TECH PUBLIC 台舟电子

TP8290BS6

High Efficiency,2MHz,40V Input,300mA Asynchronous Step Down Regulator

www.sot23.com.tw

General Description

The TP8290S6 is a high efficiency 2MHz, adaptive constant OFF time controlled asynchronous step-down DC-DC regulator capable of delivering 300mA output current. The TP8290S6 operates over a wide input voltage range from 5V to 40V.

Low output voltage ripple and small external inductor and capacitor sizes are achieved with 2MHz switching frequency.

Applications

- 5-40V input voltage range
- 2MHz switching frequency
- Adaptive constant OFF time control
- Internal softstart limits the inrush current
- 2% 0.6V reference
- RoHS Compliant and Halogen Free
- Compact package: SOT23-6

Features

- Smart meter
- Set Top Box
- Portable TV
- Access Point Router
- DSL Modem
- LCD TV

TYPICAL APPLICATION

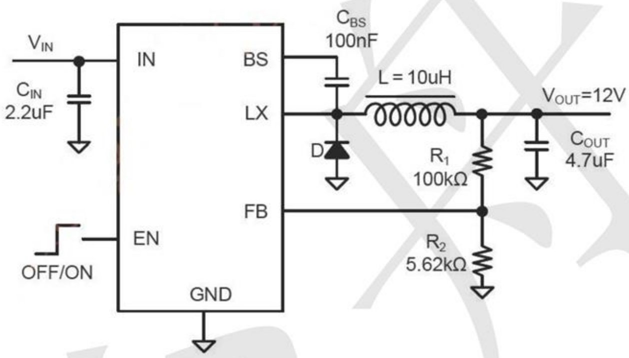


Figure 1 Schematic Diagram

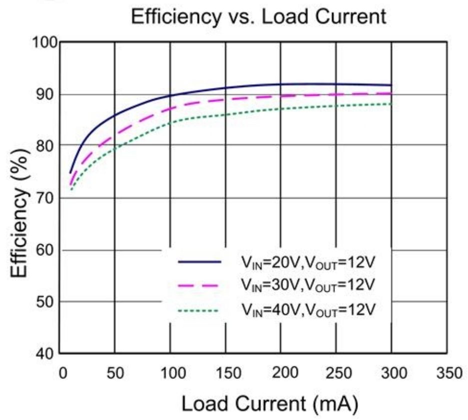
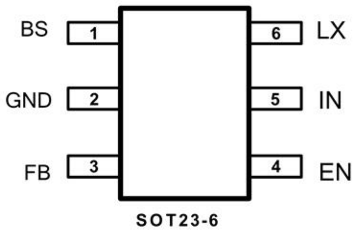


Figure 2 Efficiency Figure

PIN CONFIGURATION

TOP VIEW



Pin Name	Pin Number	Pin Description
BS	1	Boot-Strap Pin. Supply high side gate driver. Decouple this pin to LX pin with 0.1uF ceramic cap.
GND	2	Ground pin
FB	3	Output Feedback Pin. Connect this pin to the center point of the output resistor divider (as shown in Figure 1) to program the output voltage: V_{OUT}=0.6*(1+R1/R2)
EN	4	Enable control. Pull high to turn on. Do not float.
IN	5	Input pin. Decouple this pin to GND pin with at least 1uF ceramic cap
LX	6	Inductor pin. Connect this pin to the switching node of inductor

Absolute Maximum Rating (T$_A$=25°C unless otherwise noted)

Supply Input Voltage ---------- 42V
Enable Voltage---------- V_{IN} + 0.6V
FB Voltage---------- 3.6V
BS to LX Voltage---------- 3.6V
Power Dissipation, PD @ T_A = 25°C, SOT23-6---------- 0.4W
Package Thermal Resistance (Note 2)
θJ_A ---------- 250°C/W
θJ_C ---------- 130°C/W
Junction Temperature Range ---------- 150°C
Lead Temperature (Soldering, 10 sec.) ---------- 260°C
Storage Temperature Range ---------- -65°C to 150°C

Recommended Operating Conditions

Supply Input Voltage ---------- 5V to 40V
BS to LX Voltage ----------3.3V
Junction Temperature Range ---------- -40°C to 125°C
Ambient Temperature Range ---------- -40°C to 85°C

