



Low Quiescent Current 5V Buck-Boost Converter

1 Descriptions

The HT8710A is a constant frequency peak current mode control buck-boost converter. The device has a 3-A peak current limit (typical) and 1.95V to 5.5V input voltage range

The HT8710A provides a power supply solution for system pre-regulators and voltage stabilizers. Depending

on the input voltage, the HT8710A automatically operates in boost, buck, or in 3- cycle buck-boost mode when the input voltage is approximately equal to the output voltage.

6- μ A quiescent current enable the highest efficiency for light to no-load conditions.

The HT8710A offers a very small solution size with a 1.2-mm $\times$ 2.1-mm SOT-583 package, a 1- μ H inductor, and 0805 output capacitor.

2 Features

- 1.95V to 5.5V input voltage range & 1.6V falling voltage
- 2V to 5.3V output voltage range (adjustable)
- High output current capability, 3-A peak switch current
 - 2A output current for $V_{IN} \geq 2.7$ V, $V_{OUT} = 3.3$ V
 - 1.5A output current for $V_{IN} \geq 2.4$ V, $V_{OUT} = 3.3$ V
- High efficiency over the entire load range
- 6- μ A typical quiescent current
- Peak current buck-boost mode architecture
 - Seamless mode transition with < 50mV output ripple
 - Fixed frequency operation with 2-MHz switching
- Safety and robust operation features
 - Short-circuit protection
 - Over temperature protection
 - Over voltage protection
- Small solution size
 - Small 1- μ H inductor
 - Works with one 0805 output capacitor over the full V_{OUT} range

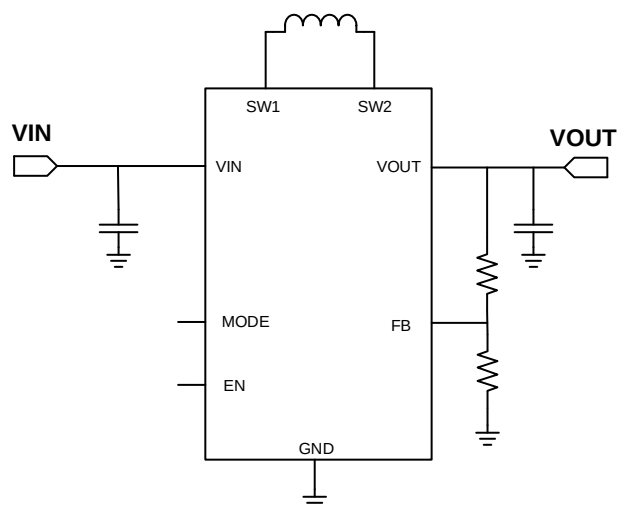
3 Applications

- System pre-regulator (smartphone, tablet, terminal, telematics)
- Point-of-load regulation (wired sensor, port/cable adapter, and dongle)
- IP camera sensors
- RF amplifier supply (smart sensors)
- Optical modules

