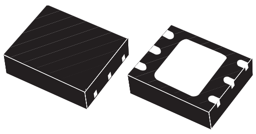
STLA02H

White LED driver for display backlight

Datasheet - preliminary data



DFN6 (2x2 mm)

Features

- Boost DC-DC converter
- Drives up to 10 LEDs with a total current up to 20 mA
- Output power capability up to 650 mW
- Input voltage range from 4.0 V to 18 V
- Output current control
- 2.3 MHz switching frequency
- PWM input for the output current dimming with 300:1 dimming range
- Overvoltage protection
- Chip overtemperature detection and protection
- Soft-start function
- Packaged in DFN6 2x2 mm

Applications

- Handheld PDA devices
- Cellular phones
- MP3 players

Description

The STLA02H is a boost converter which operates from 4.0 V to 18 V, provides an output voltage as high as 34 V and can drive up to 10 white LEDs connected in series. The total output current capability is 20 mA with an output voltage of 32 V. The total output power capability is up to 650 mW. The regulation is carried out by the internal error amplifier which works with the feedback voltage from the sensing resistor connected in high-side sensing configuration. The device can be turned on/off by the logic signal connected to the EN pin which is also dedicated to PWM dimming of the output current. Current mode control of the regulation allows a fast response to change the enable pin voltage level.

Table 1. Device summary

Order code	Part number	Package
STLA02H	STLA02HPUR	DFN6 (2x2 mm)

This is preliminary information on a new product now in development or undergoing evaluation. Details are subject to change without notice.