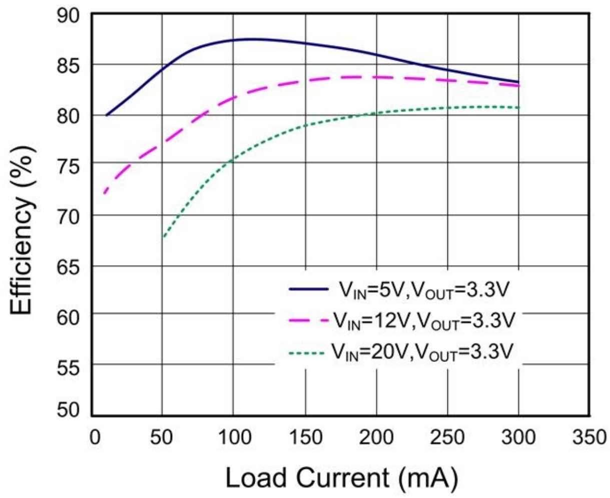
Electrical Characteristics (T_A 25 C unless otherwise noted)

(V_{IN} = 20V, V_{OUT} = 12V, L=10uH, C_{OUT} =4.7μF, T_A = 25°C, I_{OUT} = 100mA unless otherwise specified)

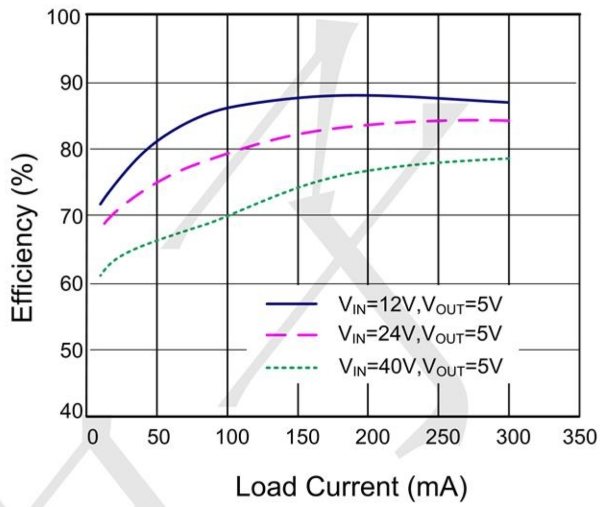
Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Input Voltage Range	V_{IN}		5		40	V
Input UVLO Threshold	V_{UVLO}	Rising		4.9		V
Input UVLO Hysteresis	V_{UVLO_HYS}			200		mV
Quiescent Current	I_Q	I_{OUT}=0, V_{FB}=V_{REF}×105%		160		μA
Shutdown Current	I_{SHDN}	EN=0			10	μA
Feedback Reference Voltage	V_{REF}		0.588	0.6	0.612	V
FB Input Current	I_{FB}	V_{FB}=V_{IN}	-50	10	50	nA
Power FET RON	$R_{DS(ON)1}$			2		Ω
Power FET Current Limit	I_{LIM}		450			mA
EN Rising Threshold	V_{ENH}		1.5			V
EN Falling Threshold	V_{ENL}				0.4	V
Minimum OFF Time	T_{OFF}				100	ns
Minimum ON Time	T_{OFF}				100	ns
Soft Start Time	T_{ss}			400		us
Switching Frequency	F_{SW}		1.6	2	2.4	MHz
Thermal Shutdown Temperature	T_{SD}			150		°C
Thermal Recovery Hysteresis	T_{HYS}			15		°C

