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XS5502-SOC of Li-Battery Transfer to Dry Battery Solution

GENERAL DESCRIPTION

XS5502 is one SOC that it integrates Li-Battery Protection and Buck converter in only DFN3x3-10 package.

This SOC can output 1.5Vout 2A with Li-Battery Input and has the whole battery protection function include Vcu、Vdl、Iov、short protection.

It only need few components and can reduce the BOM area and BOM cost.

FEATURES

- 2.5V to 5.5V Input Range
- 2A Output Capability

- High Efficiency up to 95%
- Low Quiescent Current 20uA
- Adjustable Output Voltage from 0.6V to VIN
- 1.5MHz Constant Frequency Operation
- Under Voltage Lockout, Over Current, Short Current, and Thermal Protection
- Li Protection OCU-4.3V ODU-2.4V
- Li Protection OCP-3A
- Have UVLO、OTP 、Short protection
- Operating Temperature: -40°C to +85℃
- Available in very tiny DFN3X3-10L Package
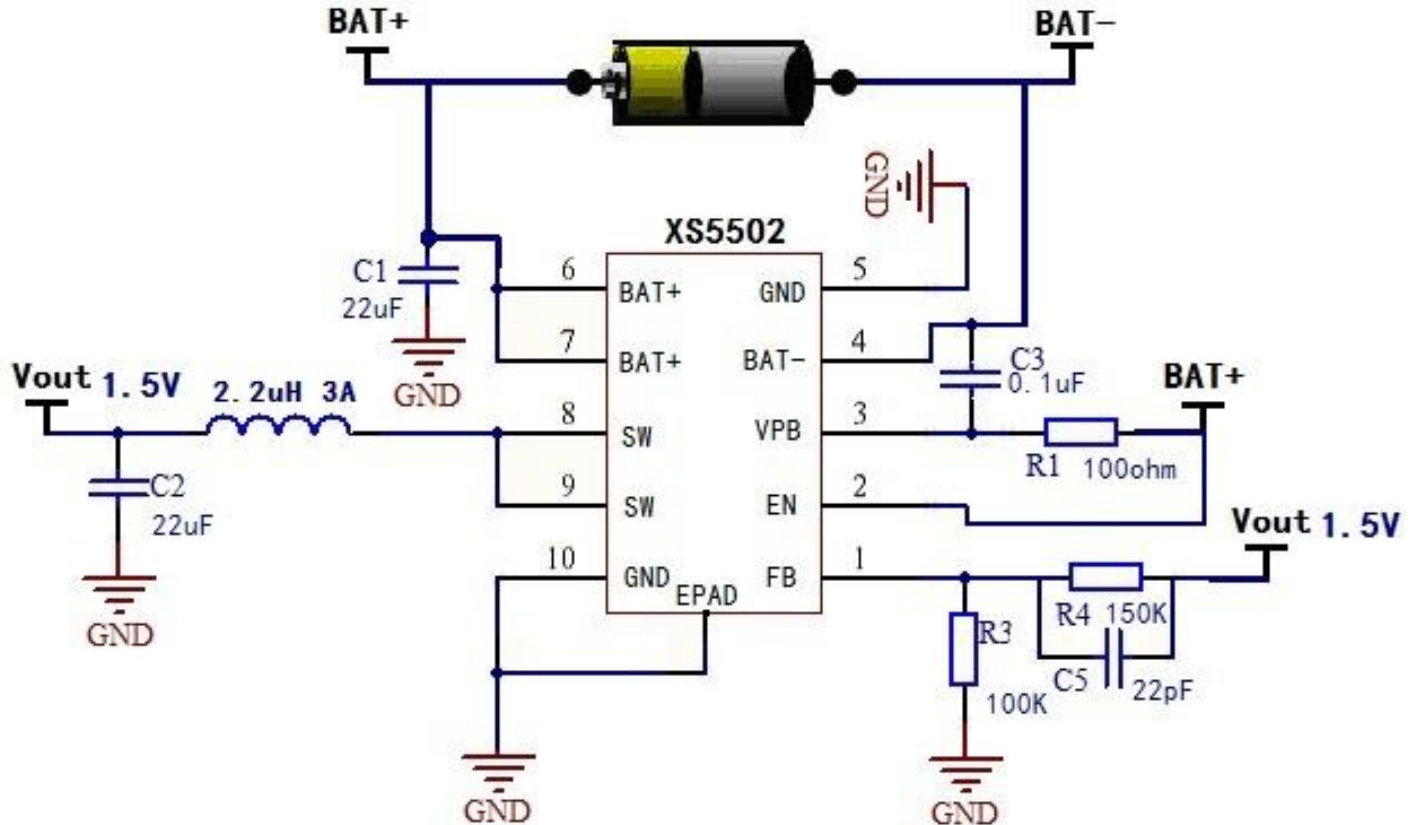- RoHS Compliant and 100% Lead(Pb)-Free

