



Features

- Input Voltage Range: 2.5V ~ 5.5V
- Main Output, AVDD
 - Adjustable Voltage
 - Load current up to 40mA@10V
 - Efficiency up to 75%
- Positive Output, VGH
 - Adjustable Voltage up to 20V@2mA
- Negative Output, VGL
 - Adjustable Voltage low to -20V@2mA
- Soft-Start
- Over-current protection cycle by cycle
- Thermal shutdown
- DFN-12L Package

Description

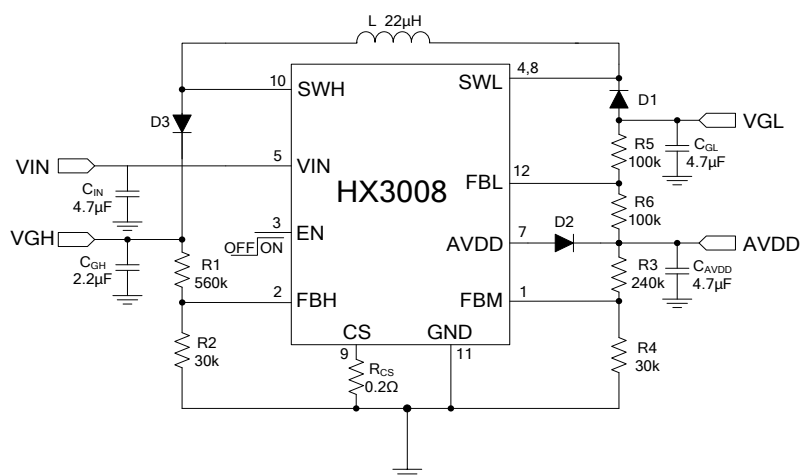
The HX3008-AJ DC-DC converter supplies all three voltages required by small thin film transistor (TFT) liquid crystal display (LCD) panels. The compact HX3008-AJ uses a single inductor to generate independently regulated positive and negative outputs.

The main output, AVDD, is post-regulated to provide a low-ripple source drive voltage for the LCD display. The auxiliary outputs generate a boosted output voltage, VGH, up to 20 V, and a negative output voltage, VGL, low to -20 V for the LCD gate drive. The device has internal over-current protection cycle by cycle and thermal shutdown for high reliability during fault conditions.

The HX3008-AJ is available in a DFN-12L package.

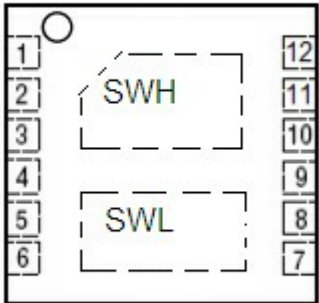
- Small Form Factor a-Si and LTPS TFT LCD
- PDAs
- Cellular Phones
- MP3 Players
- GPS Receivers

Typical Application Circuit



* $AVDD = 1.2V \cdot [1 + (R3/R4)]$, $VGH = 1.2V \cdot [1 + (R1/R2)]$, $VGL = -(R5/R6) \cdot AVDD$.

Pin Assignment and Description

TOP VIEW  DFN-12L	PIN	NAME	DESCRIPTION
	1	FBM	Output Feedback Sense for AVDD
	2	FBH	Output Feedback Sense for VGH
	3	EN	ON/OFF Control (High Enable)
	4,8	SWL	Switch Node for VGL
	5	VIN	Power Input
	6	NC	No connect
	7	AVDD	Main Output
	9	CS	Current sense
	10	SWH	Switch Node for VGH
	11	GND	Ground
	12	FBL	Output Feedback Sense for VGL

Absolute Maximum Ratings (Note1)

- Supply Voltage.....-0.3V to +6V
- SWL Voltage.....VIN - 24 V to VIN +0.3V
- SWH Voltage.....-0.3V to +23V
- VGH Voltage.....-0.3V to +25V
- AVDD Voltage.....-0.3V to +16V
- EN Voltage.....-0.3V to VIN +0.3V
- Operating Temperature Range (Note 2)-40°C to +85°C
- Maximum Junction Temperature.....+125°C
- Storage Temperature Range-65°C to +150°C

Note 1: Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Exposure to any Absolute Maximum Rating condition for extended periods may affect device reliability and lifetime.