Typical Performance Characteristics

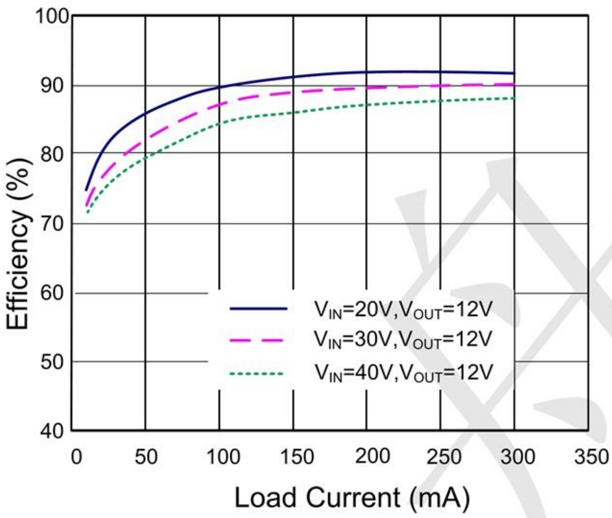
Efficiency vs. Load Current



Efficiency vs. Load Current

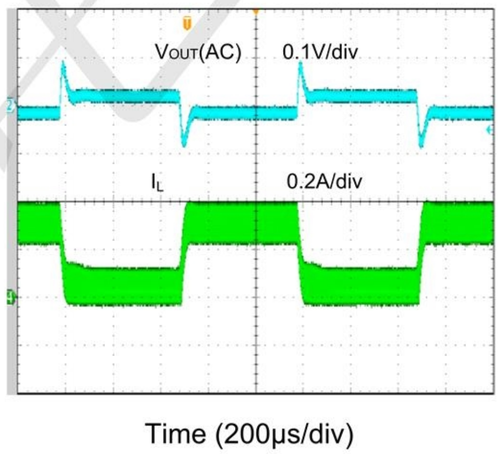


Efficiency vs. Load Current



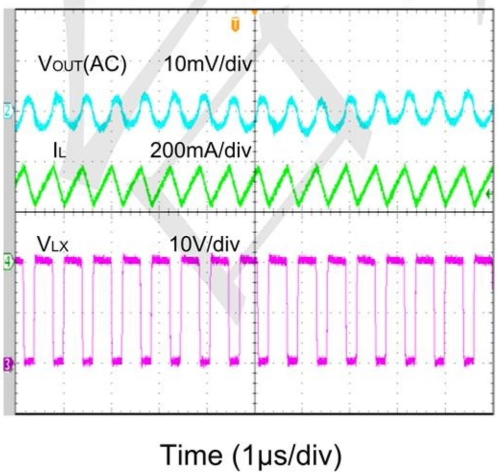
Load Transient

(V_{IN}=20V,V_{OUT}=12V,I_{OUT}=30mA-300mA)



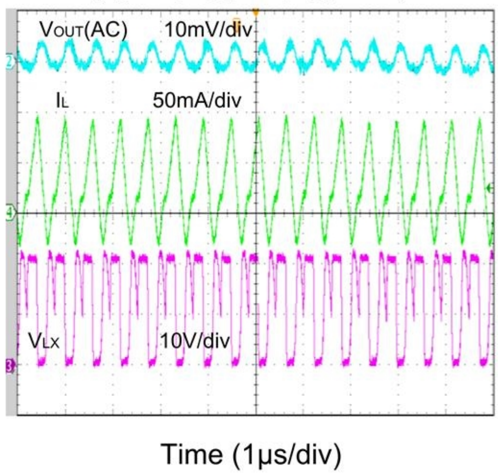
Output Ripple

(V_{IN}=20V, V_{OUT}=12V, I_{OUT}=300mA)

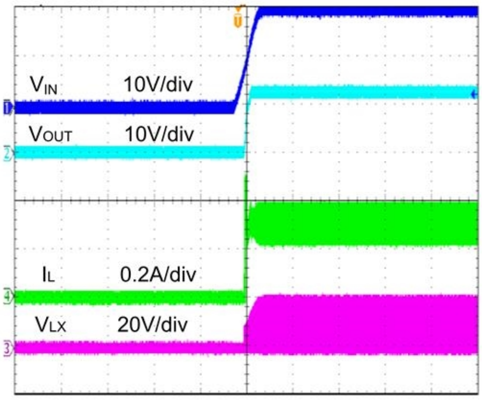


Output Ripple

(V_{IN}=20V, V_{OUT}=12V, I_{OUT}=30mA)

