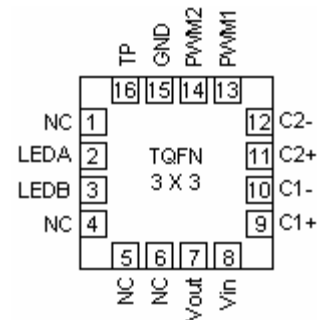# LDS8621

IXYS Display

200 mA, Dual Output LED Flash/Lamp Driver

FEATURES

o **Multi-mode charge pump: 1x, 1.33x, 1.5x, 2x**
o **Ultra low dropout PowerLite™ Current Regulator***
o **Drives two high-current LEDs up to 96 mA each**
o **PWM brightness control**
o **Power efficiency up to 95%**
o **Low noise input ripple in all modes**
o **Low current shutdown mode**
o **Soft start and current limiting**
o **Short circuit protection**
o **Thermal shutdown protection**
o **Tiny 3 x 3 x 0.8 mm 16-pin TQFN package**

APPLICATION

o **LED Light Supply for Smart Phones, PDAs, and Cell Phones**
o **LED Flashlights**
o **LED Flash/Strobe Applications**

DESCRIPTION

The LDS8621 is a high efficiency multi-mode fractional charge pump with ultra low feedback voltage that can drive up to two high-current LEDs. The inclusion of a 1.33x fractional charge pump

mode and ultra low dropout PowerLite™ Current Regulator increases device's efficiency up to 95%. New mode requires no additional external capacitors.

The PWM1/PWM2 logic inputs function as a chip enable and a PWM mode LED brightness control. PWM1 pin controls LED A, while PWM2 controls bank LED B.

The maximum LEDs current value is factory preset to 96 mA. Other current values are available upon request. Each LED may be programmed separately.

Low noise input ripple is achieved by operating at a constant switching frequency which allows the use of small external ceramic capacitors. The multi-fractional charge pump supports a wide range of input voltages from 2.7V to 5.5V.

The device is available in in 16-lead TQFN 3mm x 3mm package with a max height of 0.8mm.

TYPICAL APPLICATION CIRCUIT

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LDS8621
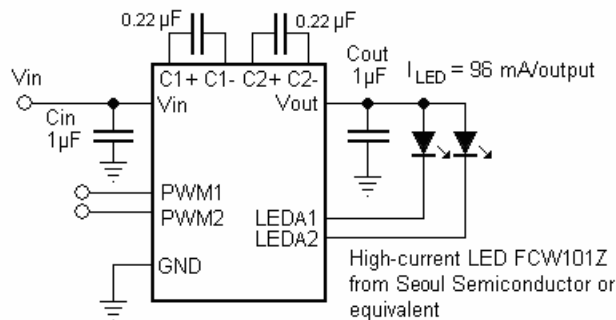
ABSOLUTE MAXIMUM RATINGS

Parameter	Rating	Unit
Vin, LEDx, C1±, C2± voltage	6	V
Vout voltage	6.5	V
EN/SET voltage	Vin + 0.7V	V
Storage Temperature Range	-65 to +160	°C
Junction Temperature Range	-40 to +125	°C
Soldering Temperature	300	°C

RECOMMENDED OPERATING CONDITIONS

Parameter	Rating	Unit
Vin	2.7 to 5.5	V
Ambient Temperature Range	-40 to +85	°C
I_{LED} per LED pin	0 to 96	mA
Total Output Current	0 to 192	mA

Typical application circuit with external components is shown on page 1.

ELECTRICAL OPERATING CHARACTERISTICS

(Over recommended operating conditions unless specified otherwise) Vin = 3.6V, Cin = Cout = 1µF, C1 = C2 = 0.22 µF, EN = High, T_{AMB} = 25°C