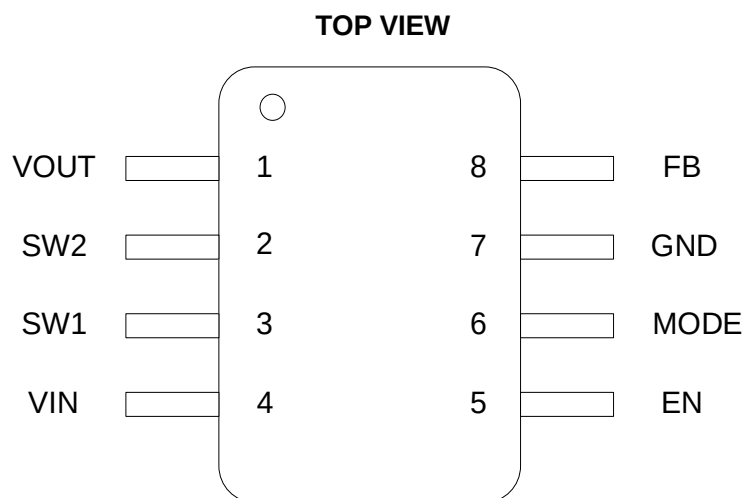
4 Device

ORDER NUMBER	FUNCTION	PARAMETER	PACKAGE	BODY SIZE
HT8710ARTZ	MODE	MODE	SOT583	1.6mm x 2.1mm

6 Typical



7 Termin



TERMINAL		I/O	DESCRIPTION
NUMBER	NAME		
1	VOUT	PWR	Power stage output
2	SW2	PWR	Switching Note1
3	SW1	PWR	Switching Note2
4	VIN	PWR	Power stage input
5	EN	I	Enable pin
6	MODE	I	Mode pin; MODE =1, PWM mode; MODE = 0, PFM mode
7	GND	PWR	GND
8	FB	I/O	Output voltage feedback point

8 Specifi

8.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted) ⁽¹⁾

PARAMETER		MIN	MAX	Unit
Voltage range at terminals ⁽²⁾	VIN, VOUT, SW1, SW2, EN, MODE, GND, FB	-0.3	6	V
	SW1, SW2 (Less than 10ns)	-2	7	V
T _J	Operating junction temperature range	-40	150	°C
T _{stg}	Storage temperature range	-65	150	°C

(1) Stresses beyond those listed under *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 under *recommended operating conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

(2) All voltage values are with respect to network ground terminal.

8.2 Handling Ratings

PARAMETER	DEFINITION		MIN	MAX	UNIT
ESD ⁽¹⁾	Human body model (HBM) ESD stress voltage ⁽²⁾	All pins except	-2	2	kV
	Charged device model (CDM) ESD stress voltage ⁽³⁾		-500	500	V

(1) Electrostatic discharge (ESD) to measure device sensitivity and immunity to damage caused by assembly line electrostatic discharges into the device.

(2) Level listed above is the passing level per ANSI, ESDA, and JEDEC JS-001. JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.

(3) Level listed above is the passing level per EIA-JEDEC JESD22-C101. JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

8.3 Recommended Operating Conditions

PARAMETER		MIN	TYP	MAX	UNIT
V _{IN}	VIN voltage range	1.95		5.5	V
V _{OUT}	VOUT voltage range	2		5.3	V
C _{IN}	Input capacitance	4.2			μF
C _{OUT}	Output capacitance	10		330	μF
L	Inductance	0.8	1	1.2	μH
T _A	Operating ambient temperature	-40		85	°C
T _J	Operating junction temperature	-40		125	°C

8.4 Therma

THERMAL RESISTANCE ⁽¹⁾		QFN-32 (4mm x 4mm)	UNIT
Θ_{JA}	Junction to ambient thermal resistance	TBD	°C/W

(1) Measured on JESD51-7, 4-layer PCB.

8.5 Electrical Characteristics

$T_J = 25^\circ\text{C}$ and $V_{IN} = 3.7\text{V}$, $V_{OUT} = 3.3\text{V}$ unless otherwise noted.

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
SUPPLY VOLTAGE						
I _{SD}	Shutdown current into VIN	V _{IN} = 3.7V, V _{OUT} = 0V, V _{EN} = 0V	0.35			μA
I _{Q_VIN}	Supply current into VIN		6			μA
V _{INUVLO}	VIN UVLO Rising		1.95			V
	VIN UVLO Falling		1.6			V
I/O SIGNALS						
V _{HL}	EN, MODE Input high voltage		1.2			V
V _{IL}	EN, MODE Input low voltage		0.4			V
T _{Delay}	Delay time of EN function	Rising & Falling	2			μs
POWER SWITCH						
F _{SW}	Switching frequency		2			MHz
T _{ON_MN}	Minimum on time		50			ns
T _{DT}	Dead Time		5			ns
R _{D_SON}	High side MOS on resistance	Q1	40			mΩ
	Low side MOS on resistance	Q2	65			mΩ
	Low side MOS on resistance	Q3	65			mΩ
	High side MOS on resistance	Q4	50			mΩ
CURRENT LIMIT						
I _{LIMIT}	Peak current Limit		3	3.5	4	A
		VOUT short status	1			A
ILIMIT	Peak current Limit in PFM		0.15			A
I _{LIMIT}	Negative peak current limit	PWM Mode	-0.6			A
OUTPUT						
V _{FB}	Reference voltage on Feedback	T _J = 25°C	495	500	505	mV
		T _J = -40°C ~ 125°C	490	500	510	mV
T _{SS}	Soft Start		2			ms
Protect						
V _{IN_OVP}			5.5	5.8		V