Contents

1 Application schematic

Figure 1. Application schematic

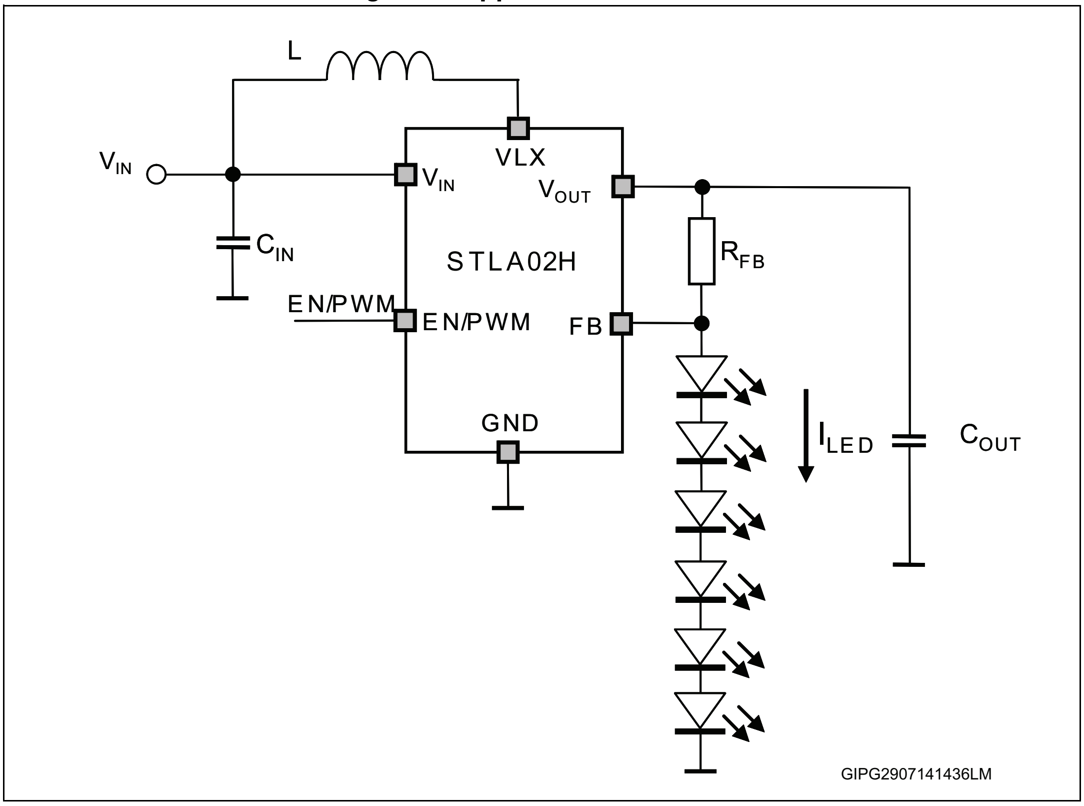
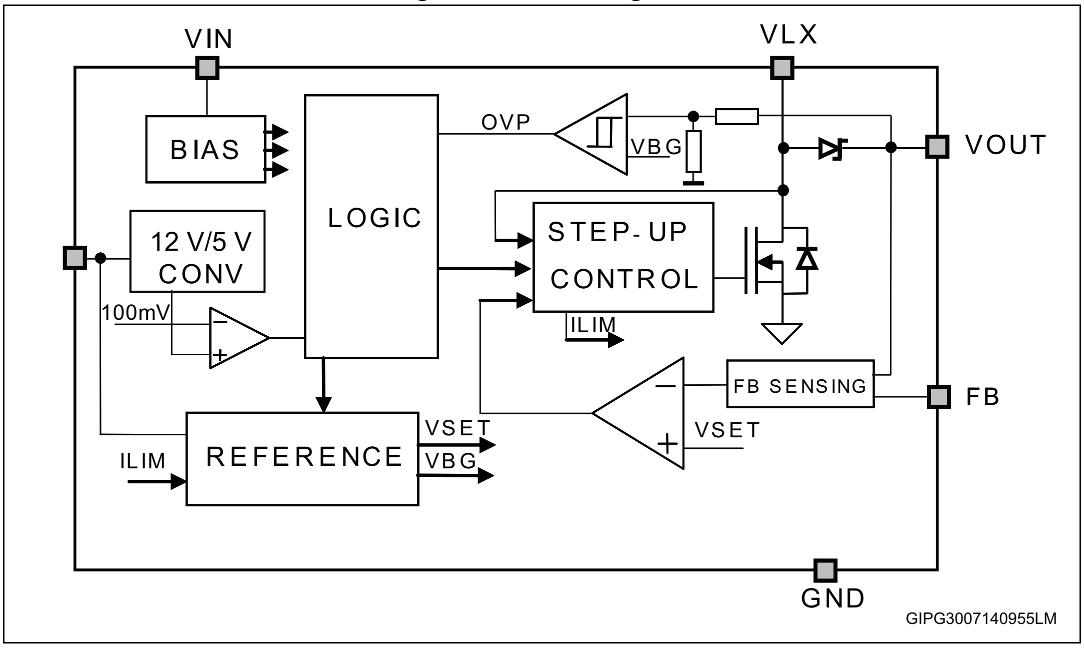


Table 2. List of external components

Component	Manufacturer	Part number	Value	Size
C_{IN}	Murata	GRM216R61E105KA12	1 µF / 25 V	0805
C_{OUT}	Murata	GRM216R61E105KA12	1 µF / 25 V	0805
L	Murata	LQH3NPN100NJ0L	10 µH	3x3x0.9 mm
	TDK	VLF3012ST-100MR59	10 µH	3x2.8x1.2 mm
R_{FB}	TYCO	CPF0402B10RE	10 Ω	0402
LED	OSRAM	LWL283-Q1R2-3K8L-1-Z	20 mA / 3.1 V	0603

2 Block diagram

Figure 2. Block diagram



3 Pin configuration

Figure 3. Pin connection (top view)