Name	Conditions		Min	Typ	Max	Units
Quiescent Current	1x mode			1.5		mA
	1.33 x mode			3.5		
	1.5x mode @ 3V			5.5		
	2x mode @ 2.7V			6.5		
Shutdown Current	V_{EN} = 0V				1	µA
LED Current Accuracy	1.5 mA ≤ Iled ≤ 96 mA			±3		%
LED Channel Matching	$(I_{LED} - I_{LEDAVG}) / I_{LEDAVG}$			±3		%
Output Resistance (open loop)	1x mode			0.7		Ω
	1.33x mode			3.5		
	1.5x mode			5.5		
	2x mode			6.5		
Charge Pump Frequency	1.33x and 2x mode			0.8		MHz
	1.5x mode			1.1		
Output short circuit Current Limit	Vout < 0.5V			35		mA
Input Current Limit	Vout > 1V			450		mA
1x to 1.33x, 1.33x to 1.5x, or 1.5x to 2x Transition Thresholds at any LED pin	$I_{LEDA,B}$ = 60 mA			50		mV
1.33x to 1x Mode Transition Hysteresis				600		mV
Transition Filter Delay				800		µs
PWM1, PWM2 Pins	Input Leakage		-1		1	µA
	Logic Level	High	1.3			V
		Low			0.4	
Thermal Shutdown, T_{SD}				150		°C
Thermal Hysteresis, T_{SD_HS}				20		
Under Voltage Lockout (UVLO)				2.1		V
Over Voltage Protection					6.2	V
PWM frequency			100		100000	Hz
PWM duty cycle			1		100	%

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PIN DESCRIPTION

Pin #	Name	Function
1	NC	No connect
2	LEDA	LED A cathode terminal
3	LEDB	LED B cathode terminal
4 - 6	NC	No connect
7	V_{OUT}	Charge pump output connected to the LED anodes
8	V_{IN}	Charge pump input, connect to battery or supply
9	C1+	Bucket capacitor 1 Positive terminal
10	C1-	Bucket capacitor 1 Negative terminal
11	C2+	Bucket capacitor 2 Positive terminal
12	C2-	Bucket capacitor 2 Negative terminal
13	PWM2	LEDB PWM brightness control
14	PWM1	LEDA PWM brightness control
15, 16	GND	Ground Reference, Connect both pins to GND
PAD	PAD	Connect to GND on the PCB
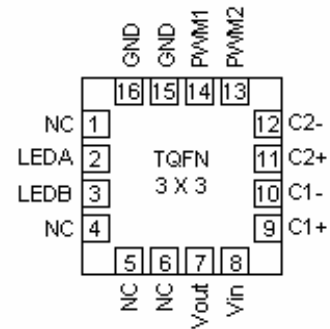
Top view: TQFN 16-lead 3 X 3 mm

PIN FUNCTION

V_{IN} is the supply pin for the charge pump. A small 1μF ceramic bypass capacitor is required between the Vin pin and ground near the device. The operating input voltage range is from 2.5V to 5.5V. Whenever the input supply falls below the under-voltage threshold (1.8V), all the LED channels are disabled and the device enters shutdown mode.

V_{OUT} is the charge pump output that is connected to the LED anodes. A small 1μF ceramic bypass capacitor is required between the V_{OUT} pin and ground near the device.

GND is the ground reference for the charge pump. The pin must be connected to the ground plane on the PCB.

C1+, C1- are connected to each side of the ceramic bucket capacitor C1

C2+, C2- are connected to each side of the ceramic bucket capacitor C2

LEDA and LEDB provide the internal regulated current source for each of the LED cathodes. These pins enter high-impedance zero current state whenever the device is in shutdown mode.

PAD is the exposed pad underneath the package. For best thermal performance, the pad should be soldered to the PCB and connected to the ground plane