VOUT_OV P				
VOUT_SC			1	V
THERMAL SHUTDOWN				
T _{SD}	Thermal shutdown temperature		165	°C
	Thermal shutdown hysteresis		15	°C

8.6 Typical Characteristics

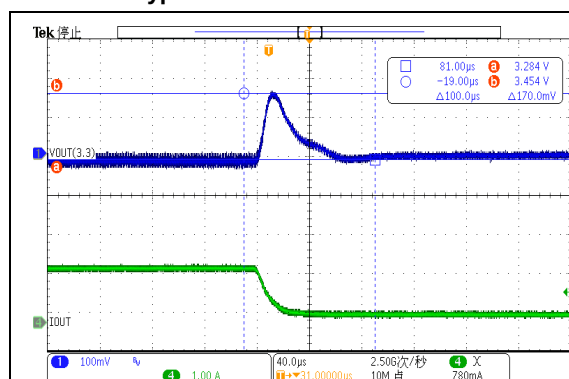


Fig1. Iload from 1.35A to 0.15A
 (VIN = 3.7V VOUT = 3.3V C_{OUT} = 0603 22uF *2)

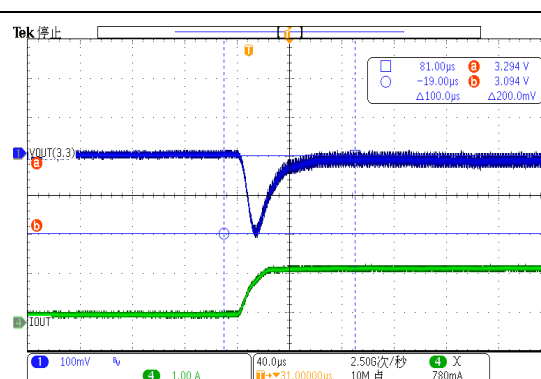


Fig2. Iload from 0.15A to 1.35A
 (VIN = 3.7V VOUT = 3.3V C_{OUT} = 0603 22uF *2)

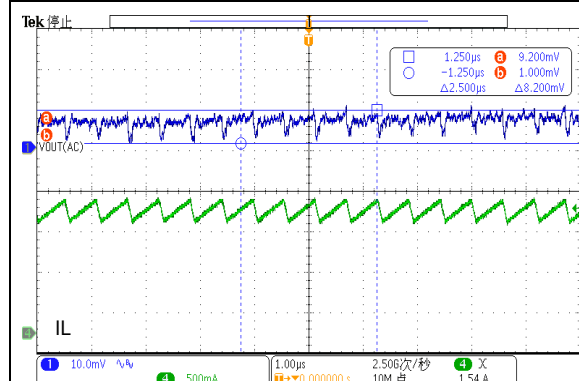


Fig3. VOUT Ripple in Buck Mode, Iout = 1.5A
 (VIN = 4.2V VOUT = 3.3V C_{OUT} = 0603 22uF *2)

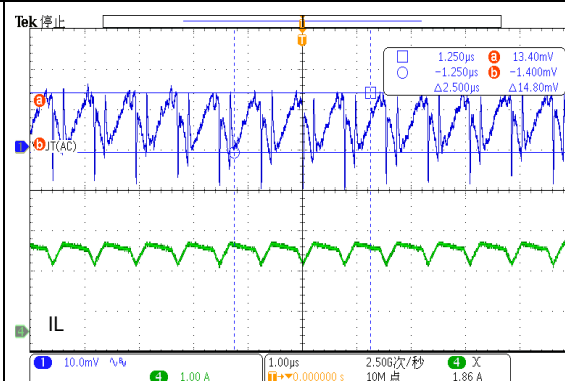


Fig4. VOUT Ripple in Buck-Boost Mode, Iout = 1.5A
 (VIN = 3.3V VOUT = 3.3V C_{OUT} = 0603 22uF *2)

