=50%)



10us/div

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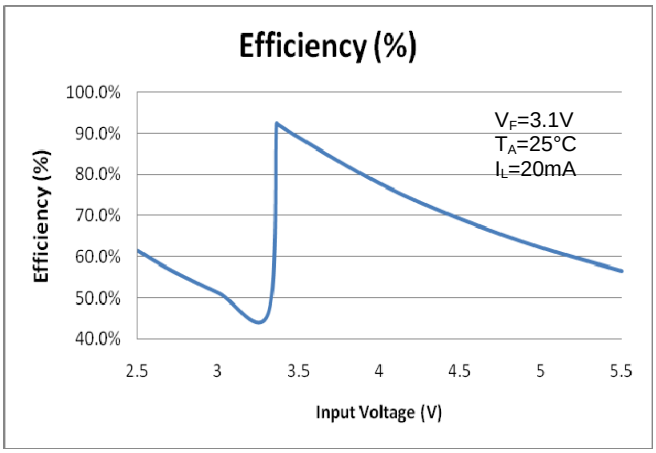
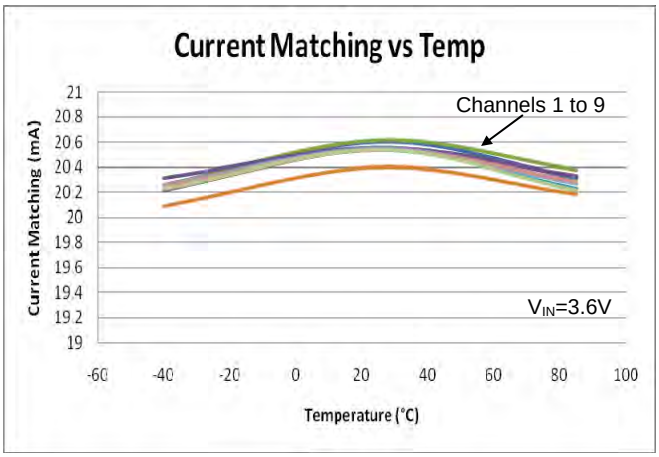
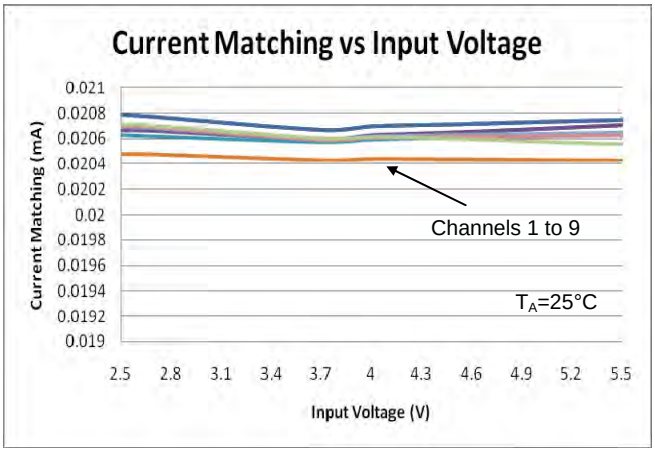
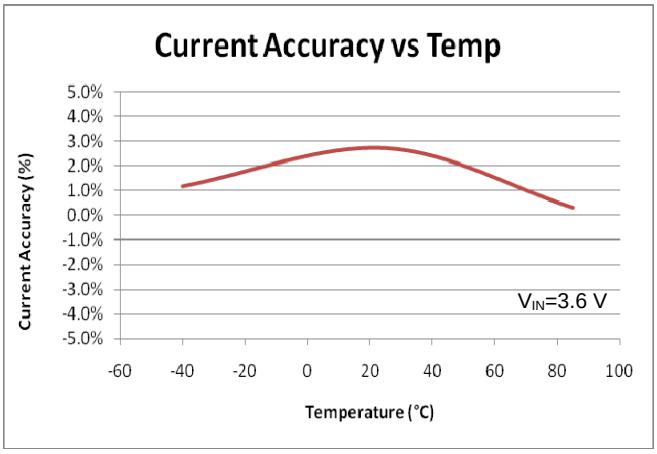
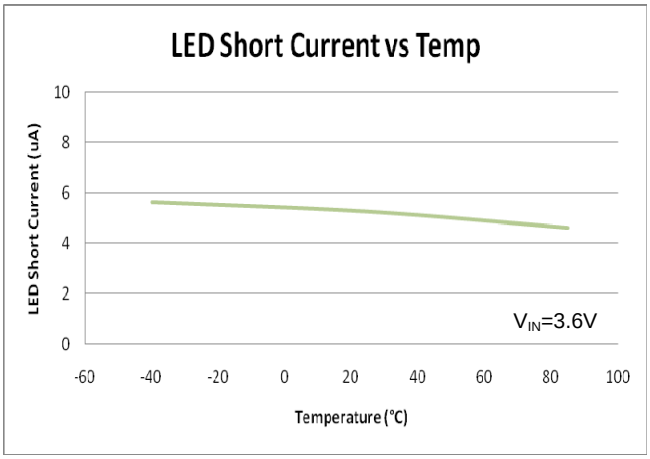
Typical Performance Characteristics (Continued)