Figure 1. Typical Application Circuit1

ORDERING INFORMATION

PART NUMBER	TEMP RANGE	VIN LI-BATTERY	OUTPUT VOLTAGE (V)	VCU	VDL	IOV	MARK	PACKAGE	PINS
XS5502	-40°C to 85°C	2.5V~5.5V	ADJ	4.3V	2.4V	3A	XS5502YW	DFN3x3	10

Note: "YW" is manufacture date code, "Y" means the year, "W" means the week

PIN CONFIGURATION

Figure 2. PIN Configuration

PIN DESCRIPTION

PIN NUMBER	PIN NAME	PIN DESCRIPTION
1	FB	Feedback Input. FB senses the output voltage to regulator that voltage. Drive FB with a resistive voltage divider from the output voltage. The feedback threshold is 0.6V
2	EN	Enable Input. EN is a digital input that turns the regulator on or off. Drive EN high to turn on the regulator, driver it low to turn it off.
3	VPB	The Power Supply of Li-Protection section , Should connect 0.1uF capacitor between Vpb and BAT- as close as possible and 100ohm resistor to BAT+
4	BAT-	Li-Battery's Negative Pole
6,7	BAT+	Li-Battery's Positive Pole , should be bypassed with a 22uF capacitor.
8,9	SW	Switch Pin
5,10, EPADF	GND	Ground and EPAD, Please connect with mass metal

ABSOLUTE MAXIMUM RATINGS

(Note: Do not exceed these limits to prevent damage to the device. Exposure to absolute maximum rating conditions for long periods may affect device reliability.)

PARAMETER	VALUE	UNIT
Supply Voltage BAT+、 BAT-、VPB	-0.3V to +6V	V
FB, EN Voltage	-0.3V to BAT+ +0.3V	V
SW Voltage	-0.3V to BAT+ +0.3V	V
Operating Ambient Temperature	-40 to 85	°C
Maximum Junction Temperature	125	°C
Storage Temperature	-55 to 150	°C
Lead Temperature (Soldering, 10 sec)	300	°C

ELECTRICAL CHARACTERISTICS

(V_{IN} = 3.6V, T_A= 25°C unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Input Voltage Range	Vbat		2.5		5.5	V
UVLO Threshold	V_{UVLO}	$V_{HYSTERESIS}$ =100mV	2.35	2.45	2.5	V
Operating Supply Current		V_{FB} =0.5V or V_{OUT} =90%, I_{Load} =0		130	170	
Standby Supply Current	I_{SUPPLY}	V_{FB} =0.7V or V_{OUT} =110%, I_{Load} =0		20		µA
Shutdown Supply Current		V_{EN} =0V, V_{bat} =4.2V		0.1	1	
Regulated Feedback Voltage	V_{FB}	T_a =25°C	0.588	0.6	0.612	V
		0< T_a <85°C	0.5865	0.6	0.6135	
		-40°C < T_a <85°C	0.585	0.6	0.615	
Reference Voltage Line Regulation		V_{bat}=2.7V to 5.5V		0.04	0.4	%
Regulated Output Voltage	V_{OUT}	V_{OUT} =1.5V; I_{OUT} =100mA	1.455	1.5	1.545	V
Output Voltage Load Regulation				0.5		%
Peak Inductor Current	I_{PEAK}	V_{bat} =3V, V_{FB} =0.5V or V_{OUT} =90%,Duty Cycle<35%		3		A
Oscillator Frequency	F_{OSC}	V_{FB}=0.6V or V_{OUT} =100%	1.2	1.5	1.8	MHz
		V_{FB}=0 or V_{OUT} =0		220		KHz