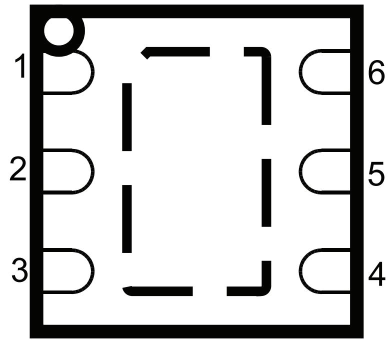


Table 3. Pin description

Pin	Symbol	Function
1	V_{IN}	Supply voltage pin
2	GND	Ground
3	LX	Switching pin
4	V_{OUT}	Output voltage pin
5	FB	Feedback voltage
6	EN/PWM	Enable pin or PWM control input for dimming
Exposed pad	GND	Ground

4 Maximum ratings

Table 4. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{IN}	Signal supply voltage	- 0.3 to 19	V
V_{LX}	Inductor connection	- 0.3 to 42	V
V_{FB}	Feedback connection(1)	- 0.3 to 42	V
$V_{EN/PWM}$	Control pin/PWM input	- 0.3 to 12	V
V_{OUT}	Output voltage connection	- 0.3 to 42	V
P_{TOT}	Continuous power dissipation (at T_A = 70 °C)(2)	650	mW
T_{OP}	Maximum operating temperature	- 40 to 85	°C
T_J	Maximum operating junction temperature	- 40 to 150	°C
T_{STG}	Storage temperature range	- 65 to 150	°C

1. The maximum acceptable difference between V_{OUT} pin potential and feedback pin potential is 5 V.
2. Power dissipation depends on PCB.

Note: Absolute maximum ratings are those values beyond which damage to the device may occur. Functional operation under these conditions is not implied.

Table 5. Thermal data

Symbol	Parameter	Value	Unit
R_{thJA}	Thermal resistance junction-ambient (1)	102	°C/W

1. Power dissipation depends on PCB. The recommended PCB design is included in this document.

5 Electrical characteristics

$V_{EN} = V_{IN} = 4.0$ V T_A = - 40 °C to 85 °C unless otherwise specified. Typical values are at T_A = 25 °C, unless otherwise specified.

Table 6. Electrical characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{IN}	Input operating supply voltage		4.0		18	V
I_S	Supply current	$V_{EN} = V_{IN}$		2.0	4.5	mA
		V_{EN} = GND		10		µA
I_O	Output current adjustment	V_{IN} = 4.0 V to 18 V, R_{FB} = 10 Ω			20	mA
V_{OUT}	Regulated voltage range	V_{IN} = 4.0 V to 18 V	V_{IN}+1		36	V
I_{PEAK}	Inductor peak current	V_{IN} = 4.0 V	400	600	800	mA
V_{FB}	Feedback voltage (V_{OUT} - V_{FB})	$V_{EN} = V_{IN}$, R_{FB} = 10 Ω	190	200	210	mV
I_{FB}	FB bias current	$V_{EN} = V_{IN}$, V_{OUT} = 32 V, V_{FB} = 32 V		6		µA
$I_{LX(leak)}$	N-MOS leakage current	V_{EN} = 0, $V_{LX} = V_{OUT}$ = 32 V			0.1	µA
ΔI_O	Output current tolerance	V_{IN} = 4.0 V, I_{OUT} = 0.2 V / R_{FB}	-5		5	%
f_s	Switching frequency	V_{IN} = 4.0 V, T_A = 25 °C	1.7	2	2.3	MHz
D_{MAX}	Maximum duty cycle	$V_{EN} = V_{IN}$, V_{OUT} = 32 V, V_{FB} = 32 V	88	92		%
$R_{DS(on)}$-N	Internal N-channel $R_{DS(on)}$	I_{LX} = 20 mA	1.1	1.6	2.0	Ω
ν	Efficiency of the chip itself	V_{IN} = 10 V, I_O = 20 mA		83		%
ν	Efficiency of the whole application	V_{IN} = 10 V, I_O = 20 mA,		80		%
OVP	Output overvoltage protection	V_{IN} = 4.0 V, no load		38		V
T_{SHDN}	Thermal shutdown		130	150		°C
T_{HYS}	Thermal shutdown hysteresis		0	15		°C
V_{IL}	Low and high level input logic signal on EN pin	V_{IN} = 4.0 V to 18 V, V_{ENMAX} = 12 V	0		1.5	V
V_{IH}			1.8		V_{IN}	