Note 2: The HX3008-AJ is guaranteed to meet performance specifications from 0°C to 85°C. Specifications over the -40°C to 85°C operating temperature range are assured by design, characterization and correlation with statistical process controls.

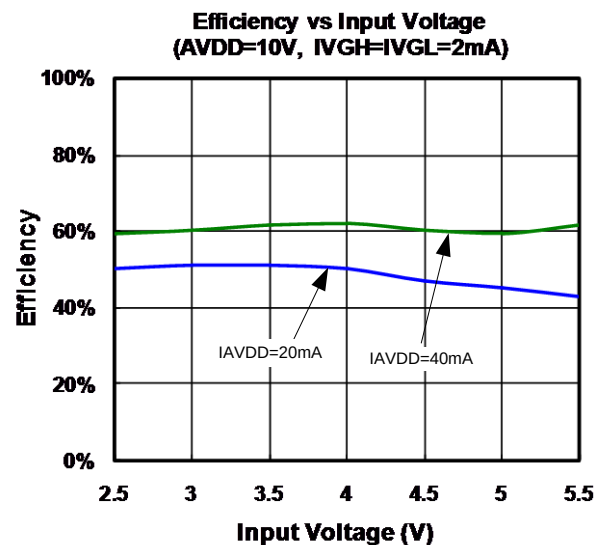
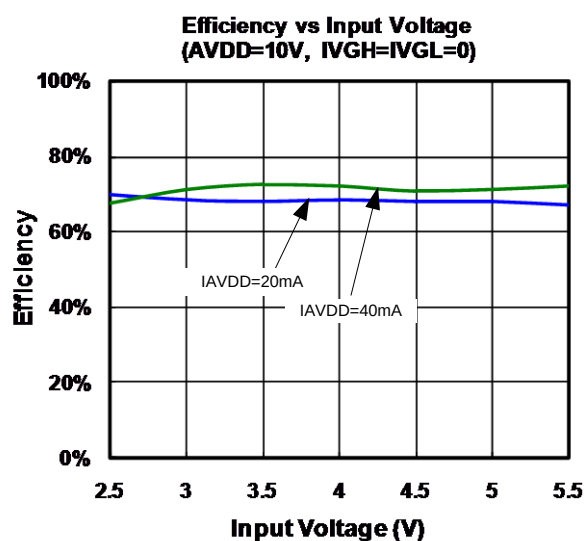
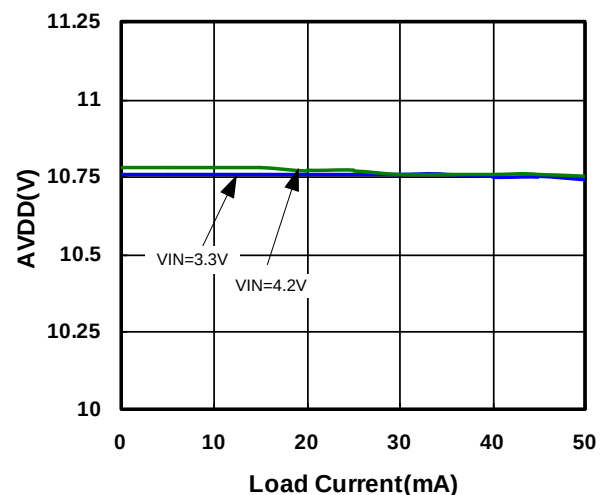
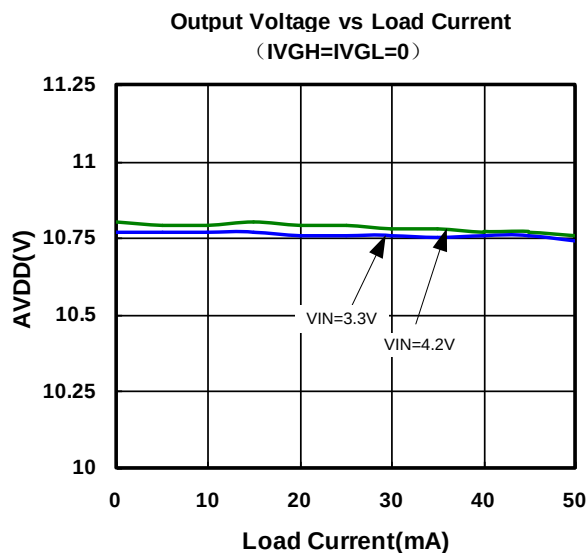
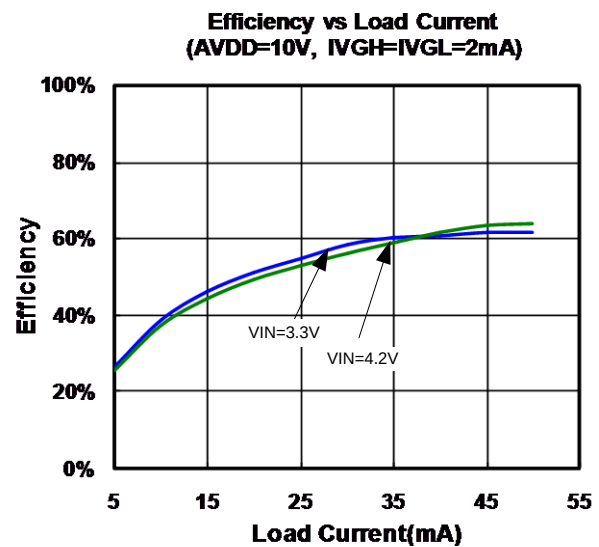
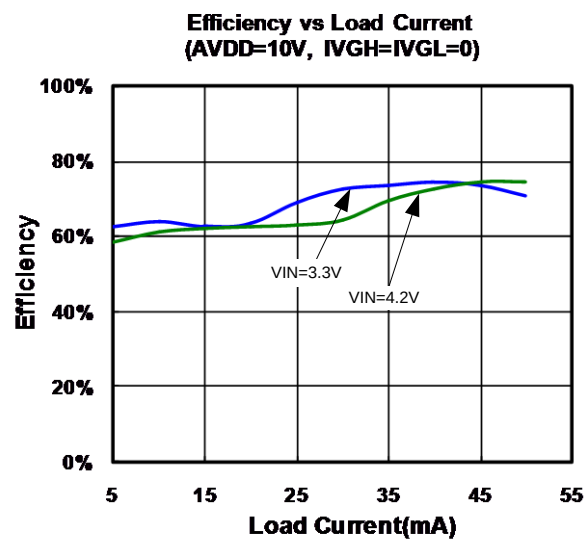
Electrical Characteristics

