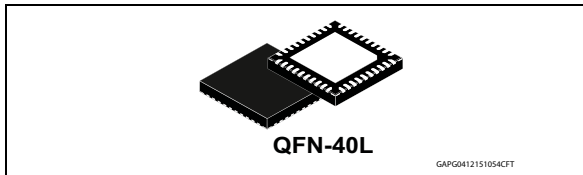


High power LED driver for automotive applications

Data brief



Features

- Automotive qualified
- General
 - ST SPI communication v4.1
 - 5.5 to 24V operating battery voltage range
 - Load dump protected
 - QFN40L (wetable flanks) with exposed pad
 - Timeout watchdog with limp home function
 - Low standby current
- Boost Section
 - Fixed frequency architecture, programmable by SPI
 - Peak current mode control
 - Dual phase operation supported
 - Input current limitation
 - Soft start
 - Overvoltage protection (OVP)
 - Open/short feedback failure protection
 - Constant voltage control
- Buck section
 - Integrated switching mosfets
 - Lossless current sensing without need of external components
 - Very accurate LED current setting programming inductor's peak current and peak-to-peak current ripple
 - Adjustable peak current by SPI
 - Adjustable current ripple by SPI
 - Integrated PWM generation unit with 10-bit resolution and phase shift
 - Peak current control

- Fixed off-time architecture
- Protection and diagnostic
 - Battery under voltage
 - Temperature warning (2 thresholds)
 - Overtemperature shutdown
 - LED voltage digital feedback through SPI
 - Buck outputs short circuit and open load protection

Applications

- Low Beam
- High beam
- Daytime running light
- Turn indicator
- Position light
- Side marker
- Fog light

Description

The L99LD21 is a flexible LED driver, which is specifically designed for the control of two independent high brightness LED strings for automotive front lighting applications. It consists of a high efficiency monolithic boost controller and a dual buck converter.

The boost controller integrates a high current gate driver for an external n-channel MOSFET. It delivers a constant output voltage, up to 60 V, which supplies the inputs of the two integrated or external buck converters.

The boost controller of two devices can be stacked, in order to operate in dual phase for high power applications, with an interleaving pattern for an improved input current ripple.

The buck converters integrate n-channel MOSFET which is driven by a bootstrap circuit.

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1 Introduction

The L99LD21 is a monolithic driver IC, which controls the current of two independent high power LED strings, whose forward current and voltage can reach up to 1.5 A (average) and up to 50V respectively.

This device has been designed with dedicated functions, in order to fulfill the stringent requirements of automotive front lighting applications.

The device offers a high level of flexibility, without any change of the external components, thanks to its programmability through the ST SPI interface. This feature support generic platform approaches, which require a software configurability of several parameters. This robust interface, offers a detailed diagnostic of the device itself, as well as of the controlled LED strings.

As the device potentially controls safety critical functions such as low beams and turn indicators, built-in features are integrated in order to support a high level of functional safety. The L99LD21 features a timeout watchdog, a monitoring of the watchdog counter, a limp home function and a direct input. The ST SPI protocol takes into account FMEA case.

The device consists of a boost controller, which controls the PWM of an external n-channel MOSFET and provides a stabilized voltage (V_{BOOST}). The input of the boost stage must be connected to the battery voltage through a reverse polarity protection.

The boost controllers of two L99LD21 can be combined to form a dual-phase, interleaved boost controller. Special care has been taken for the current balancing between the different phases and for the switching activity of the boost MOSFETs with 180° phase shift.

The output of the boost controller supplies the input of the two independent integrated buck converters, or any other external buck converters, whose input voltage is compatible with V_{BOOST} . The integrated buck converters are based on constant off-time architecture (for a given LED output voltage) and control the peak current and the peak-to-peak current ripple of their respective inductors.

Operating in continuous conduction mode, the average of each LED string's current, which is connected to the output of each buck converter, is tightly controlled.

This architecture, which consists of cascaded boost and buck stages (see [Figure 2](#)), allows the control of a wide range of LED strings, whose forward voltage is independent from the battery voltage.

With the aim of ensuring a wide operating inductor current range, the Buck MOSFETs can be set in low or high R_{DS_ON} modes, so that two different inductor peak current (I_{LX_PEAK}) ranges [0.169 A ÷ 0.836 A] or [0.338 A ÷ 1.673 A] can be selected.