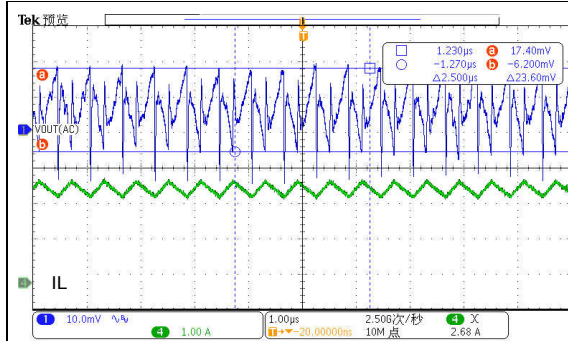


Fig5.VOUT Ripple in Boost Mode, Iout = 1.5A
(VIN = 2.5V VOUT = 3.3V C_{OUT} = 0603 22uF *2)

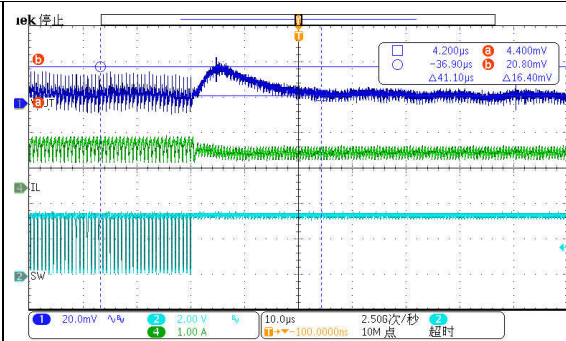


Fig6. VOUT Ripple in Boost Mode to Buck-Boost Mode, Iout = 1A
(VIN = 2.5V VOUT = 3.3V C_{OUT} = 0603 22uF *2)

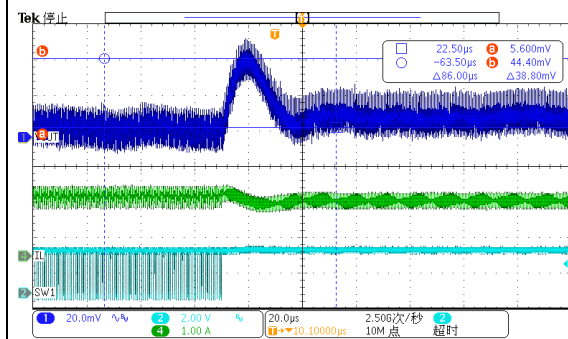


Fig7. VOUT Ripple in Buck-Boost Mode to Boost Mode, Iout = 1A
(VIN = 2.5V VOUT = 3.3V C_{OUT} = 0603 22uF *2)