Rds(ON) of P-channel FET		I_{SW} =100mA		0.15	0.3	Ohm
Rds(ON) of N-channel FET		I_{SW} =100mA		0.11	0.2	Ohm
Enable Threshold		V_{bat} = 2.5V to 5.5V	0.3	1	1.5	V
Enable Leakage Current			-0.1		0.1	µA
SW Leakage Current		V_{EN} = 0V, V_{SW} = 0V or 5V, V_{bat} = 4.2V	-1		1	uA
Overcharge Detection Voltage	V_{CU}		4.25	4.30	4.35	V
Overcharge Release Voltage	V_{CL}		4.05	4.10	4.15	V
Overdischarge Detection Voltage	V_{DL}		2.3	2.4	2.5	V
Overdischarge Release Voltage	V_{DR}		2.9	3.0	3.1	V
Charger Detection Voltage	V_{CHA}		-0.07	-0.12	-0.2	V
Overdischarge Current1 Detection	I_{IOV1}	V_{DD}=3.5V	2.1	3	3.9	A
Load Short-Circuiting Detection	I_{SHORT}	V_{DD}=3.5V	10	20	30	A
Equivalent FET on Resistance	$R_{DS(ON)}$	VDD=3.6V IVM =1.0A	40	45	55	mΩ
Overcharge Voltage Detection Delay Time	t_{CU}			130		mS
Overdischarge Voltage Detection Delay Time	t_{DL}			40		mS
Overdischarge Current Detection Delay Time	t_{IOV}	V_{DD}=3.5V		10		mS
Load Short-Circuiting Detection Delay Time	t_{SHORT}	V_{DD}=3.5V		75		uS

FUNCTIONAL DESCRIPTION

NORMAL OPERATION

XS5502 integrates Li-Battery Protection and Buck converter in only DFN3x3-10 package.

In Buck normal operation the high-side MOSFET turns on each cycle and remains on until the current comparator turns it off. At this point the low-side MOSFET turns on and remains on until either the end of the switching cycle or until the inductor current approaches zero. The error amplifier adjusts the current comparator's threshold as necessary in order to ensure that the output remains in regulation.

Li-Battery Protection can detect the battery cell's status such as Vcu、Vcl , Temp、short-cut、Over-current and take action to protect battery cell.

APPLICATION INFORMATION

INDUCTOR SELECTION

In normal operation, the inductor maintains continuous current to the output. The inductor current has a ripple that is dependent on the inductance value. The high inductance reduces the ripple current. In general, select the inductance by the following equation:

$$L = \frac{V_{OUT} \times (V_{IN} - V_{OUT})}{V_{IN} \cdot f \cdot \Delta I}$$

Where V_{OUT} is the output voltage, V_{IN} is the input voltage, f is the switch frequency, and ΔI is the peak-to-peak inductor ripple current. Typically, choose ΔI as the 30% of the maximum output current.

Manufacturer	Part Number	Inductance (uH)	DRC max (Ohms)	Dimensions L*W*H (mm3)
Murata	LQH5BPN	1	0.019	5*5*2
		2.2	0.030	
	LQH44PN	1	0.036	4*4*1.7
		2.2	0.049	
WURTH	74437324022	2.2	0.061	4.4*4.05

Table 1. Recommend Surface Mount Inductors

INPUT CAPACITOR SELECTION

The input capacitor reduces input voltage ripple to the converter, low ESR ceramic capacitor is highly recommended. For most applications, a 22uF capacitor is used. The input capacitor should be placed as close as possible to VIN and GND.

