

Description

The DIODES™ 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.

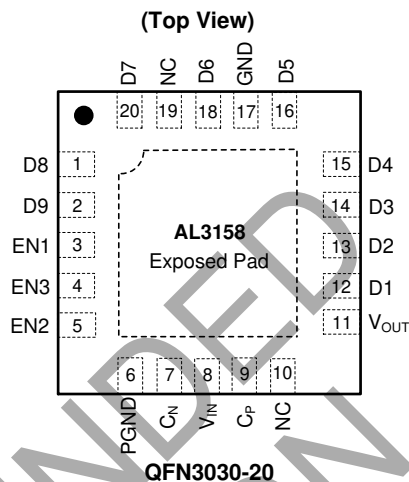
The AL3158 is available in a lead-free, space-saving, thermally enhanced 20-pin 3 x 3mm QFN3030-20 package.

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 150mV
- Dual-Mode 1x and 2x Charge Pump
- Drives up to 3 + 3 + 3 Channels of LEDs
- 1.2MHz Constant Switching Frequency
- V_{OUT} Short Circuit and Thermal Protections
- Soft Start for Reducing Inrush Current
- Under Voltage Lockout Protection
- $I_o < 1\mu A$ in Shutdown
- Thermally-Enhanced QFN3030-20 Package: Available in "Green" Molding Compound (No Br, Sb)
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**
- **For automotive applications requiring specific change control (i.e. parts qualified to AEC-Q100/101/104/200, PPAP capable, and manufactured in IATF 16949 certified facilities), please [contact us](#) or your local Diodes representative.**
<https://www.diodes.com/quality/product-definitions/>

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.

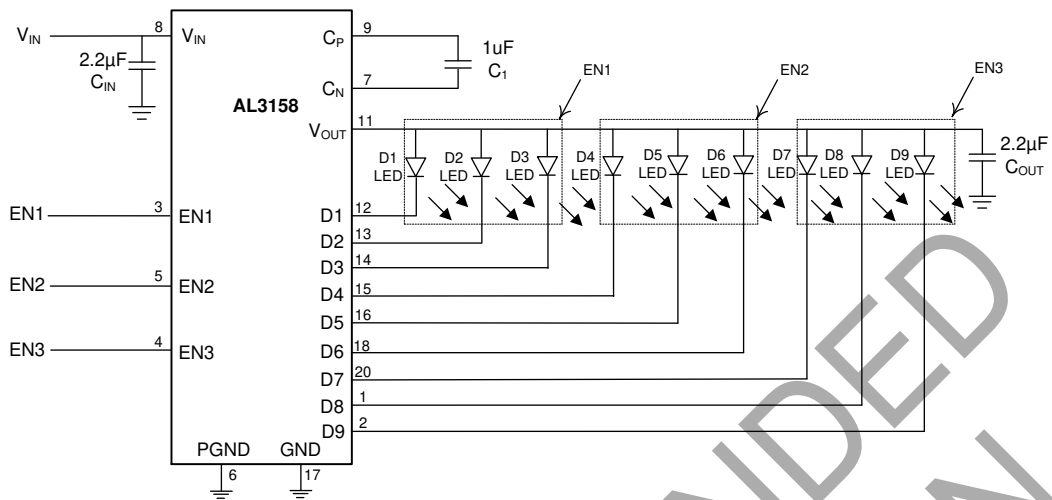
Pin Assignments



Applications

- Mobile phone white LED backlighting and indicators
- PDA white LED backlighting
- Battery-operated phone main and sub screen white LED backlighting