Operating Conditions: $T_A = 25^{\circ}\text{C}$, $V_{IN} = 3.6\text{V}$, $EN = V_{IN}$, unless otherwise specified.

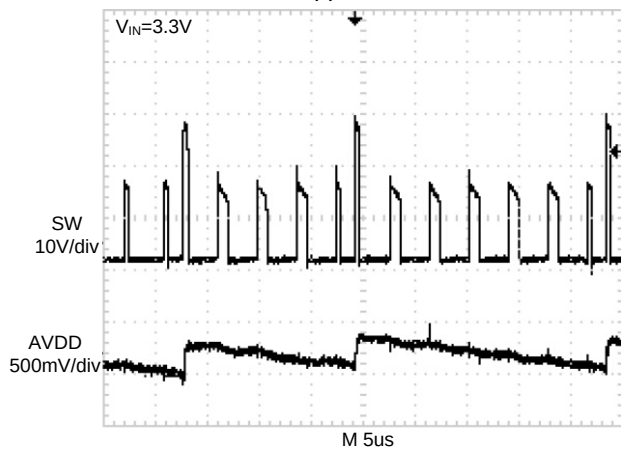
SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{IN}	Input Voltage Range		2.5		5.5	V
	Start-up Voltage			2.5		V
I_{IN}	Supply Current	$EN = V_{IN}$		380		μA
		$EN = 0$		6		μA
F_{OSC}	Oscillator Frequency			400		kHz
$R_{ds(ON)}$	P-MOS on-resistance			150		$\text{m}\Omega$
	N-MOS on-resistance			150		$\text{m}\Omega$
I_{LIM}	P-MOS current limit			400		mA
	N-MOS current limit			400		mA
V_{FBM}	FBM Voltage			1.2		V
V_{FBH}	FBH Voltage			1.2		V
V_{FBL}	FBL Voltage			0		V
I_{FBM}	Feedback input bias current	$V_{FBM} = V_{REF}$			0.1	μA
I_{FBH}	Feedback input bias current	$V_{FBH} = 0\text{V}$			0.1	μA
I_{FBL}	Feedback input bias current	$V_{FBL} = 0\text{V}$			0.1	μA
$AVDD$	Main output voltage range			10		V
VGH	VGH output voltage range				20	V
VGL	VGL output voltage range		-20		0	V
I_{AVDD}	Maximum main output current			40		mA
I_{VGH}	Maximum DC output current			2		mA
I_{VGL}	Maximum DC output current			2		mA
V_{ENL}	EN Falling Threshold			0.7		V
V_{ENH}	EN Rising Threshold			0.7		V
I_{EN}	EN Pin Bias Current				0.1	μA

Typical Performance Characteristics

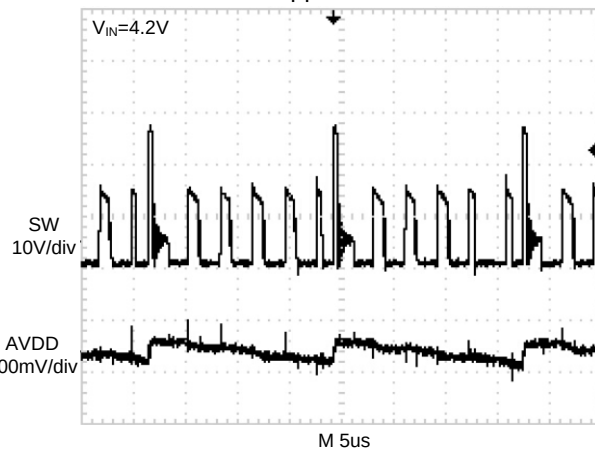
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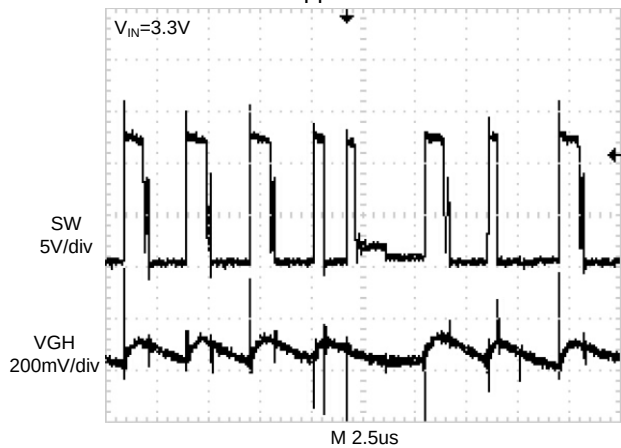
AVDD Ripple and SW wave