Table 6. Electrical characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
T_{EN}	LED current rise time I_{LED} = 0 to I_{LED} = 20 mA	V_{IN} = 9 V, V_{EN} = 0 V to 3 V 10 LEDs in series (1)		0.2		ms
$T_{RESPONSE}$	LED current rise time I_{LED} = 0 mA to I_{LED} = 20 mA	V_{IN} = 9 V, V_{EN} = 0 V to 3 V, 6 LEDs in series (1) V_{OUT} pre-charged		60		µs

1. Guaranteed by design but not tested in production.

6 Description

The STLA02H is a boost converter dedicated to powering and controlling the current of white LEDs in an LCD backlight. The device operates at a typical constant switching frequency of 2.3 MHz. It steps an input voltage ranging from 4.0 V to 18 V, up to 36 V. The output current is adjustable thanks to the resistor R_{FB} connected between V_{OUT} and FB pins. The STLA02H device contains high-side sensing to simplify the PCB layout in terms of LED connection.

The output current is dimmable using the PWM signal applied to the EN pin with a minimum PWM frequency of 100 Hz.

6.1 PWM input (EN)

The light intensity can be dimmed by a signal applied to the PWM (EN) input. The PWM signal is directly connected to the enable pin of the STLA02H. The frequency of PWM signal should be used in the range from 100 Hz to 1 kHz and amplitude of the signal = 1.8 V min.

Note: When the device operates in constant current mode with the EN pin connected to the voltage higher than 1.8 V, then the delay, between rise times of V_{IN} voltage of the device and the EN voltage, guarantees the proper internal reset of the logic of the device during ramping. It is recommended to delay the EN voltage rise time by 2 ms after the rise time on V_{IN} appears.

7 Selection of the external components

C_{IN} selection

It is recommended to use 1 µF as the input capacitor to achieve good stability of the device and low noise on the V_{IN} track.

C_{OUT} selection

1 µF is also the optimal value of the output capacitor to get the best compromise between output voltage ripple and load transient response. The output ripple can be checked according to the equation for step-up architecture:

Equation 1

$$V_{PK-PK} = \frac{I_{OUT(MAX)} * (V_{OUT} - V_{IN(MIN)}) * 100}{C_{OUT} * V_{OUT}^{2} * f} [V; A, V, F, Hz]$$

Inductor selection

A thin shielded inductor with a low DC series winding resistance is suggested for this application. To achieve good efficiency in step-up mode, it is recommended to use an inductor with a DC series resistance $R_{DCL} = R_D/10$, where R_D is the dynamic resistance of LED.

For nominal operation, the peak inductor current can be calculated using this formula:

Equation 2

$$I_{PEAK} = \left\{ \left(\frac{I_{OUT}}{\nu} \right) + \frac{\left[(V_{OUT} - V_{IN}) * V_{IN}^{2} \right]}{2 * L * f * V_{OUT}^{2}} \right\} * \frac{V_{OUT}}{V_{IN}}$$

where:

I_{PEAK}	peak inductor current
I_{OUT}	current sourced at the V_{OUT} pin
ν	efficiency of the STLA02H
V_{OUT}	output voltage at the V_{OUT} pin
V_{IN}	input voltage at the V_{IN} pin
L	inductance value of the inductor
f	switching frequency

The best performance of the STLA02H device is achieved by using an inductor value of 10 µH with low serial resistance and relevant saturation current calculated from the equation above.