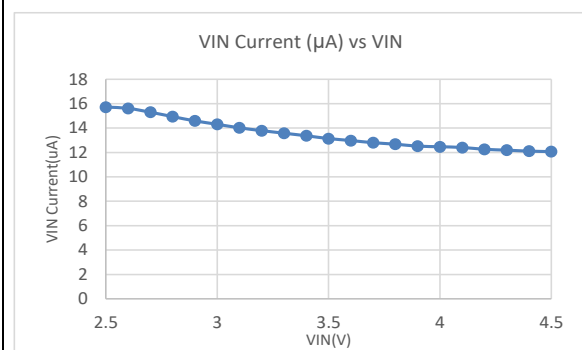
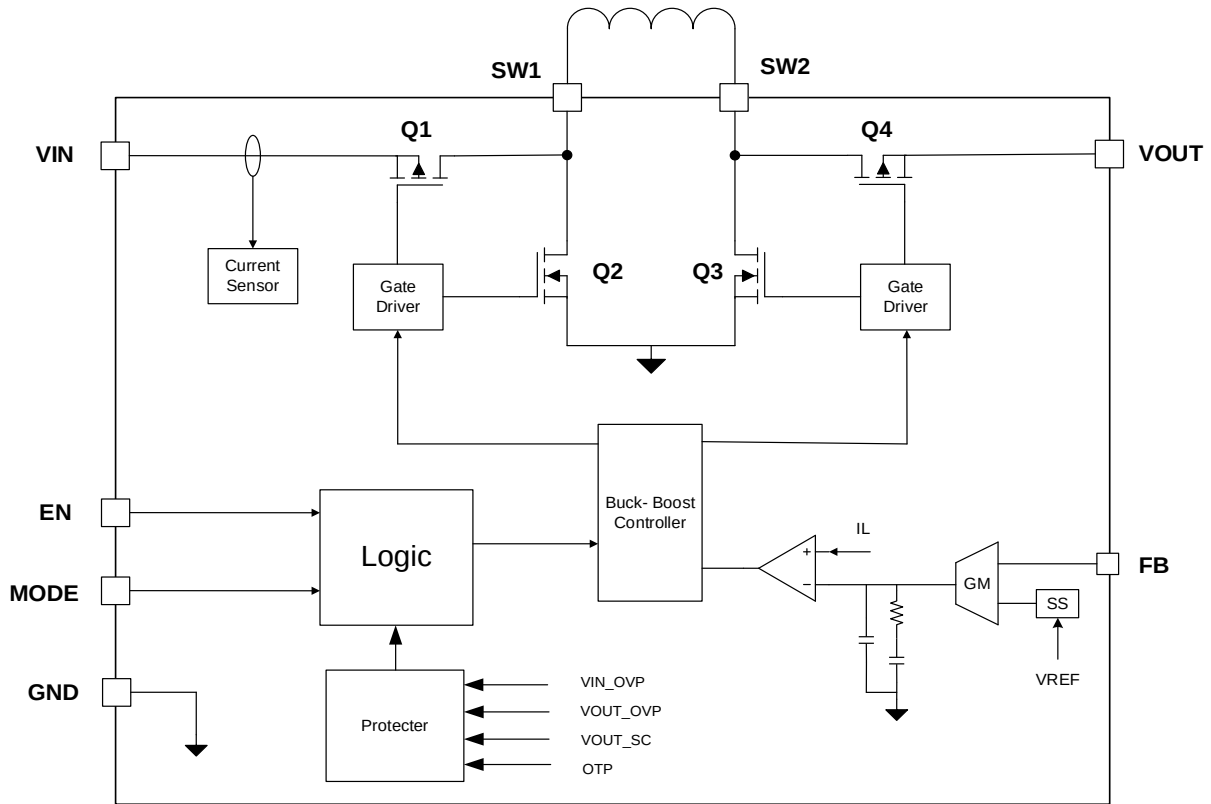


Fig8. No Load, VIN Current vs VIN

9 Functi



10 Featur

10.1 Overview

HT8710A is a wide range of 1.95 to 5.5V input voltage and an output voltage of 2V to 5.3V buck-boost DCDC converter. It can transition among buck mode, buck-boost mode, and boost mode smoothly when the input voltage is higher or lower than the output voltage. Due to

peak-current mode control, HT8710A is able to provide excellent line and load transient performance. HT8710A supports 2MHz frequency to achieve small device size.

10.2 Device Operation Modes

10.2.1 Buck Modes

When the input voltage is higher than output voltage, HT8710A works in buck mode. The buck side Q1 and Q2 switch for the buck regulation, while boost side Q3 is off and Q4 keeps on to conduct the inductor current.

10.2.2 Boost Modes

When the input voltage is lower than output voltage, HT8710A works in boost mode. The boost side Q3 and Q4 switch for the boost regulation, while buck side Q2 is off and Q1 keeps on to conduct the inductor current.

10.2.3 Buck-Boost Modes

When the input voltage is close to the output voltage, HT8710A works in buck-boost mode. The MOSFET turning on sequence are Q1&Q3 -> Q1&Q4 -> Q2&Q4.

10.3 Input Undervoltage Lockout

When the input voltage is above than 1.95V, the HT8710A can be enabled by pulling EN pin to a high voltage above 1.3V. When it starts running, HT8710A wouldn't be disabled until the input voltage is below 1.6V.

10.4 EN

The HT8710A0 has an enable control pin (EN). The voltage on the EN pin controls the ON/OFF operation. A voltage of less than 0.4V shuts down the device, while a voltage of greater than 1.2V is required to start the device. The EN pin is an input and cannot be left or floating.

HT8710A EN is a high voltage pin, it can be connected to VIN directly or through resistor. It could be established a precision system UVLO level by inserting resistors. An external logic signal can also be used to drive EN input for system sequencing and protection.