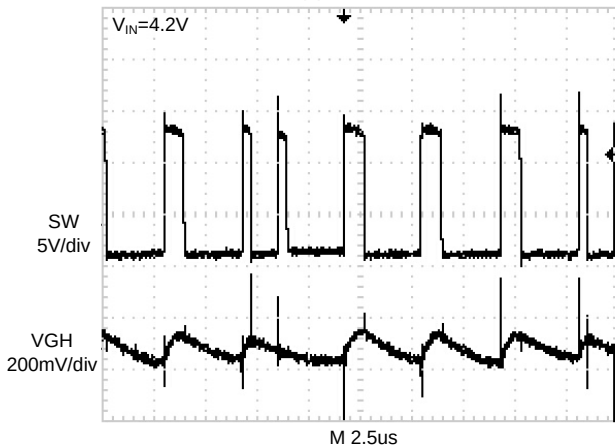
AVDD Ripple and SW wave



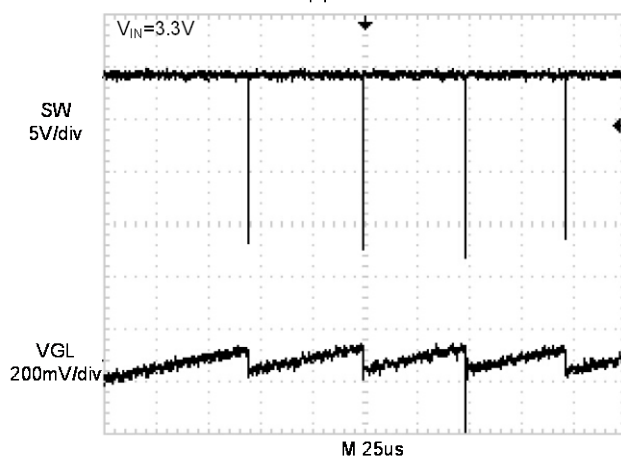
VGH Ripple and SW wave



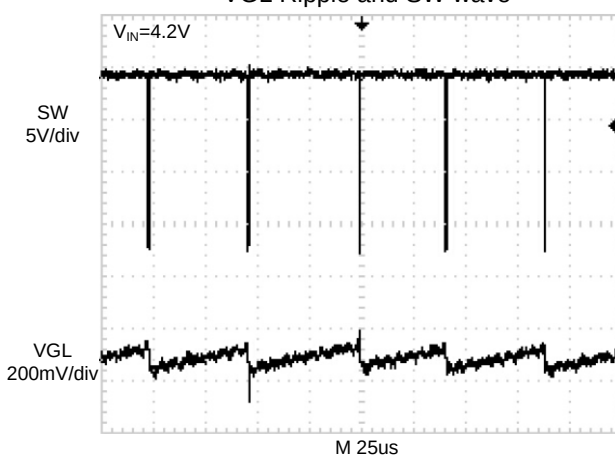
VGH Ripple and SW wave



VGL Ripple and SW wave



VGL Ripple and SW wave



Pin Functions

FBM (Pin 1): Feedback pin for the main output voltage divider. Regulate to 1.2V nominal.

FBH (Pin 2): Feedback pin for the VGH output voltage divider. Regulate to 1.2V nominal.

EN (Pin 3): Logic Controlled Shutdown Input. EN=High: Normal free running operation. EN=Low: Shutdown. Output capacitor can be completely discharged through the load or feedback resistors.

SWL (Pin 4, 8): Connect the inductor to this pin. This pin is connected to the drain of the low-side MOSFET switch.

VIN (Pin 5): This is the input voltage pin of the device.

NC (Pin 6): No connect.

AVDD (Pin 7): Main Output.

CS (Pin 9): Current sense. Connect a current-sense resistor, R_{CS} , between CS and GND.

SWH (Pin 10): Connect the inductor to this pin. This pin is connected to the drain of the high-side MOSFET switch.

GND (Pin 11): Ground.

FBL (Pin 12): Feedback pin for the negative output voltage divider. Regulate to 0 V nominal. Connect feedback resistor divider between VGL and main output.

Application Information

Operation

The typical application circuit of HX3008-AJ is a complete power supply for TFT LCD displays. The circuit generates three independent supplies for the source driver (AVDD) and the gate drivers (VGH, VGL) by using a single inductor. The AVDD and VGH are generated by a step-up converter, while VGL is generated by an inverting converter. The three output voltages are independently regulated.