OUTPUT CAPACITOR SELECTION

A low ESR output capacitor is required in order to maintain low output voltage ripple. In the case of ceramic output capacitors, capacitor ESR is very small and does not contribute to the ripple, so a lower capacitance value is acceptable when ceramic capacitors are used. A 22uF ceramic output capacitor is suitable for most applications.

OUTPUT VOLTAGE PROGRAMMING

In the adjustable version, the output voltage is set by a resistive divider according to the following equation:

$$R4 = R3 \times \left(\frac{Vout}{0.6} - 1 \right)$$

Typically choose R3=100K and determine R4 from the following equation:

For Example, R3=100K R4=150K to set 1.5Vout

Connect a small capacitor across R4 feed forward capacitance at the FB pin for better performance.

PCB LAYOUT GUIDE

1,   The input\ output\VPB capacitors should be placed very close to the device and ground, to keep the loop resistance very low and the switching loop very small.

2,   All ground connection must be tied together. It is desirable to maximize the PCB copper area connecting to GND/EPAD pin to achieve the best thermal and noise performance. If the board space allowed, a ground plane is highly desirable

3,   The FB pin connection should be made as close to the load as possible so that the voltage at the load is the expected regulated value.

4,   The FB pin and VPB connection must NOT be adjacent to the SW net on the PCB layout to avoid the noise problem

4,   The switch node connection should be low resistance to reduce power losses.
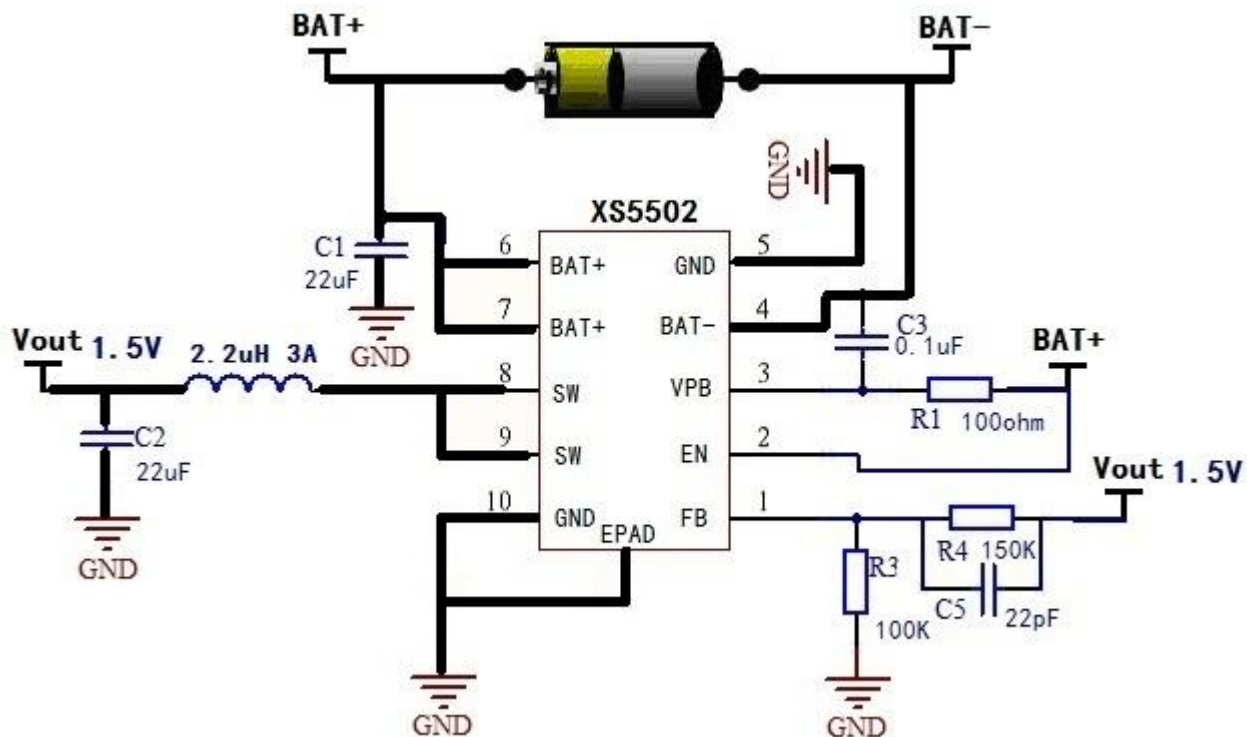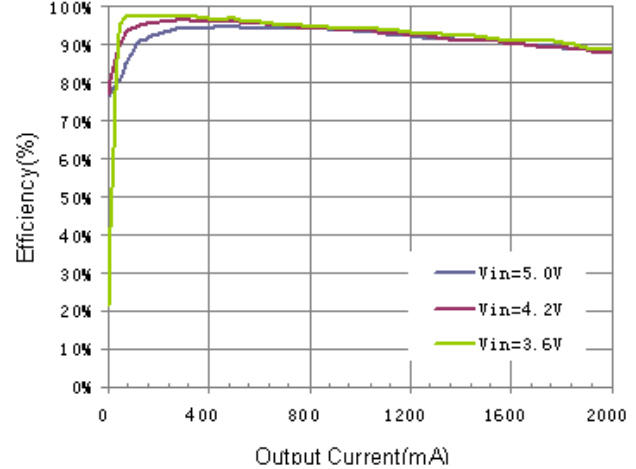