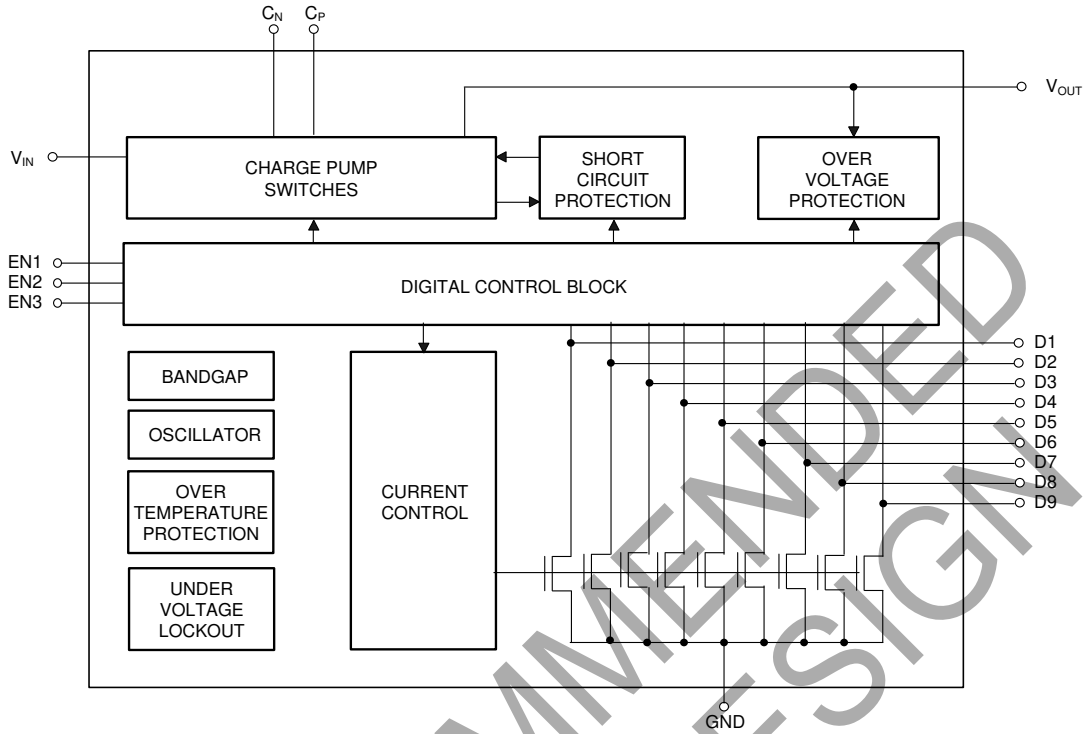
Typical Application Circuit



Pin Descriptions

Pin Name	Pin Number	Description
D8	1	Current Sink Input #8. Connected to V_{OUT} when unused.
D9	2	Current Sink Input #9. Connected to V_{OUT} when unused.
EN1	3	Enable Pin 1
EN3	4	Enable Pin 3
EN2	5	Enable Pin 2
PGND	6	Charge Pump Switch Ground
C_N	7	Negative Terminal of Flying Capacitor
V_{IN}	8	Input Power Supply. Requires $2.2\mu F$ capacitor between this pin and ground.
C_P	9	Positive Terminal of Flying Capacitor
NC	10, 19	No-Connect
V_{OUT}	11	Charge Pump Output to Drive Load Circuit. Requires $2.2\mu F$ capacitor between this pin and ground.
D1	12	Current Sink Input #1. Connected to V_{OUT} when unused.
D2	13	Current Sink Input #2. Connected to V_{OUT} when unused.
D3	14	Current Sink Input #3. Connected to V_{OUT} when unused.
D4	15	Current Sink Input #4. Connected to V_{OUT} when unused.
D5	16	Current Sink Input #5. Connected to V_{OUT} when unused.
GND	17	Ground
D6	18	Current Sink Input #6. Connected to V_{OUT} when unused.
D7	20	Current Sink Input #7. Connected to V_{OUT} when unused.
Exposed Pad	EP Pad	Exposed Pad (bottom). Connected to GND directly underneath the package.

Functional Block Diagram



Absolute Maximum Ratings (Note 4)

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	+150	°C
T _{LEAD}	Maximum Soldering Temperature (at leads, 10 sec)	+300	°C

Note: 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.