A free-running, variable-peak-current PWM control scheme is used to time-multiplex the inductor between three outputs. This inherently-stable control architecture operates at a pseudo fixed frequency, providing fast response to line and load transients while maintaining a relatively constant switching frequency and high efficiency over a wide range of input and output voltages.

Soft Start

The HX3008-AJ has an internal soft-start circuit that limits the inrush current during startup. This prevents possible voltage drops of the input voltage in case the battery or a high impedance power source is connected to the input of the device.

Setting the output voltage

The output voltages are defined as shown in typical circuit.

$$AVDD = V_{FBM} \cdot [1 + (R3/R4)],$$

with an internal reference voltage $V_{FBM} = 1.2V$.

$$VGH = V_{FBH} \cdot [1 + (R1/R2)],$$

with an internal reference voltage $V_{FBH} = 1.2V$.

$$VGL = - (R5/R6) \cdot AVDD.$$

Fault Protection

The HX3008-AJ has internal over-current protection cycle by cycle and thermal shutdown for high reliability during fault conditions.

The HX3008-AJ implements a cycle by cycle current limit. During each switching cycle the high side switch current is compared to the reference voltage. When the instantaneous switch current intersects the reference voltage, the high side switch is turned off. During over-current conditions that pull the output voltage low, the error amplifier responds by driving the reference pin high, increasing the switch current. The error amplifier output is clamped internally. This clamp functions as a switch current limit.

The total power dissipation in HX3008-AJ is limited by a thermal protection circuit. When the device temperature rises to approximately +165°C, this circuit turns off the pass transistor, allowing the IC to cool. The thermal protection circuit can protect the device from being damaged by overheating in the event of fault conditions. Continuously running the HX3008-AJ into thermal shutdown degrades device reliability.

R_{CS} Selection

The HX3008-AJ enters into burst mode operation at light loads which results in large ripple output voltage. In order to reduce this ripple, a sampling resistor R_{CS} should be connected at cs pin. Then the

enters into normal operation mode. The sampling resistor R_{CS} is given by:

$$R_{CS} = (0.02 \cdot V_{IN}) / (AVDD \cdot I_{AVDD} + V_{GH} \cdot I_{VGH} + V_{GL} \cdot I_{VGL}).$$

For example, when $V_{IN}=3V$ and $AVDD=10V$, the selection of R_{CS} should refer to Figure1:

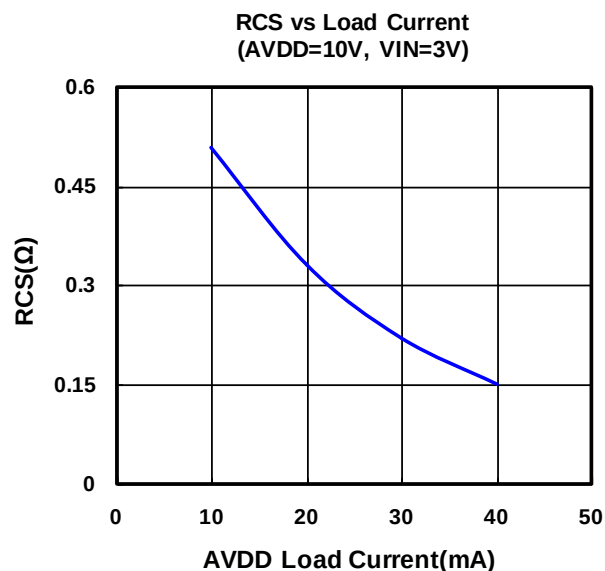


Figure1. RCS vs AVDD Load Current

Diode Selection

The output current of AVDD is always larger than the others. Because of this, the diode with AVDD is the main parameter affecting the efficiency of the converter. To achieve high efficiency, use a 30V Schottky diode.

Inductor Selection

Since the control scheme of the HX3008-AJ device is inherently stable, the inductor value does not affect the stability of the converter. To operate the HX3008-AJ properly at full performance, choose inductors over 22μH. In order not to saturate the inductor when operating at a higher output power, select an inductor with a higher saturation-current rating.