BIG CURRENT CIRCUIT
As above(Heavy Lines)

TYPICAL PERFORMANCE CHARACTERISTICS

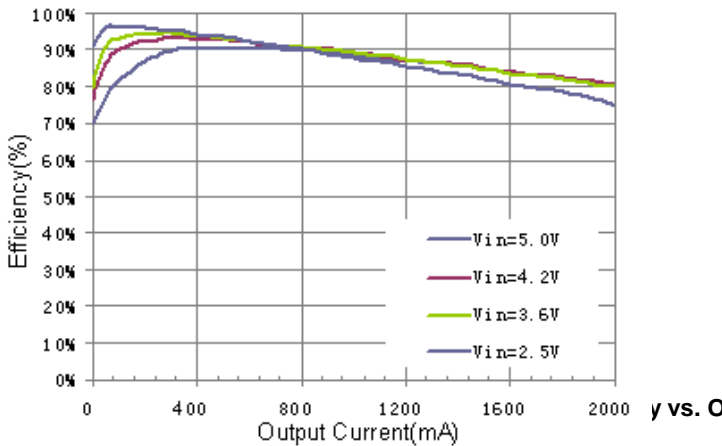(VIN=VEN=5V, L=2.2uH, CIN=22uF, COUT=22uF，if not mentioned)
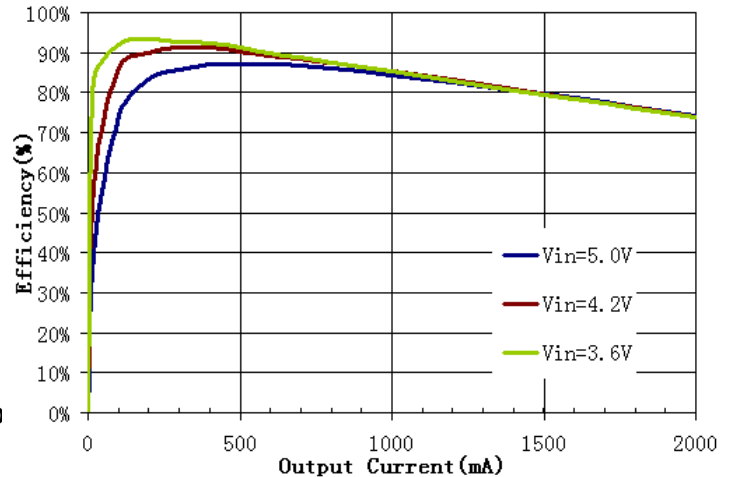