PWM1, PWM2 are the enable and PWM LED brightness control logic inputs. Guaranteed levels of logic high and logic low are set at 1.3 V and 0.4 V respectively. When any of PWM pins is taken high, the device becomes enabled with maximum LED current at associated LED. To place the LDS8621 into zero current mode, both PWM pins must be held low for more than 30 ms.
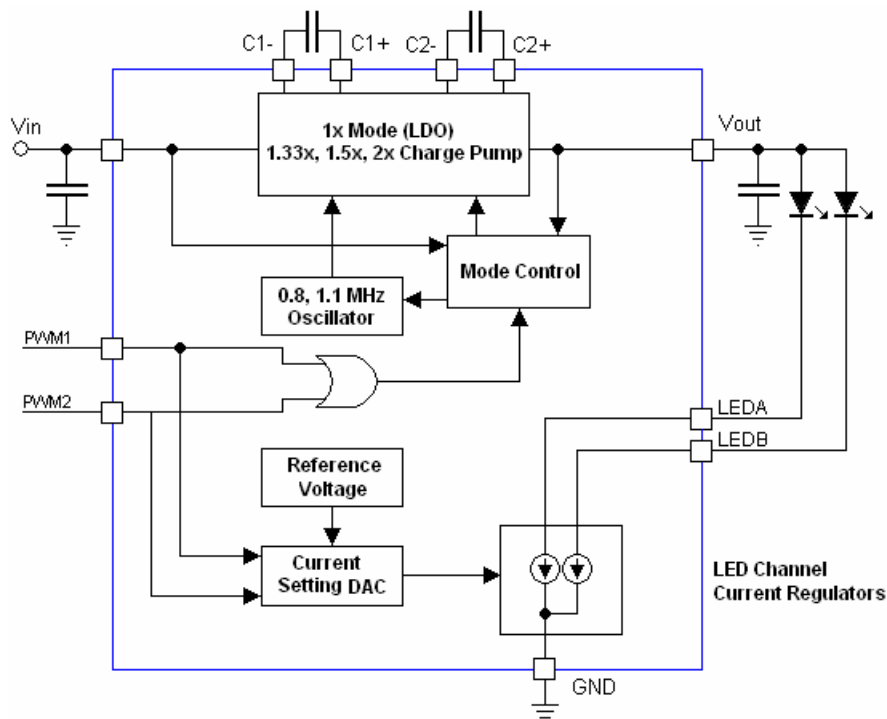
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BLOCK DIAGRAM

Figure 2. LDS8621 Functional Block Diagram

BASIC OPERATION

At power-up, PWM1 and PWM2 pins should be logic LOW. During power-up device performs internal circuit reset that requires less than 10 µs. To start device, either PWM1 or PWM2 pin should be set logic HIGH. The LDS8621 starts operating in 1x mode, at which the output is approximately equal to the input supply voltage (less any internal voltage losses). If the output voltage is sufficient to regulate all LED currents, the device remains in 1x operating mode.

The low dropout PowerLite™ Current regulator (PCR) performs well at input voltages up to 50 mV above LED forward voltage significantly increasing driver's efficiency. The LDS8621 monitors voltage drop Vd across PCR at every channel in ON state. If this voltage falls below 50 mV (typical) at any one channel, (channel with LED with highest forward voltage), the Mode Control Block changes charge pump mode to the next multiplication ratio.

$Vd = V_{IN} \times M - V_F - Rcp \times Iout$, where Rcp is a Charge Pump Output Resistance at given mode, Iout is sum of all LED currents, and M is a charge pump' multiplication ratio.

If the input voltage is insufficient or falls to a level where Vd ≤ 50 mV, and the regulated currents cannot be maintained, the low dropout PowerLite™ Current Regulator switches the charge pump into 1.33x mode (after a fixed delay time of about 800 µs). In 1.33x mode, the charge pump' output voltage is approximately equal to 1.33 times the input supply voltage (less any internal voltage losses).

This sequence repeats at every mode until driver enters the 2x mode.

If the device detects a sufficient input voltage is present to drive all LED currents in 1x mode, it will change automatically back to 1x mode. This only applies for changing back to the 1x mode. The difference between the input voltage when exiting 1x mode and returning to 1x mode is called the 1x mode transition hysteresis (about 600 mV).

LED Current Setting

The maximum current value in each of the LED is factory preset. Each LED has independendet current setting that allows use one of the LEDs for flash, while other for a torch mode. If both LEDs should be used in flash mode, or both cannels are connected in

parallel to provide maximum current through one LED in flash mode, the lower average current value in torch mode may be achieved using PWM. PWM signal may be applied to one of the PWM pins, while other channel is off, or to both PWM pins. The average LED current is proportional PWM duty cycle and number of channels that are in ON state. For instance, if both channels are connected in parallel to provide 196 mA through one LED in flash mode, turning one channel of in torch mode redjuces current to 96 mA, while applying PWM signal with 50% duty cycle to this channel reduces average LED current to 48 mA. LDS8621 allows modulation frequiencies in the range from 100 Hz to 100000 kHz with duty cycle from 100% to 1%. Lower than 100 Hz modulation frequiencies is not recommended especialy at short duty cycles because LED flicker may be visible.

