Low Quiescent Current & High Efficiency Boost Converter

General Description

The DS4801 allows systems to take advantage of new battery chemistries that can supply significant energy when the battery voltage is lower than the required voltage for system power ICs. By combining built-in power transistors, synchronous rectification, and low supply current; this IC provides a compact solution for systems using advanced Li-Ion battery chemistries.

The DS4801 is a boost regulator designed to provide a minimum output voltage from a single-cell Li-Ion battery, even when the battery voltage is below system minimum. In boost mode, output voltage regulation is guaranteed to a maximum load current of 0.5A. Quiescent current in Shutdown Mode is less than 0.1uA, which maximizes battery life.

Features

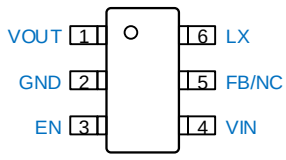
- Operates from a Single Li-ion Cell : 2.5V to 5.5V
- Adjustable Output Voltage : 2.8V to 5V
- PSM Operation
- Up to 96% Efficiency
- Boost Current Limit
- Output Over Voltage Protection
- Internal Compensation
- Output Discharge
- Output Short Protection
- True Load Disconnect During Shutdown
- DFN2x2-6L & SOT-23-6 Package Available

Applications

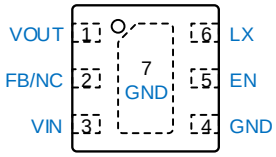
- Laptop, Palmtops and PDAs
- Single-Cell Li-Ion Smart-Phones
- Portable Equipment
- True Wireless Stereo (TWS)
- Electronic Cigarette (E-Cig)
- Low-Power Handheld Device

Pin Configurations

SOT-23-6



DFN2x2-6L



Ordering Information

DS4801-AABB

Designator	Description	Symbol	Description
AA	Voltage type		Adjustable
		50	VOUT = 5.0V
BB	Package type	S6	SOT-23-6
		D6	DFN-2x2-6L

Example: Adjustable (FB) / SOT-23-6 Package . Part no = DS4801S6

Description of Functional Pins

Pin No		Pin Name	Pin Function
DFN2X2-6L	SOT23-6		
1	1	VOUT	Boost converter output.
2	5	FB / NC	Voltage feedback. The output is adjustable mode as Voltage Feedback, and the output is fixed voltage as No Internal Connection .
3	4	VIN	Power input. Input capacitor C_{IN} must be placed as close to IC as possible.
4	2	GND	Power ground.
5	3	EN	Enable input (1 enabled, 0 disabled), must not be floating.
6	6	LX	Switching Node.
Exposed Pad		PGND	Substrate of Chip. Leave floating or tie to GND.

Typical Application Circuits

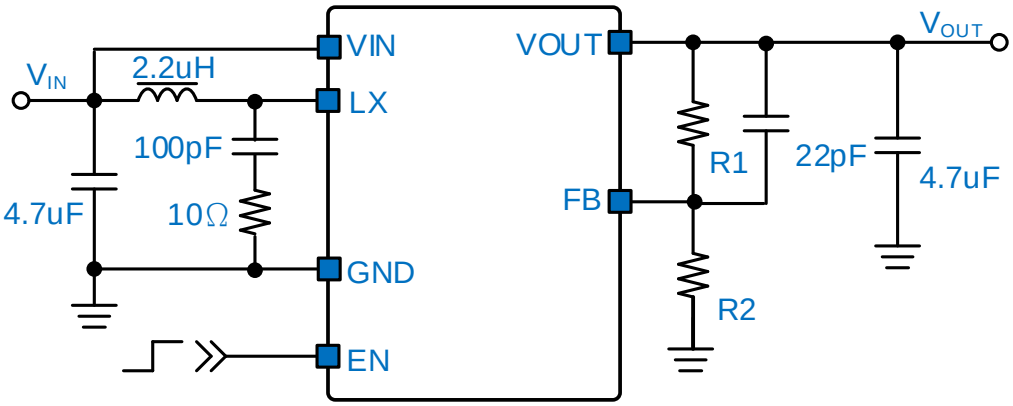


Figure 1: Adjustable output voltage application circuit by DS4801 .