Recommended Operating Conditions

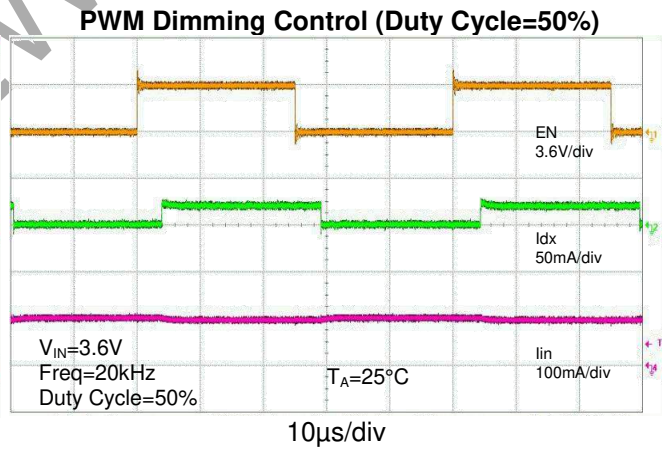
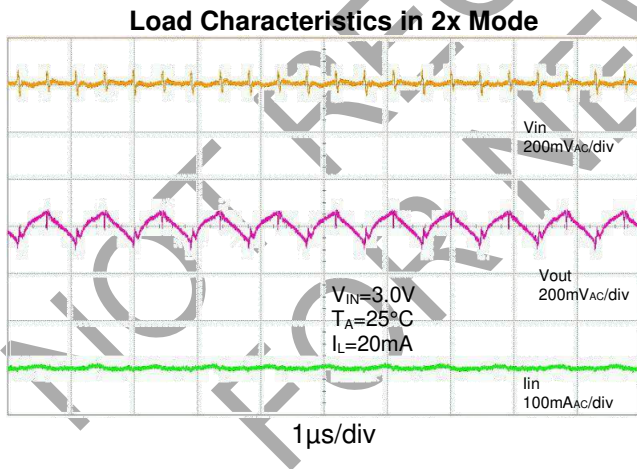
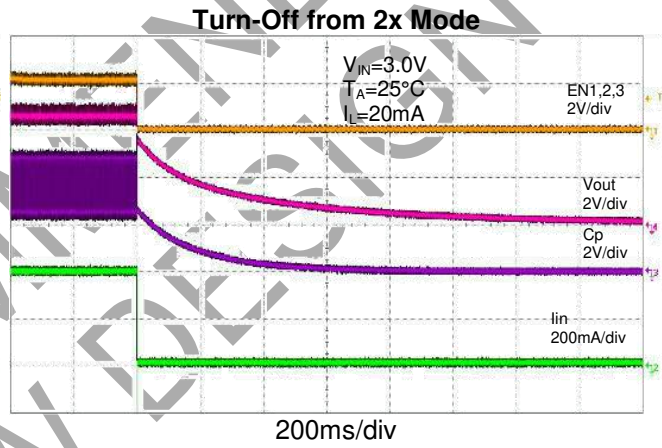
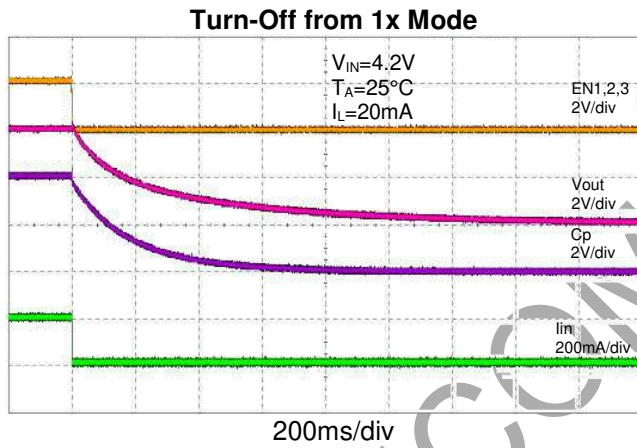
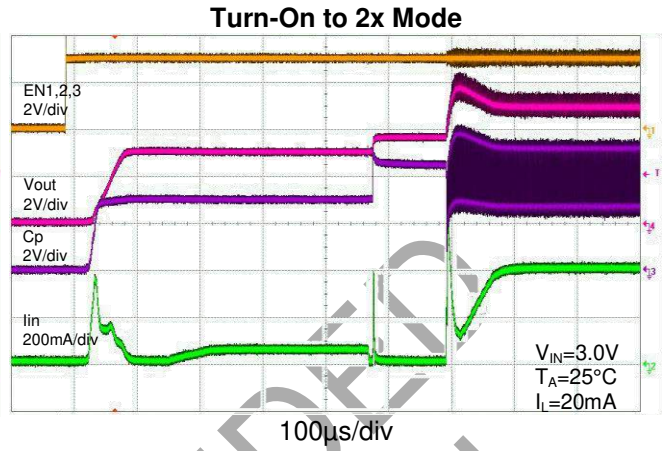
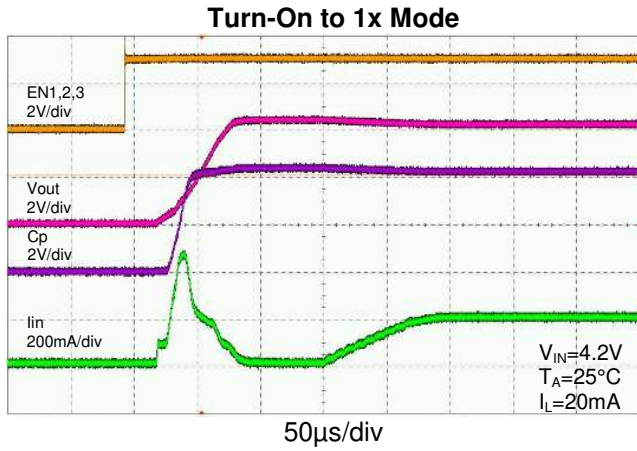
Symbol	Parameter	Min	Max	Unit
V _{IN}	Input Voltage	2.7	5.5	V
T _A	Operating Ambient Temperature	-40	+85	°C