The average LED current is controlled by setting the inductor's peak current and peak-to-peak current ripple. Sensing of the peak current is integrated, not requiring any external shunt resistance, which saves cost and reduces the power dissipation.

Buck n-channel MOSFET R_{DS_ON} value depends on the operative conditions as junction temperature, Input voltage and LED string current. For example, at $V_{Buckin} = 45$ V, $I_{led} = 700$ mA, $T_j = 25$ °C the maximum R_{DS_ON} is 365 mΩ (low R_{DS_ON} mode).

1.1 Typical application

Figure 1. Functional block diagram

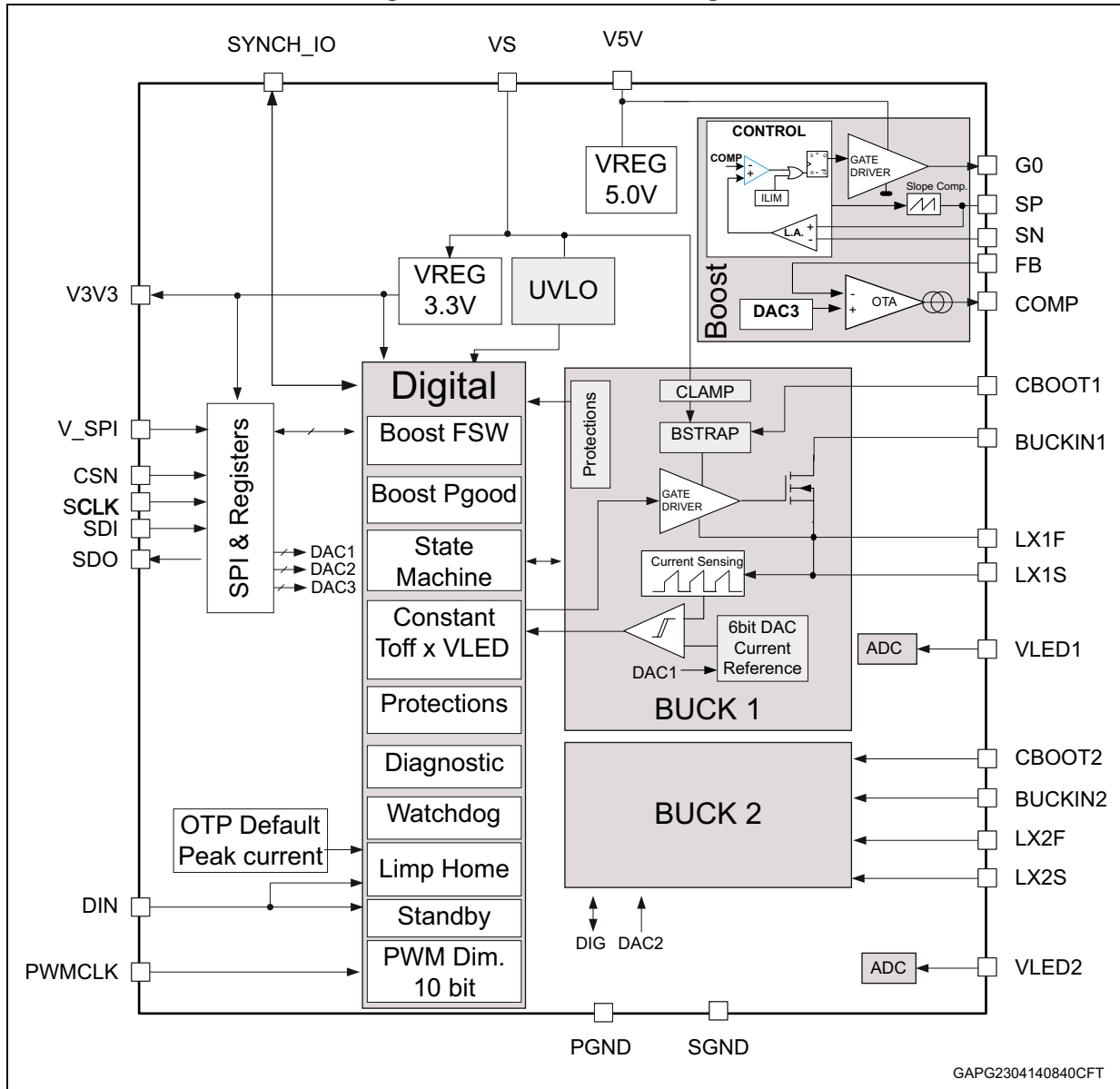


Figure 2. Typical application

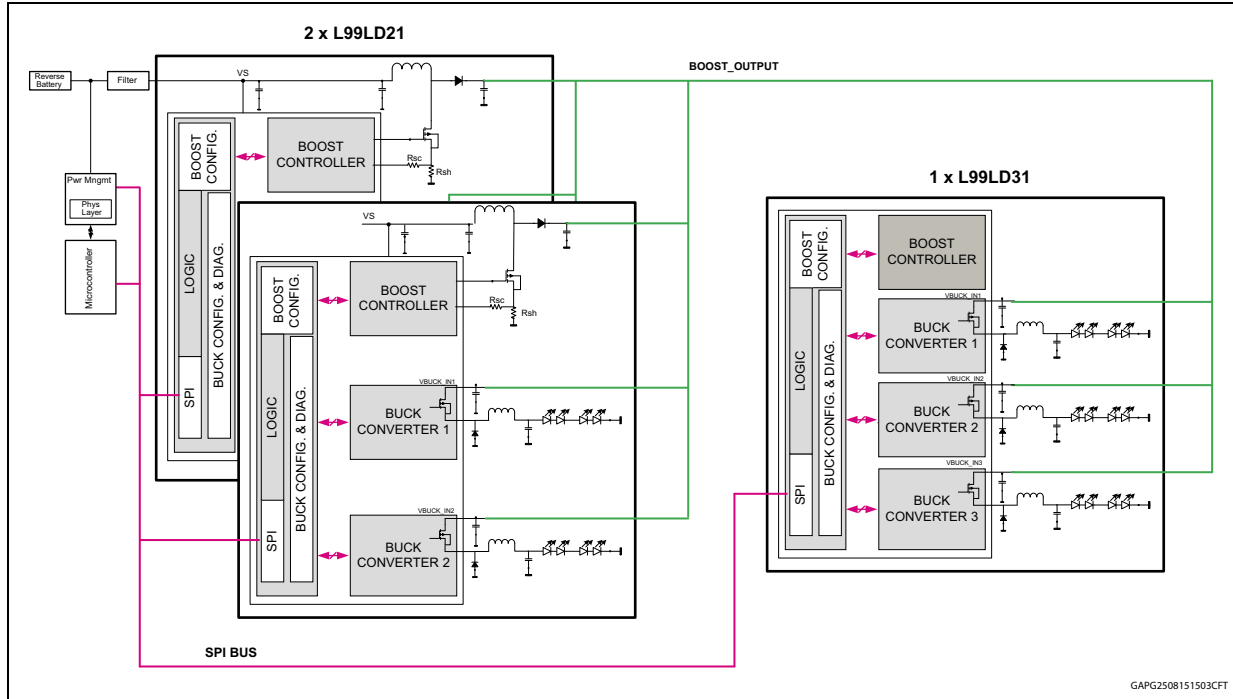


Figure 3. QFN-40L connection diagram

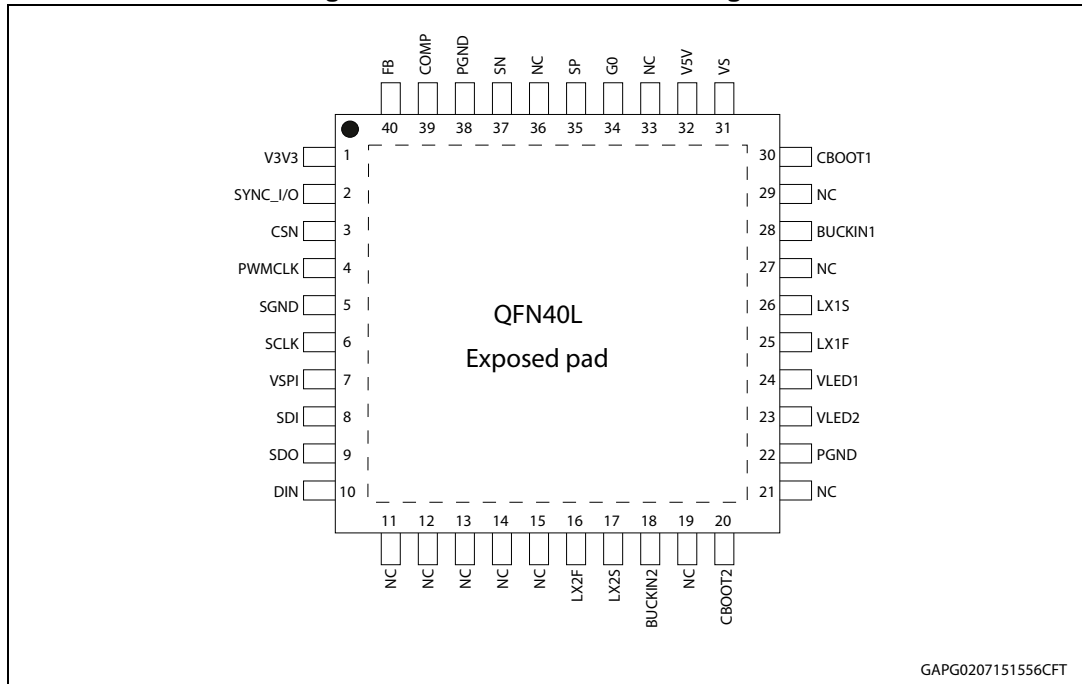


Table 1. Pin functionality

Pin number	Name	Function
1	V3V3	Output of the 3.3 V regulated internal supply. Connect a low ESR capacitor close to this pin.
2	SYNC_I/O	Boost synchronization Input or Output. This pin generates the clock signal for synchronizing another L99LD21 Boost in dual phase configuration.
3	CSN	Chip Select Not (active low) for SPI communication. It is the selection pin of the device. It is a CMOS compatible input.
4	PWMCLK	Clock input for the internal PWM dimming generator.