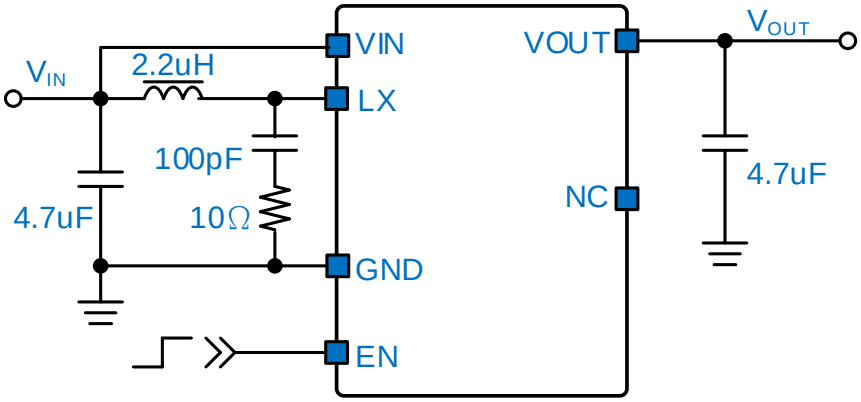
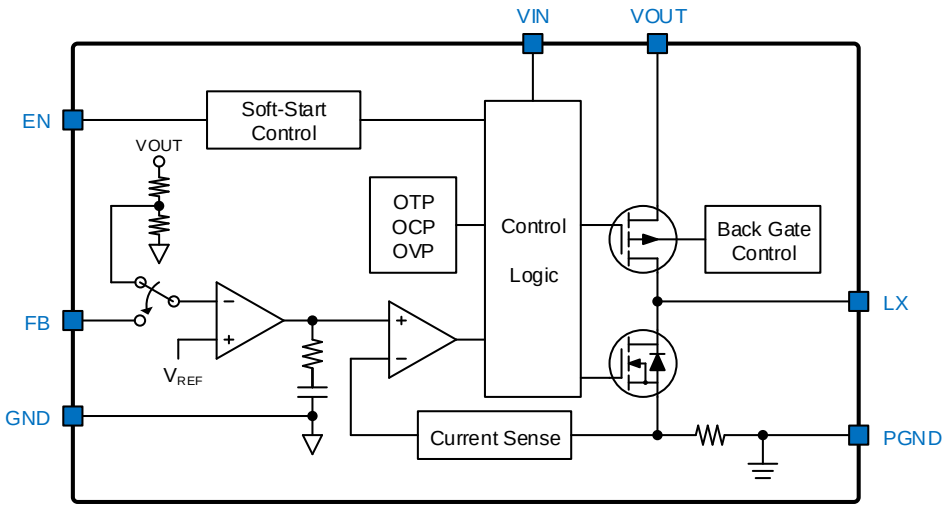


Figure 2 : Application circuit of Fixed V_{OUT} by DS4801-50 .

Function Block Diagram



Absolute Maximum Ratings (Note 1)

VIN to GND ---------- -0.3V to 6V

Other to GND ---------- -0.3V to 6V

Package Thermal Resistance (Note 2)

SOT-23-6 , θ_{JA} ---------- 200 °C /W

DFN2x2-6L , θ_{JA} ---------- 95 °C /W

Lead Temperature (Soldering, 10 sec.) ---------- 260 °C

Junction Temperature ---------- 150 °C

Storage Temperature Range ---------- -60 °C to 150 °C

ESD Susceptibility

HBM ---------- 2KV

MM ---------- 200V

Recommended Operating Conditions

Input Voltage VIN ---------- 2.5V to 5V

Junction Temperature Range ---------- -40 °C to 125 °C

Ambient Temperature Range ---------- -40 °C to 85 °C

Electrical Characteristics

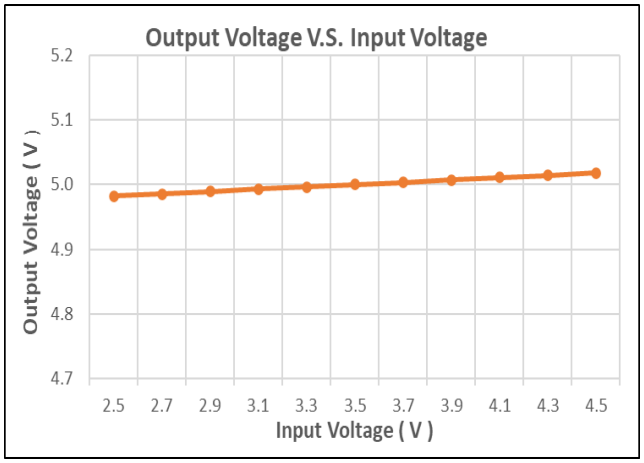
(V_{IN} =5V, T_A=25°C unless otherwise specified)