R_{FB} value

Equation 3

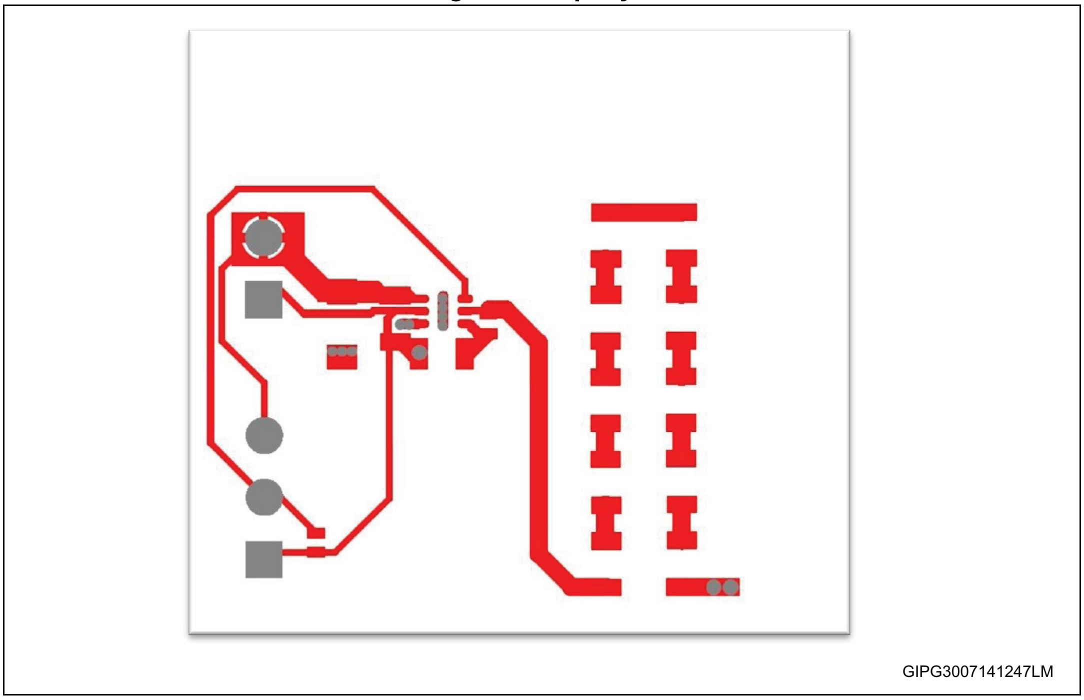
$R_{FB} = V_{FB} / I_{LED}$

In case of a typical setting I_{LED} = 20 mA, V_{FB} = 200 mV, and R_{SENSE} = 10 Ω. The resistor must be rated for a power dissipation of R_{FB} x I² LED = 10 Ω x 0.02² A=0.004 W.

8 PCB layout

Since the STLA02H is a powerful switching device, the PCB has to be designed in line with rules to design switching supplies. A two-layer PCB should be used. The power wirings must be as short and wide as possible. All external components have to be placed close to the STLA02H. High-energy switched loops should be as small as possible to reduce EMI. Most of LEDs need cooling, which may come from a defined area of copper on the PCB. The reference guide should be used for each LED to design the heatsink. R_{FB} resistor should be placed as closer as possible to pin 4 and 5. When a change of PCB layer is needed, vias have to be used. During routing, the PCB must be focused on the minimum area of the application ground, the smaller the ground area of DC-DC converter [a], the better the stability and lower noise issues are achieved. It is recommended to place the copper plate, connected through vias to the exposed pad, on the bottom layer to create the heatsink of the device.

Figure 4. Top layer



a. The application ground area is represented by the area formed by ground pins of C_{IN}, C_{OUT}, and ground of the device and GND connection of the load.