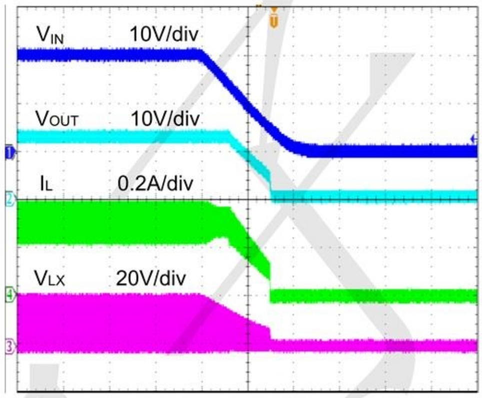


Startup From VIN
(V_{IN}=20V, V_{OUT}=12V, I_{OUT}=300mA)



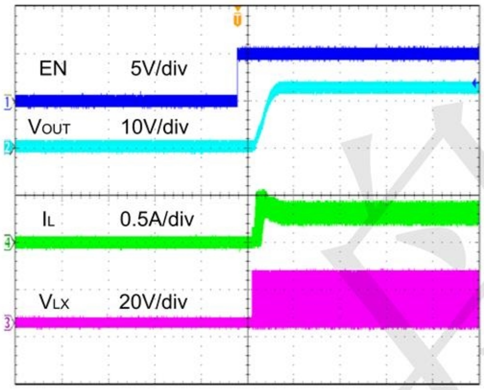
Time (4ms/div)

Shutdown From VIN
(V_{IN}=20V, V_{OUT}=12V, I_{OUT}=300mA)



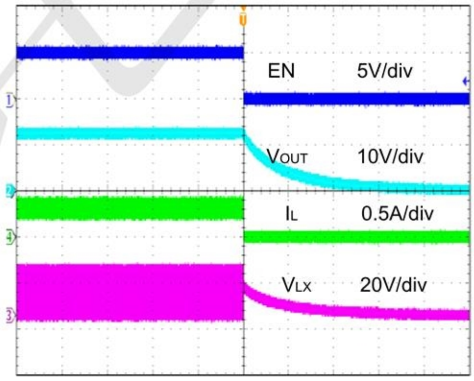
Time (20ms/div)

Startup From Enable
(V_{IN}=20V, V_{OUT}=12V, I_{OUT}=300mA)



Time (800μs/div)

Shutdown From Enable
(V_{IN}=20V, V_{OUT}=12V, I_{OUT}=300mA)



Time (200μs/div)

FUNCTIONAL DESCRIPTION

Operation

TP8290 is an asynchronous buck regulator IC that integrates the PWM control, main switch on the same die. High switch frequency minimizes the external inductor and capacitor size, thus minimizes the PCB area and cost. It features low output voltage ripple, cycle by cycle current limit output short circuit protection and thermal shutdown protection.

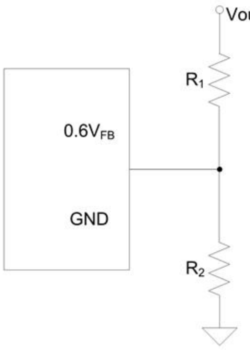
Applications Information

Because of the high integration in the TP8290 IC, the application circuit based on this regulator IC is rather simple. Only input capacitor C_{IN}, output capacitor C_{OUT}, output inductor L and feedback resistors (R_1 and R_2) need to be selected for the targeted applications.

Feedback resistor dividers R_1 and R_2

Choose R_1 and R_2 to program the proper output voltage. To minimize the power consumption under light loads, it is desirable to choose large resistance values for both R_1 and R_2. A value of between 10kΩ and 1MΩ is highly recommended for both resistors. If V_{out} is 5V, R_1=100kΩ is chosen, then using following equation, R_2 can be calculated to be 13.7kΩ:

$$R_2 = \frac{0.6V}{V_{out} - 0.6V} R_1$$



Input capacitor C_{IN}

The ripple current through input capacitor is calculated as：

$$I_{CIN\_RMS} = I_{OUT}\sqrt{D(1-D)}$$

To minimize the potential noise problem, place a typical X5R or better grade ceramic capacitor really close to the IN pin and the negative end of rectifier. A low ESR ceramic capacitor is recommended with greater than 1µF capacitance.

Output capacitor C_{OUT}

The output capacitor is selected to handle the output ripple noise requirements. Both steady state ripple and transient requirements must be taken into consideration when selecting this capacitor. For the best performance, it is recommended to use X5R or better grade ceramic capacitor with greater than 4.7µF capacitance.