Electrical Characteristics ($T_A = +25^\circ\text{C}$, $V_{IN} = 3.6\text{V}$, $C_{IN} = C_{OUT} = 2.2\mu\text{F}$, $C_1 = 1\mu\text{F}$, unless otherwise noted.)

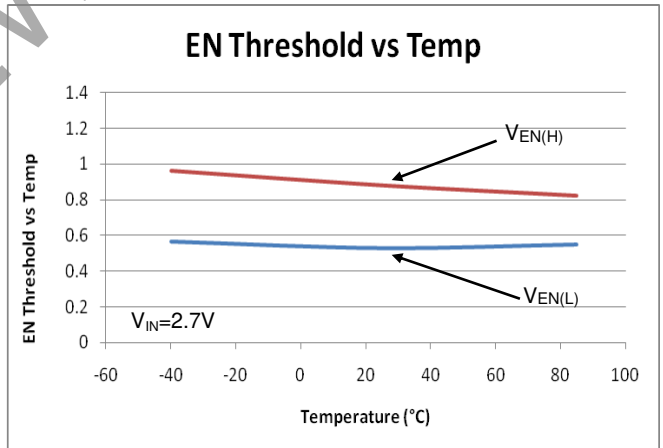
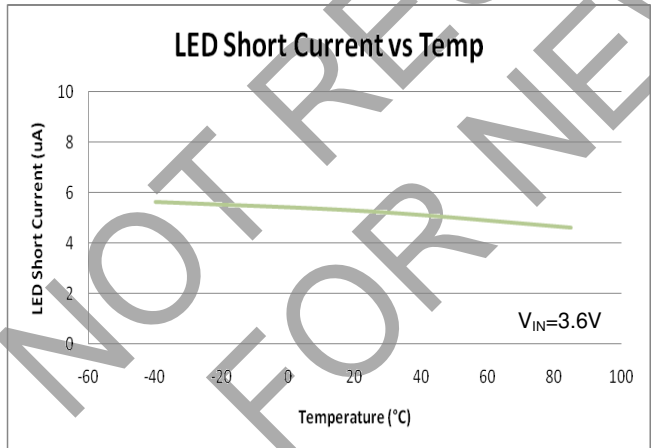
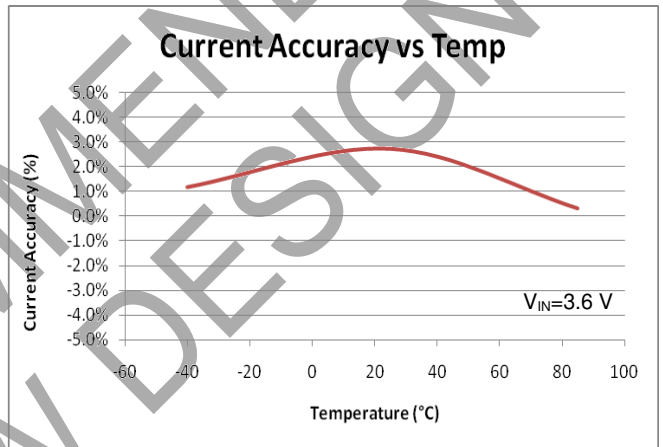
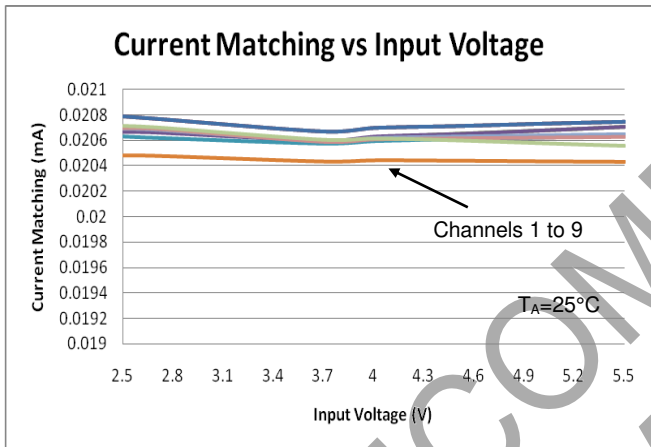
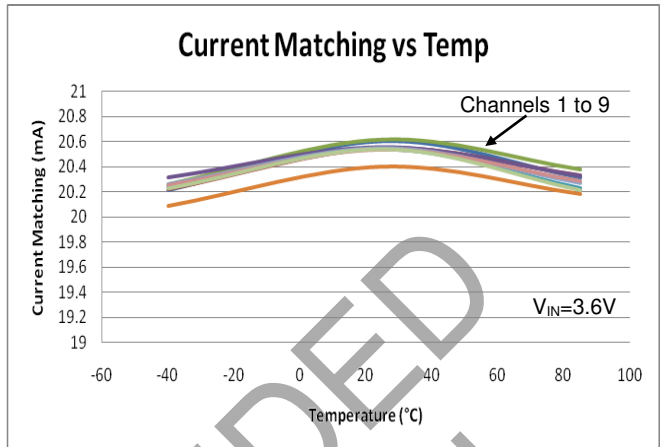
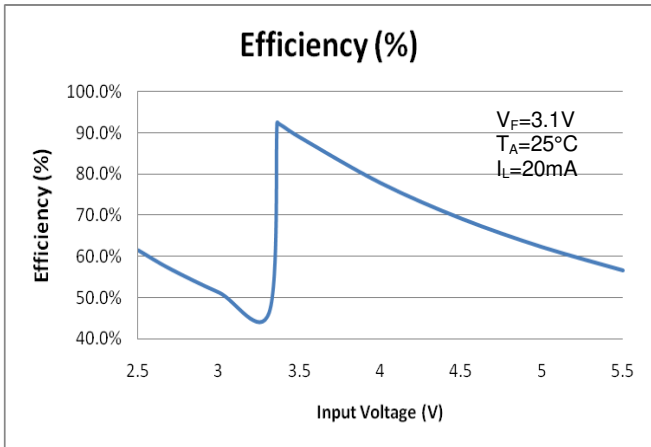
Symbol	Parameter	Test Conditions	Min	Typ.	Max	Unit
I _Q	Quiescent Current	1x Mode, $3.0 \leq V_{IN} \leq 5.5$, Active No Load Current	—	0.3	0.6	mA
		2x Mode, $3.0 \leq V_{IN} \leq 5.5$, Active No Load Current	—	2	5	
I _{SHDN}	Shutdown Current	EN1, EN2, EN3 = 0	—	—	1	μA
I _{DX}	I _{SINK} Current Accuracy (Note 5)	—	19	20	21	mA
I _{D-Match}	Current Matching Between Any Two Current Sink Inputs (Note 6)	V _F : D1:D9 = 3.6V	—	1	2	%
R _{OUT}	Open Loop V _{OUT} Resistance	1x Mode	—	0.5	—	Ω
		2x 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
f _{sw}	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 7)	—	52	—	°C/W