Figure 5. Bottom layer

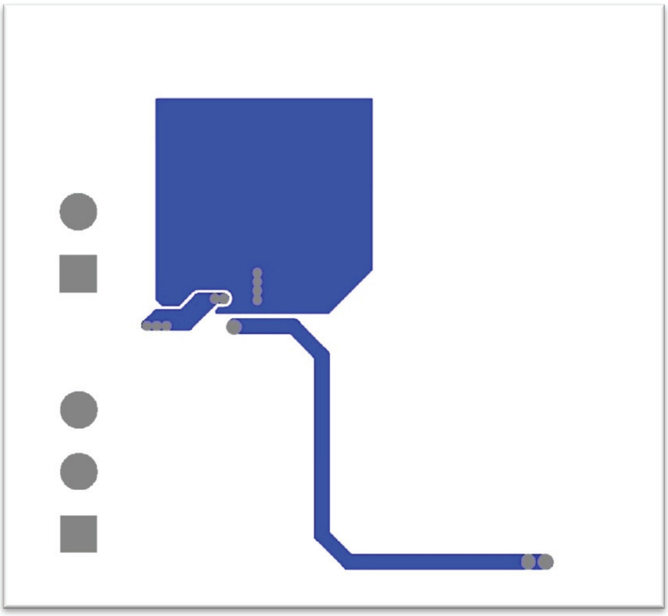


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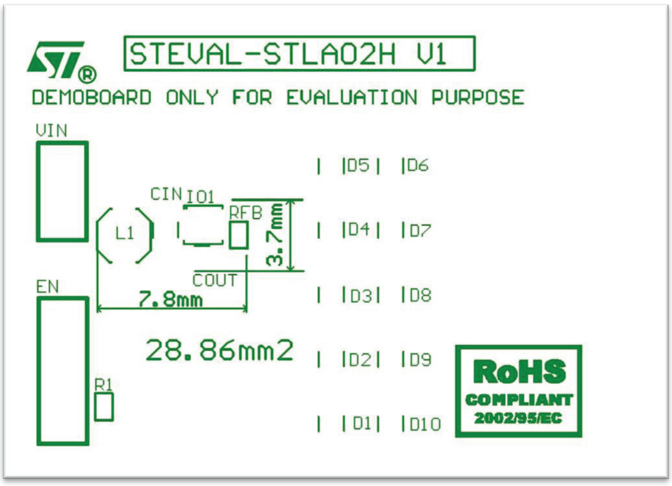
Figure 6. Top overlay



GIPG3007141255LM

9 Package mechanical data

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.