5	SGND	Signal Ground connection.
6	SCK	Serial Clock for SPI communication. It is a CMOS compatible input.
7	VSPI	Connection to external 3.3 V or 5 V supplies voltage. The external supply powers SPI interface and the I/O signal pins to the microcontroller.
8	SDI	Serial Data Input for SPI communication. Data is transferred serially into the device on SCK rising edge.
9	SDO	Serial Data Output for SPI communication. Data is transferred serially out of the device on SCK falling edge.
10	DIN	Direct input pin.
16	LX2F	Connection to the switching source node of the buck2. This pin must be connected to external free-wheeling diode.
17	LX2S	Kelvin connection to the switching source node of the buck2. This pin has to be connected to external bootstrap capacitance.
18	BUCKIN2	Connection to the input of the buck channel 2
20	CBOOT2	Connection to the bootstrap capacitor of the buck channel 2.
22, 38	PGND	Power Ground connection.
23	VLED2	Connection to the anode of the LED string for read back of the forward voltage of the channel 2.
24	VLED1	Connection to the anode of the LED string for read back of the forward voltage of the channel 1.
25	LX1F	Connection to the switching source node of the buck1. This pin must be connected to external free-wheeling diode.
26	LX1S	Kelvin connection to the switching source node of the buck1. This pin has to be connected to external bootstrap capacitance.
28	BUCKIN1	Connection to the input of the buck channel 1.
80	CBOOT1	Connection to the bootstrap capacitor of the buck channel 1.
31	VS	Input supply pin of the IC. Connect VS to the battery voltage.
32	V5V	Output of the 5V regulated internal supply. Connect a low ESR capacitor close to this pin.
34	G0	Output of the gate driver for the external the boost switching MOSFET.
35	SP	Positive connection to the boost shunt resistor, in series to the boost switching MOSFET.

Table 1. Pin functionality (continued)

Pin number	Name	Function
37	SN	Negative connection to the boost shunt resistor, in series to the boost switching MOSFET.
39	COMP	Output of the error amplifier of the boost controller. Connect the compensation network between this pin and SGND.
40	FB	Boost output voltage feedback. Connect the FB pin to the boost output voltage, via a resistor divider.
11, 12, 13, 14, 15, 19, 21, 27, 29, 33, 36	NC	Not connected

2 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK[®] packages, depending on their level of environmental compliance. ECOPACK[®] specifications, grade definitions and product status are available at: www.st.com.

ECOPACK[®] is an ST trademark.