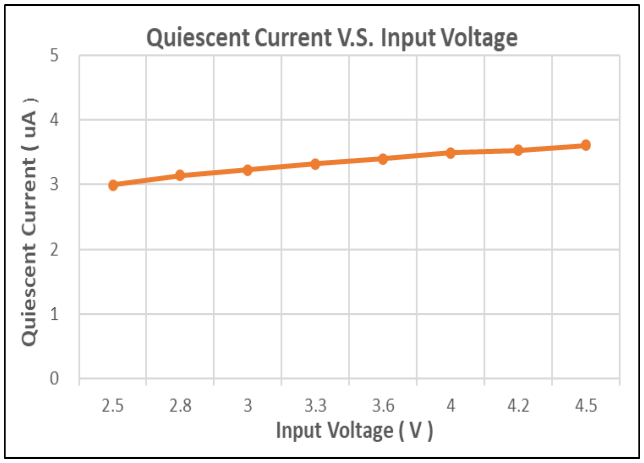
Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Input Voltage Range	V_{IN}		2.5		5.5	V
Under Voltage Lockout Threshold for Turn Off	V_{UVLO}	V_{IN} Decreasing		2.1		V
Output Voltage Range	V_{OUT}	V_{IN} < V_{OUT}	3.3		5.5	V
Over Voltage Protection	V_{OVP}		5.5	6.0		V
Shutdown Current form Power Source	I_{SD}	EN = 0V V_{OUT} = 0V		0.3	0.8	uA
Feedback Voltage	V_{FB}		1.1	1.125	1.15	V
FB Input Bias Current	I_{FB}			0.01	0.1	uA
Fix Output Voltage	V_{OUT}			5.0		V
Quiescent Current	I_Q	V_{EN}=V_{IN}=3.3V , V_{FB}=1.2V , Non-Switch		3		uA
Standby Current	I_Q	V_{EN}=V_{IN}=3.3V , V_{OUT}=5V , Switch & No Load		9		uA
NMOS Switch On-Resistance	$R_{DS(ON)}$	V_{OUT} = 5V	--	0.2	--	Ω
PMOS Switch On-Resistance	$R_{DS(ON)}$	V_{OUT} = 5V	--	0.3	--	Ω
NMOS Current Limit			0.7	0.9		A
Oscillation Frequency	F_W		0.5	1.0	1.5	MHz
EN Input Low Voltage	V_{IL}				0.4	V
EN Input High Voltage	V_{IH}		1.2			V
EN Input Current	I_{EN}			0.01	0.1	uA
Thermal shutdown temperature	T_{SD}			160		°C
Thermal shutdown temperature Threshold	ΔT_{SD}	Hysteresis		30		°C

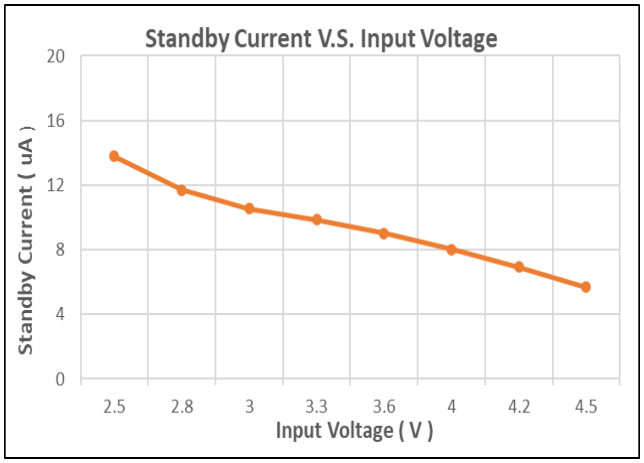
Note 1. Stresses beyond those listed “Absolute Maximum Ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions may affect device reliability.