Figure 7. DFN6 (2x2 mm) drawings

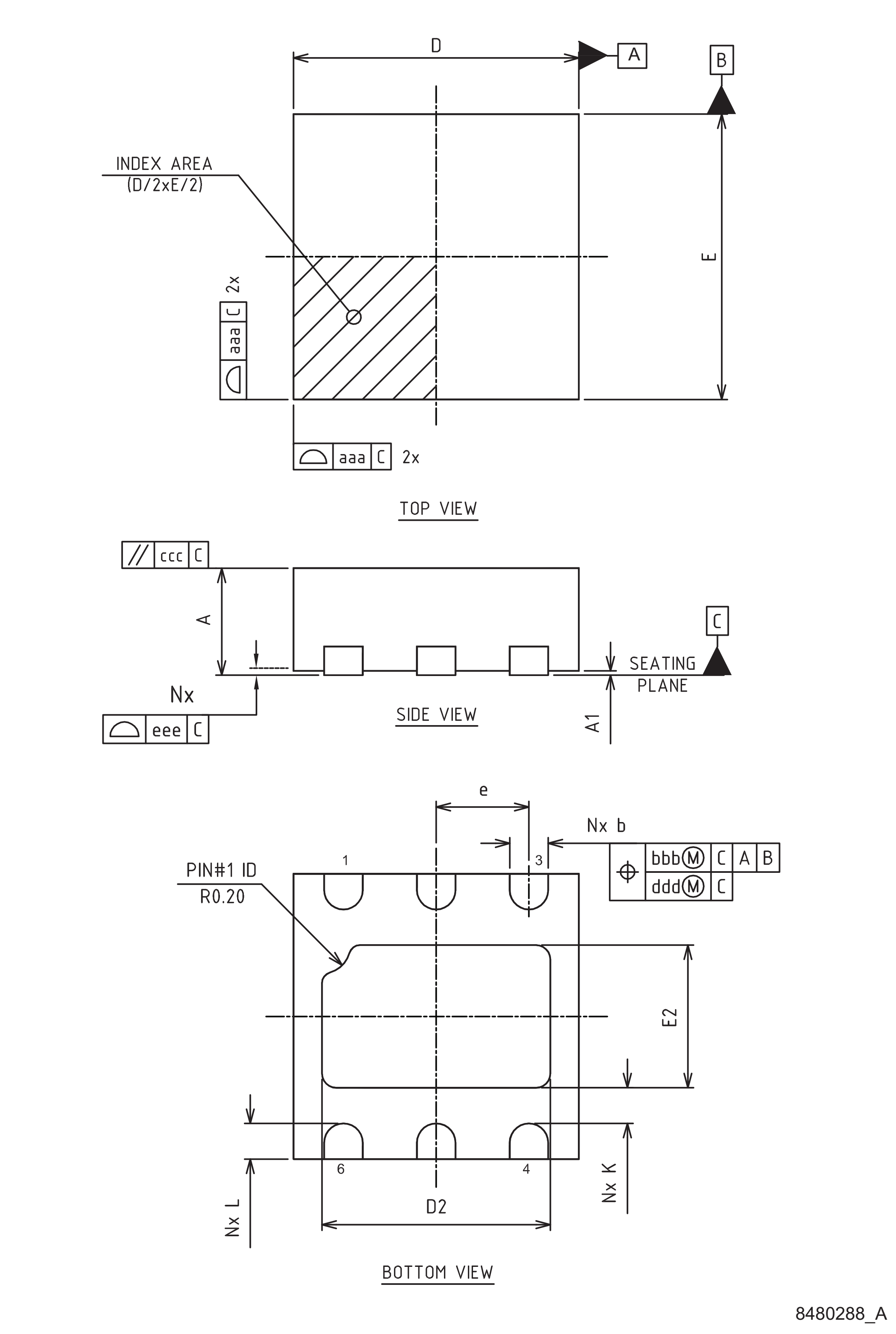
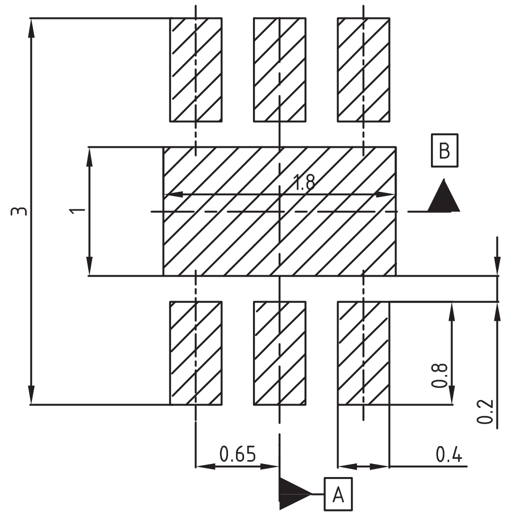


Table 7. DFN6 (2x2 mm) mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	0.80	0.90	1.00
A1	0.00	0.02	0.05
b	0.25	0.30	0.35
D	2.00 BSC		
E	2.00 BSC		
e	0.65 BSC		
D2	1.45	1.60	1.70
E2	0.85	1.00	1.10
L	0.20	0.25	0.30
K	0.15		
aaa	0.05		
bbb	0.10		
ccc	0.10		
ddd	0.05		
eee	0.08		
N	6		

Figure 8. DFN6 (2x2 mm) footprint recommended data



Notes:

1) This footprint is able to ensure insulation up to 60 Vrms (according to CEI IEC 664-1)

2) The device must be positioned within ⌖ 0.02 | A | B

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10 Revision history

Table 8. Document revision history

Date	Revision	Changes
08-Aug-2014	1	Initial release.