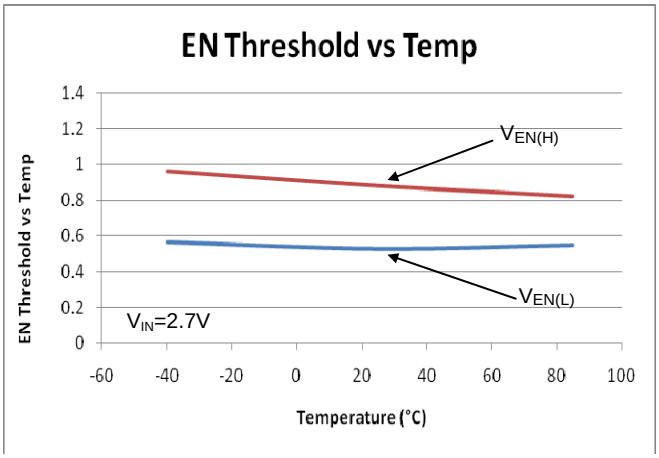












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Functional Description

The AL3158 is a dual-mode high efficiency charge pump (1x and 2x) device, driving three groups of three LED channels at 30mA maximum each, intended for white LED backlight applications. An internal comparator circuit compares the voltage at each constant current sink input against a reference voltage. To ensure maximum power efficiency, the most appropriate switching mode (1x and 2x) is automatically selected.

The AL3158 requires only three external components: one 1µF ceramic flying capacitor (C_1) for the charge pump, one 2.2µF ceramic input capacitor (C_{IN}), and one 2.2µF ceramic charge pump output capacitor (C_{OUT}).

The each output channel of the AL3158 can drive three groups of three individual LED channels with a maximum current of fixed manufacture setting (20mA or 30mA) per channel. These can be paralleled to give a total output current of 270mA.

EN<3:1>	LED ON/OFF CONTROL
XX0	LED1~LED3 OFF
XX1	LED1~LED3 ON
X0X	LED4~LED6 OFF
X1x	LED4~LED6 ON
0XX	LED7~LED9 OFF
1xX	LED7~LED9 ON

Disabled Current Sinks
Unused current channels must be disabled by connecting the sinks to VOUT with only a small sense current flowing through the disabled channel.

Soft-Start
Soft-start is incorporated to prevent excessive inrush current during power-up, mode switching, and transitioning out of stand-by mode.

Short-Circuit Protection
Short-circuit protection function is incorporated to prevent excessive load current when either flying cap terminals or output pin electrically tied to a very lower voltage or ground.

Over-Voltage Protection
Over-Voltage Protection function is incorporated to limit the output voltage under a safe value to avoid on-chip device breakdown.

Under-Voltage Lockout
Under-Voltage lockout feature disables the device when the input voltage drops below UVLO threshold.

Thermal Auto Shutdown
When the die temperature exceeds the thermal limit, the device will be disabled and enter stand-by mode. The operation resumes whenever the die cools off sufficiently.

PWM Dimming Control
The AL3158 provides simple PWM dimming control through ENx pins, and the current is adjusted by the duty cycle of the signal applied on ENx pin. The recommended PWM frequency is from 200Hz to 50KHz depending on applications.

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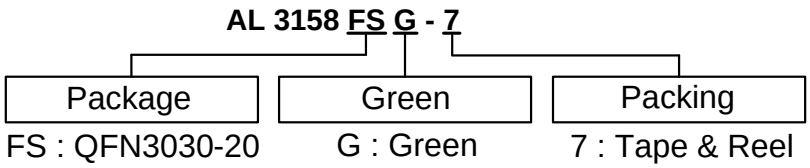
Ordering Information



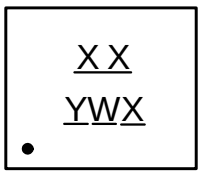
Device	Package Code	Packaging (Note 7 and 8)	7" Tape and Reel	
			Quantity	Part Number Suffix
AL3158FSG-7	FS	QFN3030-20	3000/Tape & Reel	-7