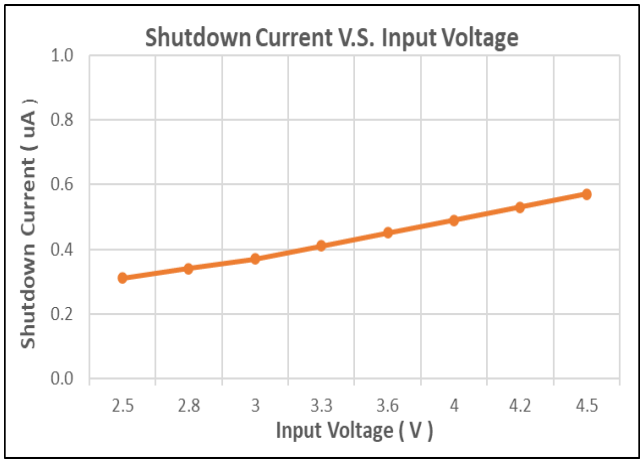
Note 2. θ_{JA} is measured at T_A = 25°C on a DSTECH EVB board.

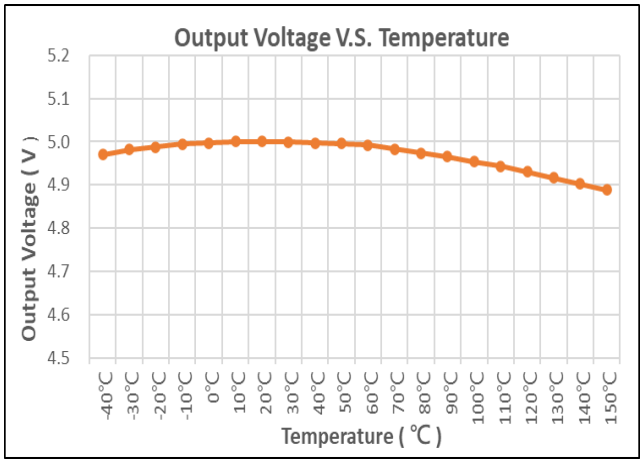
Typical Characteristics

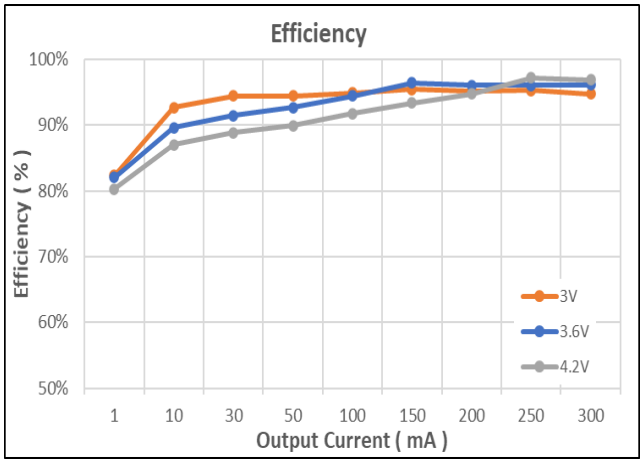












Application Guideline

Power-Down or Undervoltage Lockout (UVLO)

The DS4801 has a built-in undervoltage lockout (UVLO) circuit to ensure the device working properly. When the input voltage is above the UVLO rising threshold of 2.1 V, the DS4801 can be enabled to boost the output voltage. After the DS4801 starts up and the output voltage is above 2.4 V, the DS4801 works with input voltage as low as 1.5 V.

Switching Frequency and Power-Save Mode

The DS4801 switches at a quasi-constant 1.5 MHz frequency when the input voltage is above 2.1 V. The DS4801 integrates a power-save mode with PFM to improve efficiency at light load. When the load current decreases, the inductor valley current set by the output of the error amplifier no longer regulates the output voltage. When the inductor valley current hits the low limit, the output voltage exceeds the setting voltage as the load current decreases further. When the FB voltage hits the PFM reference voltage, the DS4801 goes into the power-save mode. In the power-save mode, when the FB voltage rises and hits the PFM reference voltage, the device continues switching for several cycles because of the delay time of the internal comparator then it stops switching. The load is supplied by the output capacitor, and the output voltage declines. When the FB voltage falls below the PFM reference voltage, after the delay time of the comparator, the device starts switching again to ramp up the output voltage.