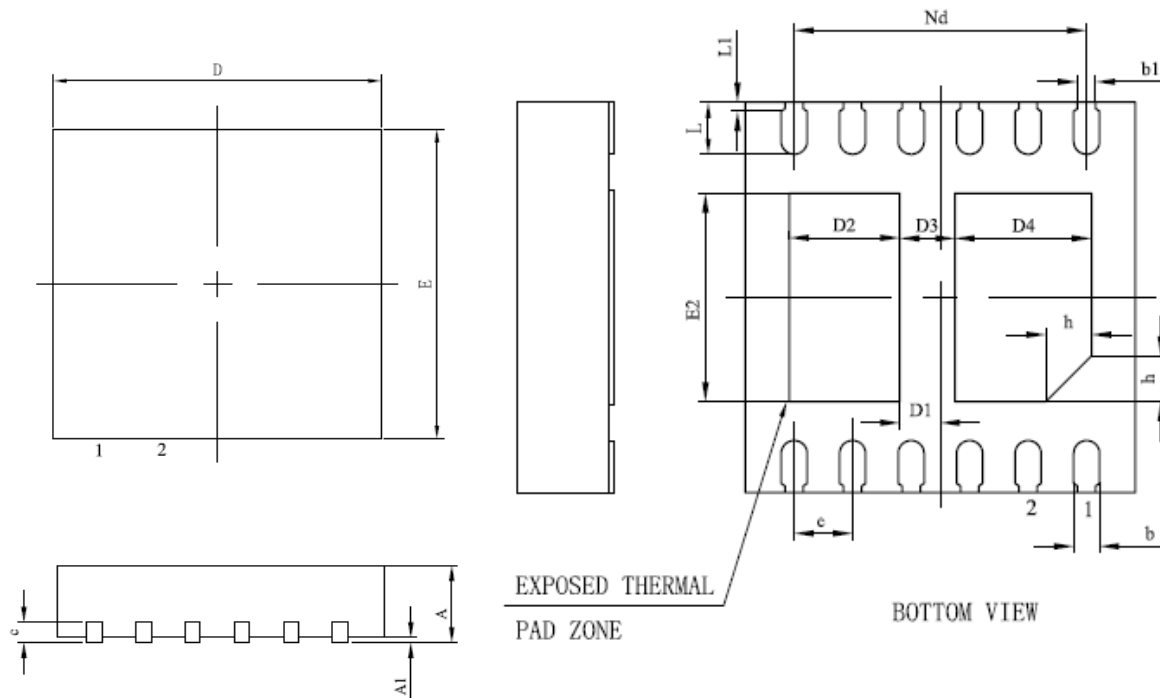
Output and Input Capacitors Selection

Larger output capacitors reduce noise and improve load-transient response, stability, and power-supply rejection. Since output ripple in boost DC-DC designs is dominated by capacitor equivalent series resistance (ESR), Low-ESR capacitors must be used.

The input capacitor reduces the current peaks caused by the input supply and reduces noise injection. Its value is largely determined by the source impedance of the input supply. High source impedance requires high input capacitance, particularly at the input voltage falls. At low input voltage, increasing C_{IN} or lowering its ESR can improve efficiency.

Packaging Information

DFN-12L Package Outline Dimension



Symbol	Dimensions In Millimeters		
	Min	NOM	Max
A	0.70	0.75	0.80
A1	—	0.02	0.05
b	0.15	0.20	0.25
b1	0.14REF		
c	0.18	0.20	0.25
D	2.90	3.00	3.10
D1	0.26	0.31	0.36
D2	0.75	0.85	0.95
D3	0.32	0.42	0.52
D4	0.95	1.05	1.15
e	0.45BSC		
Nd	2.25BSC		
E	2.90	3.00	3.10
E2	1.50	1.60	1.70
L	0.30	0.40	0.50
L1	0.10REF		
h	0.30	0.35	0.40
L/F	75X50/75X42		

Subject changes without notice.