- Notes:
- Determined by the average current levels of all active channels.
 - 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.
 - Device mounted on FR-4 substrate, 2" x 2", 2oz copper, double-sided PC board, with minimum recommended pad on top layer and 4 vias to bottom layer.

Typical Performance Characteristics



Typical Performance Characteristics (continued)



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 1 μ F ceramic flying capacitor (C_F) for the charge pump, one 2.2 μ F ceramic input capacitor (C_{IN}), and one 2.2 μ F ceramic charge pump output capacitor (C_{OUT}).

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 to LED3 OFF
XX1	LED1 to LED3 ON
X0X	LED4 to LED6 OFF
X1x	LED4 to LED6 ON
0XX	LED7 to LED9 OFF
1xX	LED7 to LED9 ON

Disabled Current Sinks

Unused current channels must be disabled by connecting the sinks to V_{OUT} 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.

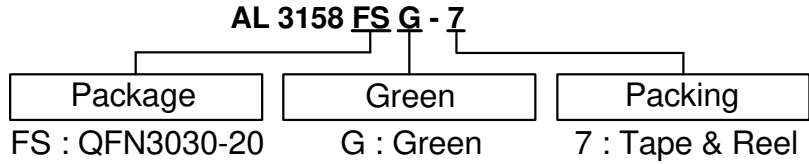
Thermal Auto Shutdown

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 EN_x pins, and the current is adjusted by the duty cycle of the signal applied on EN_x pin. The recommended PWM frequency is from 200Hz to 50kHz depending on applications.

Ordering Information



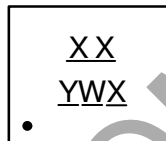
Part Number	Part Number Suffix	Package Code	Package (Note 8)	Packing	
				Qty.	Carrier
AL3158FSG-7	-7	FS	QFN3030-20	3000	7" Tape & Reel

Note: 8. Pad layout as shown on Diodes Incorporated's suggested pad layout, which can be found on our website at <http://www.diodes.com/package-outlines.html>.

Marking Information

QFN3030-20

(Top View)



XX : B8 : AL3158
Y : Year : 0 to 9 (ex: 2 = 2022)
W : Week : A to Z : week 1 to 26;
a to z : week 27 to 52; z represents
week 52 and 53
X : A to Z : Green