Efficiency vs. Output Current
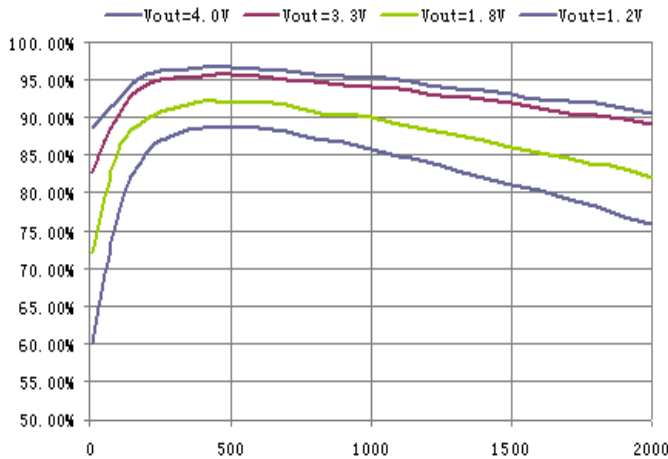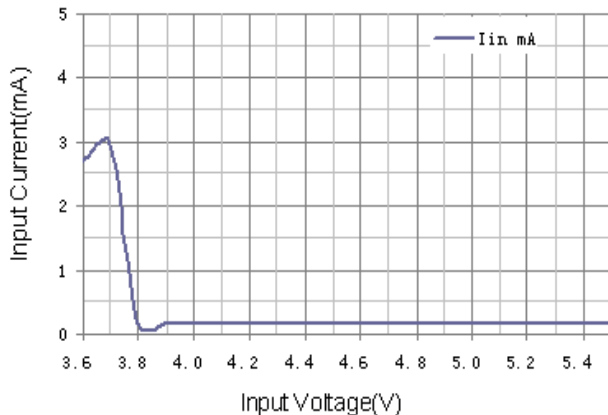

Efficiency vs. Output Current(Vout=3.3V)
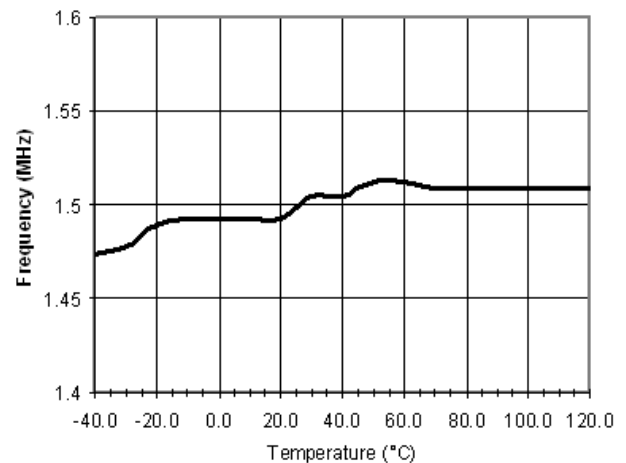

Efficiency vs. Output Current(Vout=1.8V)