The LDS8621 has follow protection modes:

1. LED short to V_{OUT} protection

If LED pin is shorted to V_{OUT}, LED burned out becomes as short circuit, or LED pin voltage is within (V_{OUT} - 1.5V) range, LDS8621 recognizes this condition as "LED Short" and disables this channel with 750 µA control current. If LED pin voltage is less than (Vout – 1.5V), LDS8621 restores LED current at this particular channel to programmed value.

2. V_{OUT} Over-Voltage Protection

The charge pump' output voltage V_{OUT} automatically limits at about 6.2 V maximum. This is to prevent the output pin from exceeding its absolute maximum rating.

3. V_{OUT} Short Circuit Protection

If V_{OUT} is shorted to ground before LDS8621 is enabled, input current may increase up to 200 – 300 mA within 20 µs after enable and is limited to 35 – 40 mA after that.

4. Over-Temperature Protection

If the die temperature exceeds +150°C, the driver will enter shutdown mode. The LDS8621 requires restart after die temperature falls below 130°C.

5. Input Voltage Under-Voltage Lockout

If V_{IN} falls below 2.2 V (typical value), LDS8621 enters shutdown mode. Device requires restart when input voltage rises above 2.3 V.

6. Low V_{IN} or High LED V_F Voltage Detection

If, in 2x mode, V_{IN} is too low to maintain regulated LED current for given LED V_F, or LED becomes an open circuit, or if any LED at active channels is disconnected, LDS8621 starts subsequently changing modes (2x – 1x – 1.33x -1.5x – 2x -…) in an attempt to compensate insufficient voltage. As a result, average current at all other channels that are ON may be below regulated level.

LED Selection

LEDs with forward voltages (V_F) ranging from 1.6V to 4.5V may be used. Charge pumps operate in the highest efficiency mode when V_F voltage is close to Vin voltage multiplied by switching mode, i.e. Vin x 1, Vin x 1.33 and so on. If the voltage source is a Li-ion battery, we recommend selecting LED with V_F = 2.7 – 3.6 V to extend the battery life and achieve highest efficiency.

External Components

The LDS8621 requires two external 1µF ceramic capacitors (X5R or X7R type) for decoupling input, output, and two 0.22 µF capacitors the same type for the charge pump. In all charge pump modes, the input current ripple is very low, and an input bypass capacitor of 1µF is sufficient.

In 1x mode, the device operates in linear mode and does not introduce switching noise back onto the supply.

Recommended Layout

In charge pump mode, the driver switches internally at a high frequency. It is recommended to minimize trace length to all four capacitors. A ground plane should cover the area under the driver IC as well as the bypass capacitors. Short connection to ground on capacitors Cin and Cout can be implemented with the use of multiple via. A copper area matching the TQFN exposed pad (PAD) must be connected to the ground plane underneath. The use of multiple via improves the package heat dissipation.