Notes: 7. Pad layout as shown on Diodes Inc. suggested pad layout document AP02001, which can be found on our website at http://www.diodes.com/datasheets/ap02001.pdf
8. EU Directive 2002/95/EC (RoHS). All applicable RoHS exemptions applied. Please visit our website at http://www.diodes.com/products/lead_free.html

Marking Information

(1) QFN3030-20

(Top View)



XX : B8 : AL3158
Y : Year : 0~9
W : Week : A~Z : 1~26 week;
a~z : 27~52 week; z represents
52 and 53 week
X : A~Z : Green

Part Number	Package	Identification Code
AL3158FSG	QFN3030-20	B8

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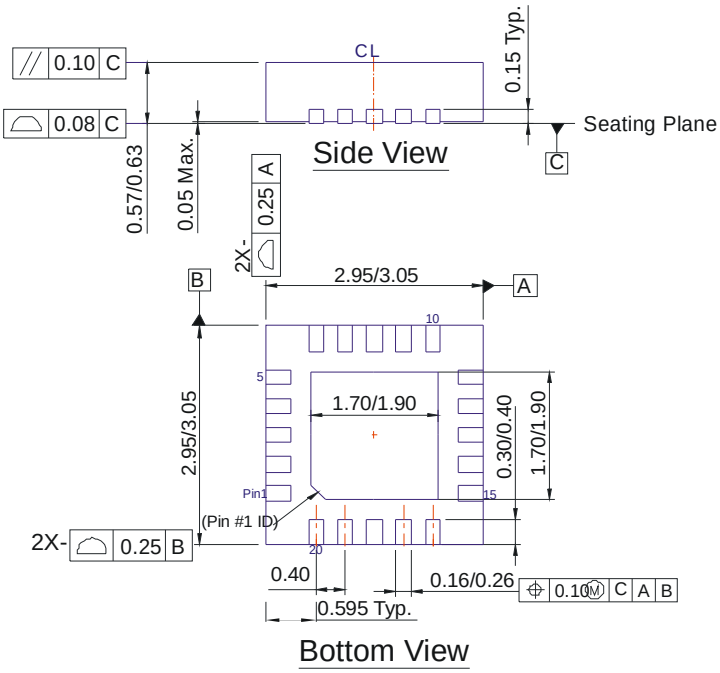
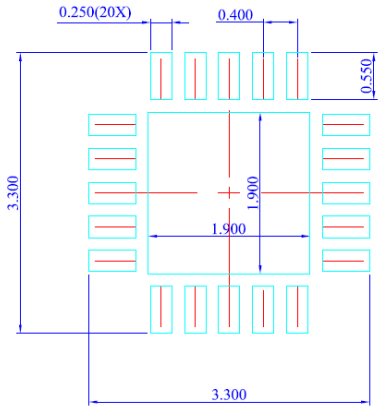
Package Outline Dimensions (All Dimensions in mm)

Package type: QFN3030-20





Pad Layout Top View

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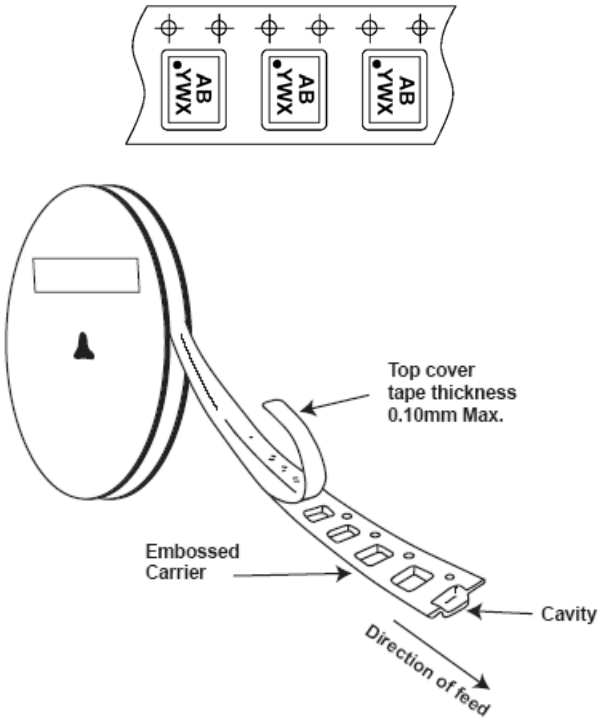
Taping Orientation (Note 9)



Notes: 9. The taping orientation of the other package type can be found on our website at http://www.diodes.com/datasheets/ap02007.pdf

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