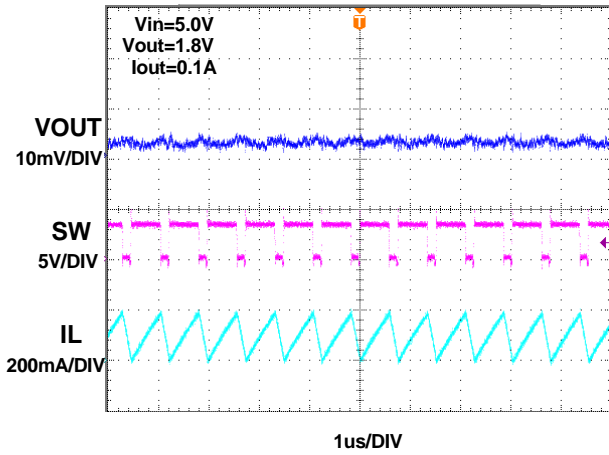**Efficiency vs.Output Current(Vout=1.2V)**
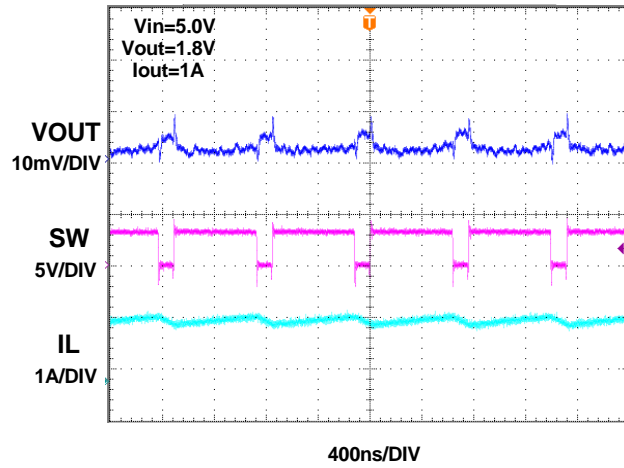

Input Current VS. Input Voltage（Vout=3.3V）

Oscillator Frequency vs. Temperature

Steady State Waveform

Vin=5.0V
Vout=1.8V
Iout=0.1A

VOUT
10mV/DIV

SW
5V/DIV

IL
200mA/DIV

1us/DIV

Steady State Waveform

Vin=5.0V
Vout=1.8V
Iout=1A

VOUT
10mV/DIV

SW
5V/DIV

IL
1A/DIV

400ns/DIV

Transient Waveform(Vout=3.3V,Iout=0.15A-1.5A)

Ch1 200mV Ch2 50.0mV M 100μs A Ch2 548mV
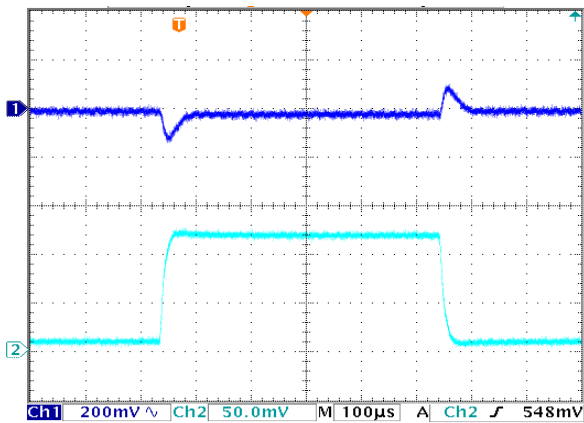
Startup through Enable Waveform