LDS8621

PACKAGE DRAWING AND DIMENSIONS

16-PIN TQFN (HV3), 3mm x 3mm, 0.5mm PITCH
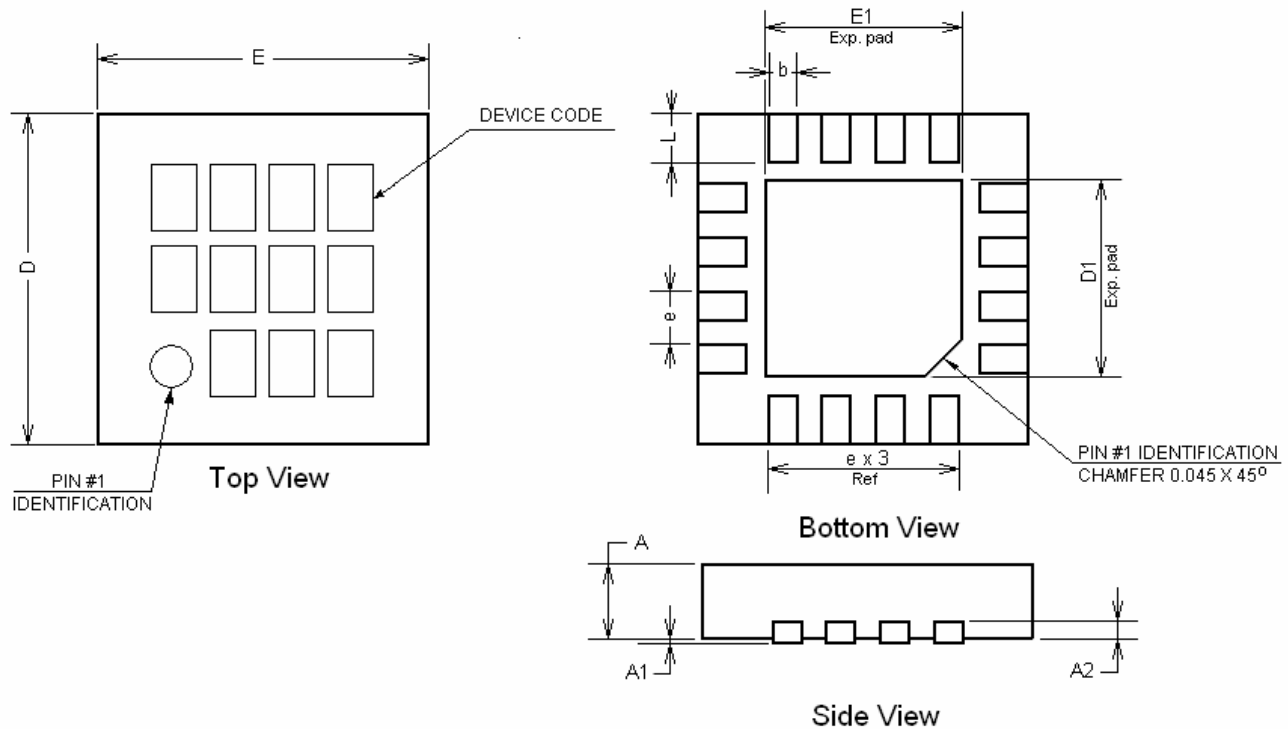
SYMBOL	MIN	NOM	MAX
A	0.70	0.75	0.80
A1	0.00	0.02	0.05
A2	0.178	0.203	0.228
b	0.18	0.23	0.28
D	2.90	3.00	3.10
D1	1.40	1.55	1.70
E	2.90	3.00	3.10
E1	1.40	1.55	1.70
e		0.50 typ	
L	0.35	0.40	0.45

Note:
1. All dimensions are in millimeters
2. Complies with JEDEC Standard MO-220

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ORDERING INFORMATION

Part Number	Package	Package Marking
LDS8621 002-T2	TQFN-16 3 x 3mm[1]	8621

Notes:

1. Matte-Tin Plated Finish (RoHS-compliant)
2. Quantity per reel is 2000

EXAMPLE OF ORDERING INFORMATION

Prefix	Device #	Suffix	
LDS	8621	002	T2

Product Number

Optional Company ID

Package
002: 3x3 TQFN

Tape & Reel
T: Tape & Reel
2: 2000/Reel
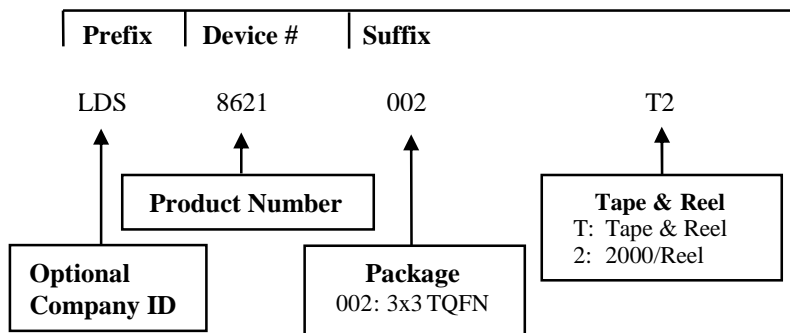
Notes:

1) All packages are RoHS-compliant (Lead-free, Halogen-free).
2) The standard lead finish is Matte-Tin.
3) The device used in the above example is a LDS8621 002–T2 (3x3 TQFN, Tape & Reel).
4) For additional package and temperature options, please contact your nearest IXYS Corp. Sales office.

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IXYS Display

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IXYS Display

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