Output inductor L

There are several considerations in choosing this inductor.

1) Choose the inductance to provide the desired ripple current. It is suggested to choose the ripple current to be about 40% of the maximum output current. The inductance is calculated as:

$$L = \frac{V_{OUT}(1 - V_{OUT}/V_{IN,MAX})}{F_{SW} \times I_{OUT,MAX} \times 40\%}$$

Where F_{SW} is the switching frequency and $I_{OUT,MAX}$ is the maximum load current.

The TP8290 regulator IC is quite tolerant of different ripple current amplitude. Consequently, the final choice of inductance can be slightly off the calculation value without significantly impacting the performance.

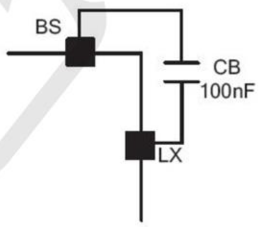
2) The saturation current rating of the inductor must be selected to be greater than the peak inductor current under full load conditions.

$$I_{SAT,MIN} > I_{OUT,MAX} + \frac{V_{OUT}(1 - V_{OUT}/V_{IN,MAX})}{2 \times F_{SW} \times L}$$

3) The DCR of the inductor and the core loss at the switching frequency must be low enough to achieve the desired efficiency requirement. It is desirable to choose an inductor with DCR<50mΩ to achieve a good overall efficiency.

External Bootstrap Cap

This capacitor provides the gate driver voltage for internal high side MOSEFET. A 100nF low ESR ceramic capacitor connected between BS pin and LX pin is recommended.

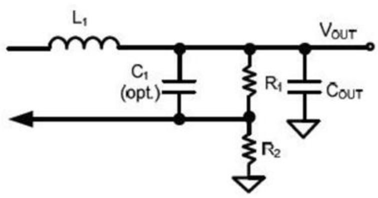


Rectifier Diode

Because of high switching speed of TP8290, a schottky diode with low forward voltage and fast switching speed is desirable for the application. The voltage rating of the diode must be higher than maximum output voltage. The diode's average and peak current rating should exceed the average output current and peak current.

Load Transient Considerations

The TP8290 regulator IC integrates the compensation components to achieve good stability and fast transient responses. In some applications, adding a small ceramic cap in parallel with R_1 may further speed up the load transient response and it is recommended for high step load applications.



Layout Design

The layout design of TP8290 regulator is relatively simple. For the best efficiency and minimum noise problem, we should place the following components close to the IC: C_{IN}, L, R_1 and R_2.

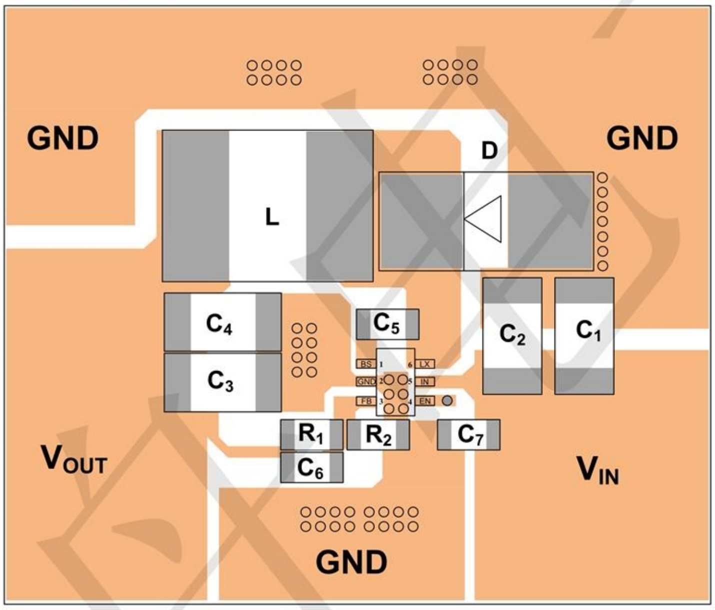
1) It is desirable to maximize the PCB copper area connecting to GND pin to achieve the best thermal and noise performance. If the board space allowed, a ground plane is highly desirable.