Vin=5V
Vout=1.8V
Iout=600mA

VOUT
1V/DIV

EN
5V/DIV

40us/DIV
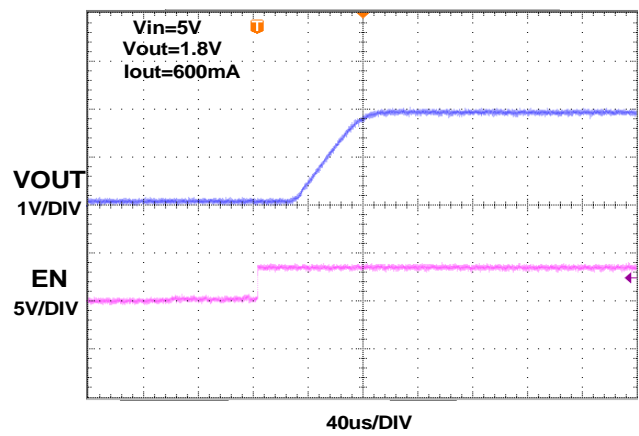
PACKAGE OUTLINE

DFN-10L 3MM X 3MM PACKAGE OUTLINE AND DIMENSIONS

Top View

Bottom View

Side View
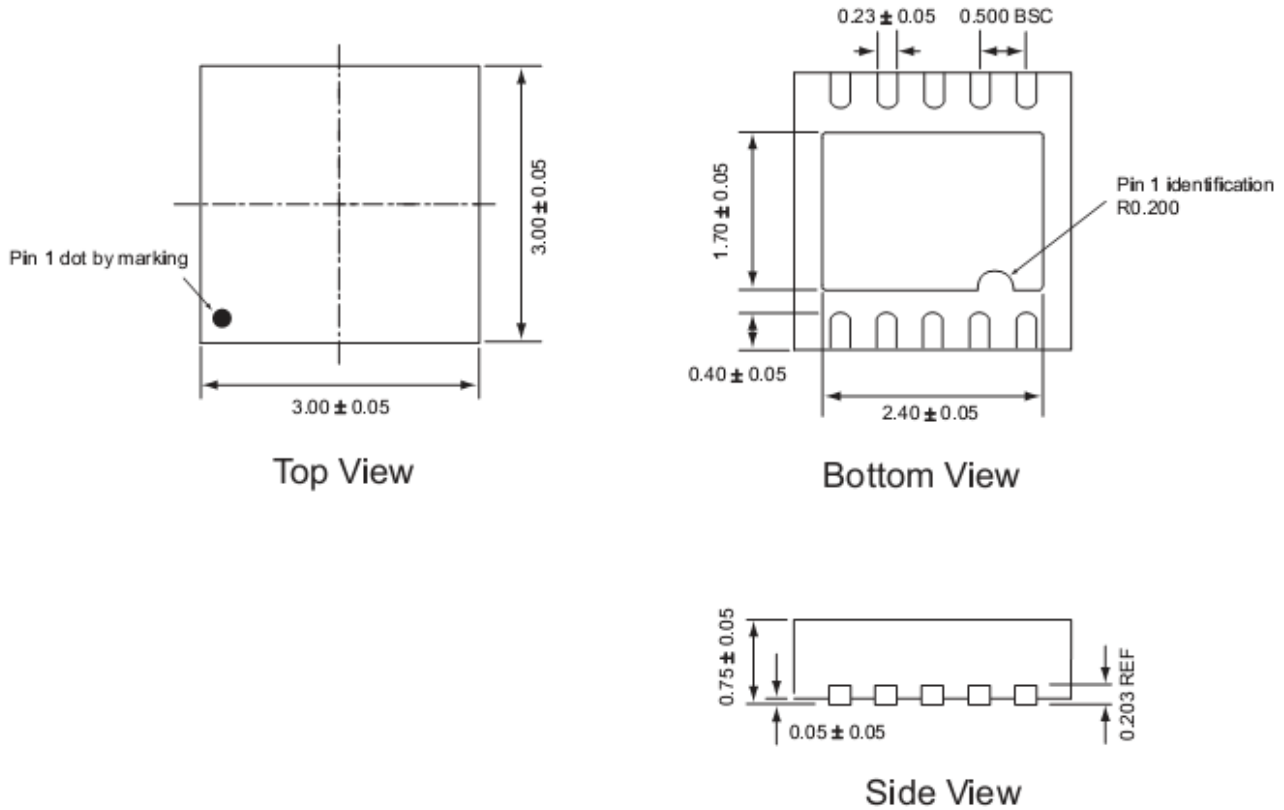
PROUCT CHANGE NOTICE LIST

NO	Updated date	Version update	Update content
1	2015-1-13	Rev 0.1	Create datasheet