Enable and Soft Start

When the input voltage is above the UVLO rising threshold and the EN pin is pulled to a voltage above 1.2 V, the DS4801 is enabled and starts up. At the beginning, the DS4801 charges the output capacitors with a current of about 100 mA when the output voltage is below input voltage. When the output voltage is charged above input voltage, the output current is changed to having output current capability to drive the 12Ω resistance load. After the output voltage reaches the input voltage, the DS4801 starts switching, and the output voltage ramps up further. The typical start-up time is300 μs accounting from EN high to output reaching target voltage for the application with input voltage is 3.3 V, output voltage is 5 V, output effective capacitance is 4.7 μF, and no load. When the voltage at the EN pin is below 0.4 V, the internal enable comparator turns the device into shutdown mode. In the shutdown mode, the device is entirely turned off. The output is disconnected from input power supply.

Current Limit

The DS4801 uses a valley current limit sensing scheme. Current limit detection occurs during the off-time by sensing of the voltage drop across the synchronous rectifier.

When the load current is increased such that the inductor current is above the current limit within the whole switching cycle time, the off-time is increased to allow the inductor current to decrease to this threshold before the next on-time begins (so called frequency foldback mechanism). When the current limit is reached, the output voltage decreases during further load increase.

Adjustable Output Voltage Application

The output voltage is set by an external resistor divider (R1, R2 in Equation 1). When the output voltage is regulated, the typical voltage at the FB pin is V_{FB}. Thus the resistor divider is determined by Equation 1:

$$V_{OUT} = \frac{R1+R2}{R2} \times V_{FB} \quad (1)$$

For the best accuracy, should be kept R2 smaller than 1MΩ to ensure the current flowing through R2 is at least 100 times larger than the FB pin leakage current. Changing R2 towards a lower value increases the immunity against noise injection. Changing the R2 towards a higher value reduces the quiescent current for achieving highest efficiency at low load currents.

Inductor Selection

Because the selection of the inductor affects steady-state operation, transient behavior, and loop stability. The inductor is the most important component in power regulator design. There are three important inductor specifications, inductor value, saturation current, and dc resistance (DCR) .

The DS4801 is designed to work with inductor values between 1 μH and 10 μH. To calculate the current in the worst case, use the minimum input voltage, maximum output voltage, and maximum load current of the application. To have enough design margins, choose the inductor value with –30% tolerances, and low power-conversion efficiency for the calculation .

Output Capacitor Selection

The output capacitor is mainly selected to meet the requirements for output ripple and loop stability. The ripple voltage is related to capacitor capacitance and its equivalent series resistance (ESR).

Recommends using the X5R or X7R ceramic output capacitor in the range of 2.2μF to 47μF effective capacitance. The output capacitor affects the small signal control loop stability of the boost regulator. If the output capacitor is below the range, the boost regulator can potentially become unstable. Increasing the output capacitor makes the output ripple voltage smaller in PWM mode.

OTP (Over Temperature Protection)

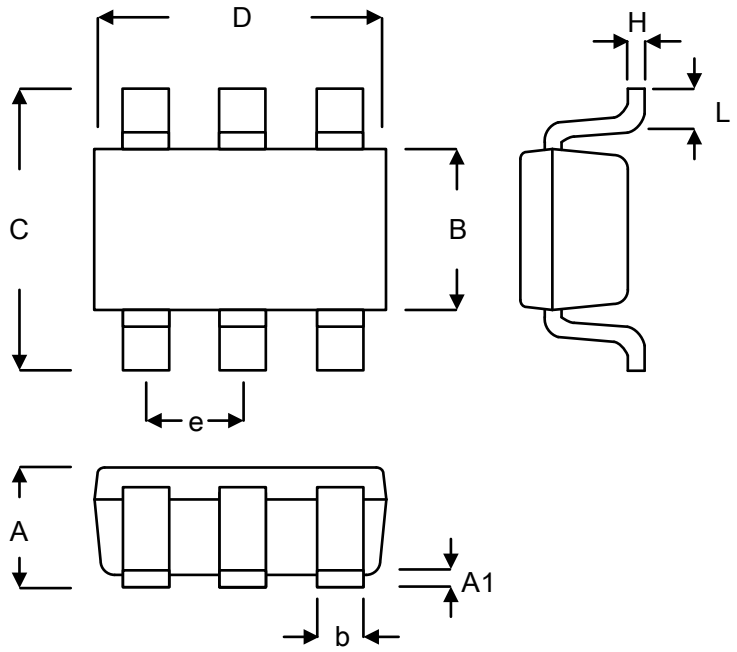
The DS4801 goes into thermal shutdown once the junction temperature exceeds 160°C. When the junction temperature drops below the thermal shutdown recovery temperature, typically 130°C, the device starts operating again.