1

The integrated soft-start circuit prevents input inrush current and the input power supply. Soft start is achieved by slowly ramping up the internal reference voltage when the device is first enabled or powered up. If the output of HT8710A is pre-biased to a certain voltage during start-up, the IC disables the switching of both the high-side and low-side switches until the voltage on the internal Soft-start capacitor exceeds the internal feedback voltage.

10.6 Switching Current Limit

HT8710A provides peak current limit by sensing Q1 current. In buck mode, the next period won't start before IL rises to the peak current limit, which prevents inductor current runaway during short circuits on the output.

10.7 Adjustable Output Voltage

The output voltage is set by an external resistor divider. The feedback voltage is given by V_{FB} .

The output voltage could be calculated with the formula as below:

$$V_{OUT} = V_{FB} \times \left(1 + \frac{R_{FB_UP}}{R_{FB_DOWN}} \right)$$

The V_{FB} voltage is 0.5 V.

10.8 Mode Selection (PFM/FPWM)

The mode pin is a digital input to enable PFM/FPWM. When the MODE pin is connected to logic low, the device works in auto PFM mode. The device features a power save mode to maintain the highest efficiency over the full operating output current range. PFM automatically changes the converter operation from CCM to pulse frequency modulation.

When the MODE pin is connected to logic high, the device works in forced PWM mode, regardless of the output current, to achieve minimum output ripple.

10.9 Protection Features

The following sections describe the protection features of the device.

10.9.1 Input Overvoltage Protection

HT8710A has input overvoltage protection. When the input voltage at the VIN pin is detected above 5.8V typically, the HT8710A turns off both high-side switches and low-side switches.

10.9.2 Outp

HT8710A has output overvoltage protection. When the output voltage at the VOUT pin is detected above 5.6V typically, the HT8710A turns off both high-side switches and low-side switches. If the VOUT pin voltage drops to 5.3V, the device will return to normal operation.

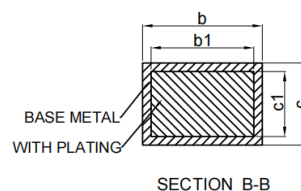
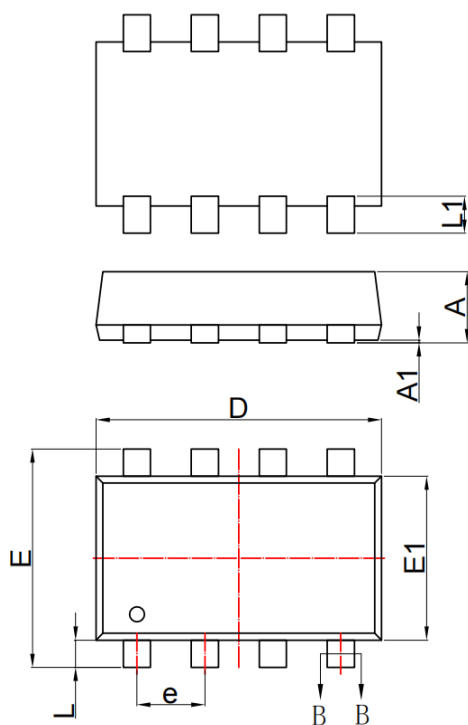
10.9.3 Short Circuit Protection

Once the output voltage is lower than 1V, HT8710A will enters short mode to reduce peak current limit. The HT8710A exits short mode once the output voltage is higher than 1.2V.

10.9.4 Thermal Shutdown

HT8710A is protected by a thermal shutdown circuit that shuts down the device when the internal junction temperature exceeds 150°C (Typical). The internal soft-start circuit is reset but all internal registers values remain unchanged. The DCDC portion will automatically restarts when the junction temperature drops below the thermal shutdown hysteresis.

MECHANICAL DATA



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	0.53	---	0.60
A1	0.00	---	0.05
b	0.18	---	0.26
b1	0.17	0.20	0.23
c	0.11	---	0.15
c1	0.10	0.11	0.12
D	<u>2.00</u>	<u>2.10</u>	<u>2.20</u>
E	1.50	1.60	1.70
E1	1.10	1.20	1.30
e	0.50BSC		
L	0.10	0.20	0.30
L1	0.20	0.30	0.40