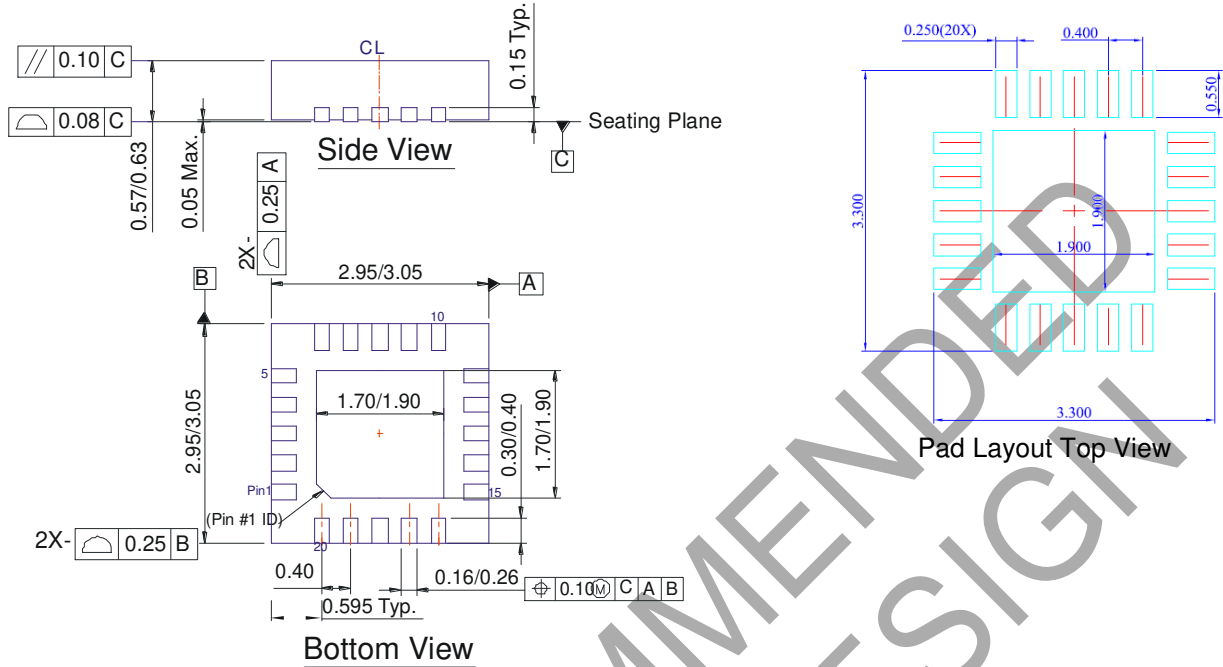
Part Number	Package	Identification Code
AL3158FSG-7	QFN3030-20	B8

NOT RECOMMENDED FOR NEW DESIGN

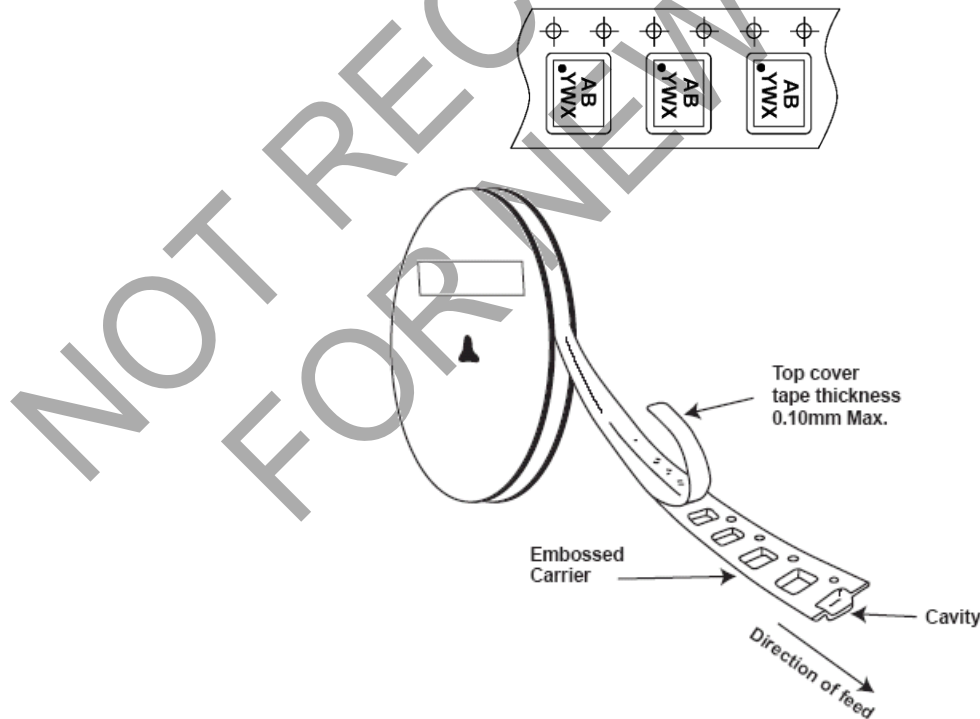
Package Outline Dimensions (All Dimensions in mm)

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

Package Type: QFN3030-20



Taping Orientation (Note 9)



Note: 9. The taping orientation of the other package type can be found on our website at <https://www.diodes.com/assets/Packaging-Support-Docs/ap02007.pdf>.

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