Layout Consideration

The best performance can be achieved by placing the DS4801 LX pins and inductor on the same side of the PCB and placing them as close as possible to the package. The ground connections of the input and output capacitors must be returned to the DS4801 ground pins, using copper traces as wide and as short as possible.

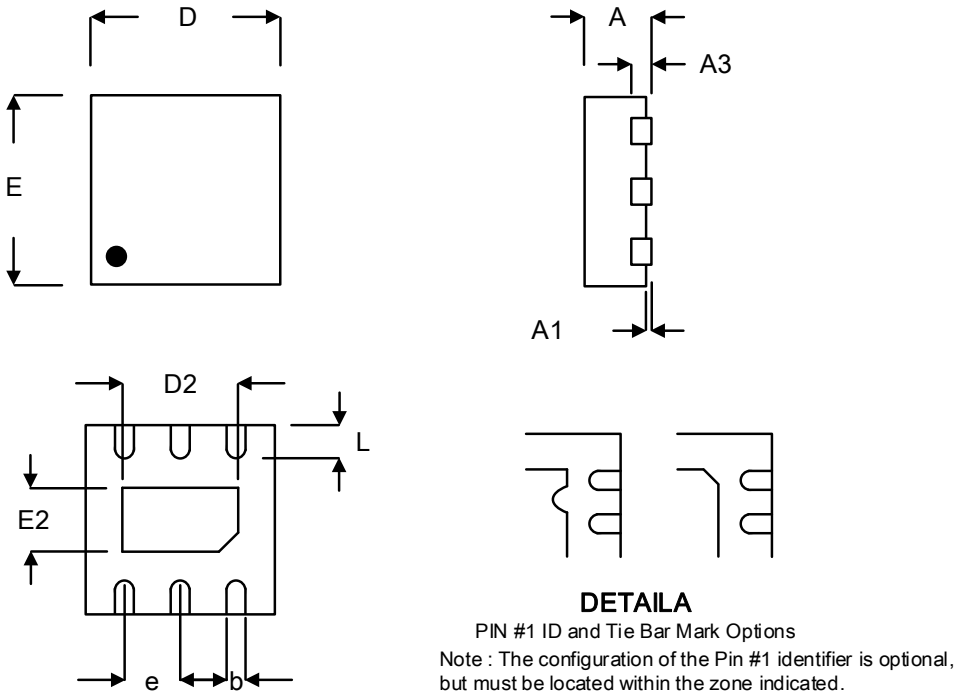
The use of connections with long trace lengths, narrow trace widths, and/or connections through vias must be avoided. These will increase parasitic inductance and resistance, leading to poor performance, especially under transient conditions.

Package Information:



Symbol	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A	0.889	1.295	0.035	0.051
A1	0.000	0.152	0.000	0.006
B	1.397	1.803	0.055	0.071
b	0.356	0.559	0.014	0.022
C	2.591	2.997	0.102	0.118
D	2.692	3.099	0.106	0.122
e	0.838	1.041	0.033	0.041
H	0.080	0.254	0.003	0.010
L	0.300	0.610	0.012	0.024

SOT-23-6L



Symbol	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A	0.700	0.800	0.028	0.031
A1	0.000	0.050	0.000	0.002
A3	0.175	0.250	0.007	0.010
b	0.200	0.350	0.008	0.014
D	1.950	2.050	0.077	0.081
D2	1.000	1.450	0.039	0.057
E	1.950	2.050	0.077	0.081
E2	0.500	0.850	0.020	0.033
e	0.650		0.026	
L	0.300	0.400	0.012	0.016

DFN2X2-6L