2) The loop area formed by IN, LX, C_{IN} and the rectifier diode must be minimized.

3) The PCB copper area associated with LX pin must be minimized to avoid the potential noise problem.

4) The components R_1 and R_2, and the trace connecting to the FB pin must NOT be adjacent to the LX net on the PCB layout to avoid the noise problem.

5) If the system chip interfacing with the EN pin has a high impedance state at shutdown mode and the IN pin is connected directly to a power source, it is desirable to add a pull down 1MΩ resistor between the EN and GND pins to prevent the noise from falsely turning on the regulator at shutdown mode.



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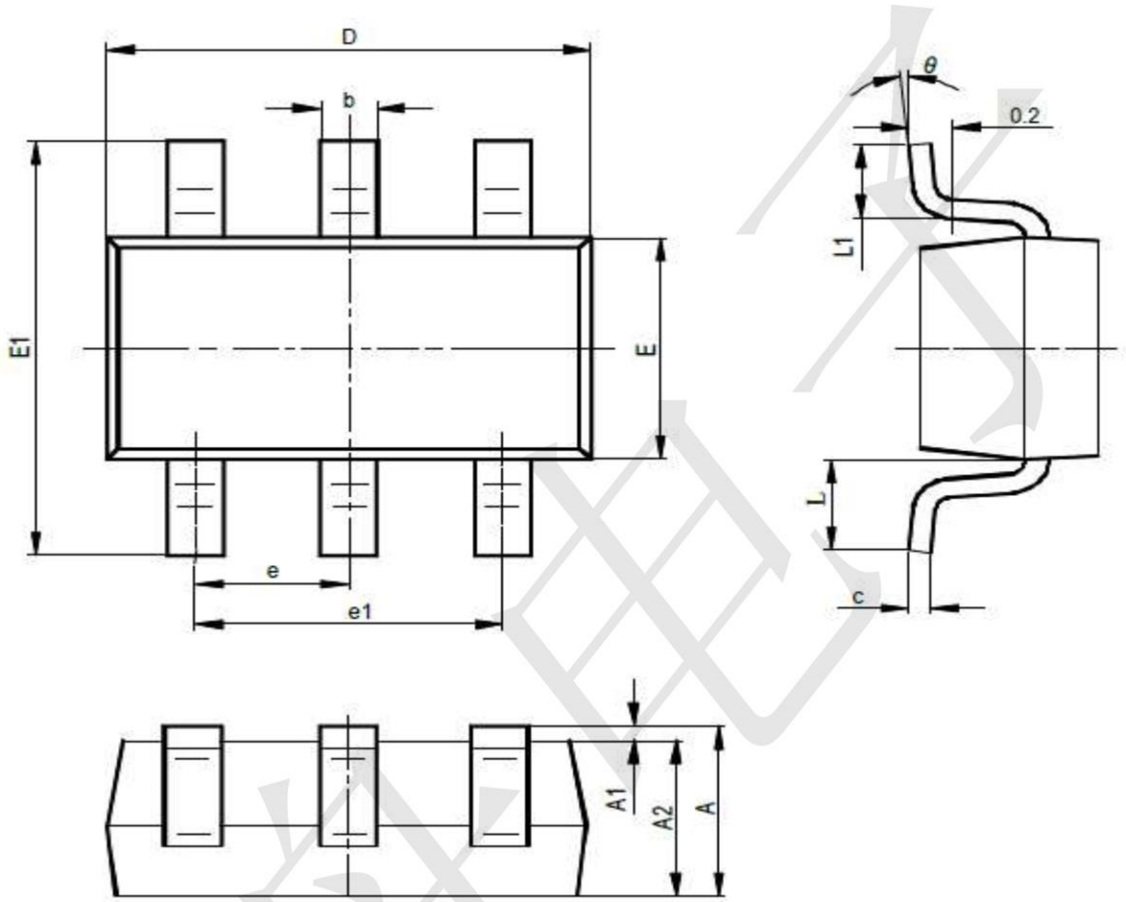

SYMBOL	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.400	0.012	0.016
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950TYP		0.037TYP	
e1	1.800	2.000	0.071	0.079
L	0.700REF		0.028REF	
L1	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°