2.1 QFN-40L package information

Figure 4. QFN-40L package dimensions

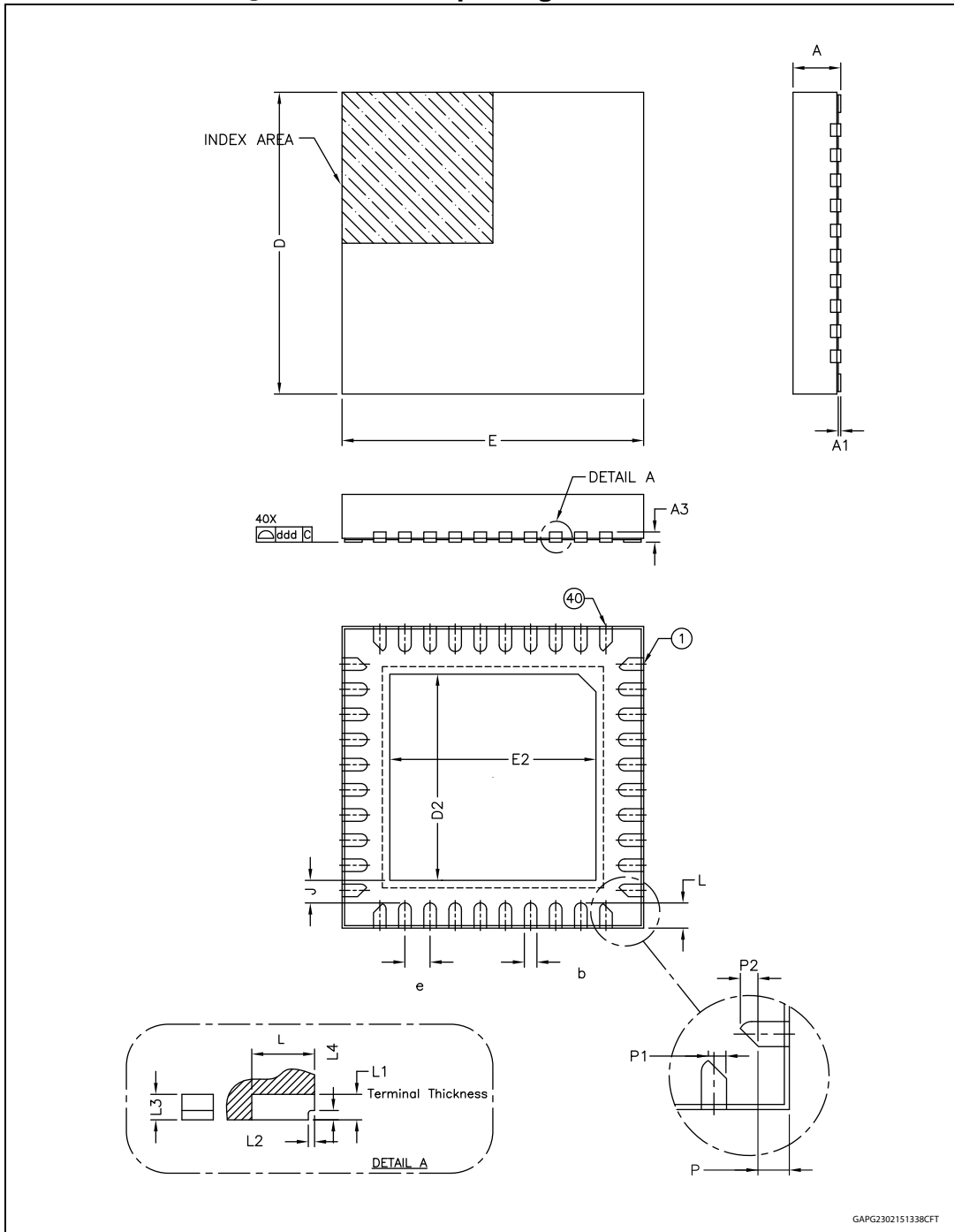


Table 2. QFN-40L mechanical data

Symbol	Min	Typ	Max
A	0.85	0.95	1.05
A1	0		0.05
A3		0.20	
b	0.20	0.25	0.30
D	5.85	6.00	6.15
E	5.85	6.00	6.15
D2	3.95	4.10	4.25
E2	3.95	4.10	4.25
e		0.50	
J		0.45	
L	0.40	0.50	0.60
L1		0.20	
L2		0.05	
L3		0.20	
L4		0.075	
P		0.31	
P1		0.18	
P2		0.18	
ddd		0.08	

3 Order codes

Table 3. Device summary

Package	Order code	
	Tube	Tape and reel
QFN-40L	L99LD21Q6	L99LD21Q6TR

4 Revision history

Table 4. Document revision history

Date	Revision	Changes
09-Dec-2015	1	Initial release.

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