

Features

- 200mΩ Typ. High-Side MOSFET
- Guaranteed 0.55A Continuous Current
- Small SOT-23-5 Package Minimizes Board Space
- Soft Start
- Thermal Protection
- Low 46.5 μA Supply Current
- Wide Input Voltage Range: 1.9V ~ 5.5V

Applications

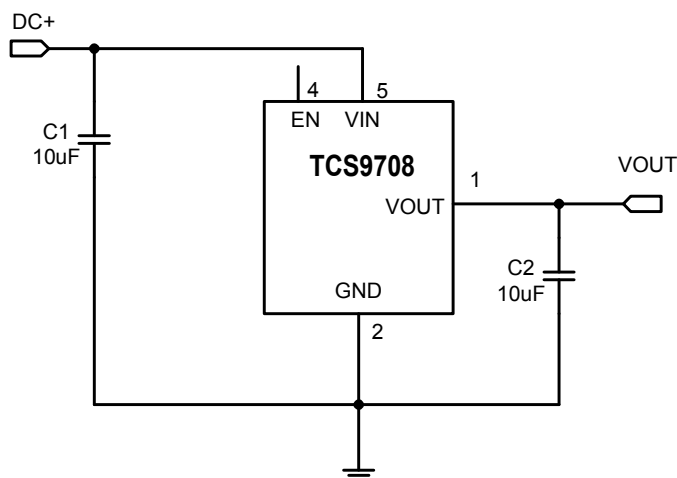
- Battery-Powered Equipment
- Motherboard USB Power Switch
- USB Device Power Switch
- Hot-Plug Power Supplies
- Battery-Charger Circuits

Description

The TCS9708 is an integrated 200mΩ power switch for self-powered and bus-powered Universal Series Bus (USB) applications. A built-in charge pump is used to drive the MOSFET that is free of parasitic body diode to eliminate any reversed current flow across the switch when it is powered off. Its low quiescent supply current (46.5μA) and small package (SOT-23-5) is particularly suitable in battery-powered portable equipment.

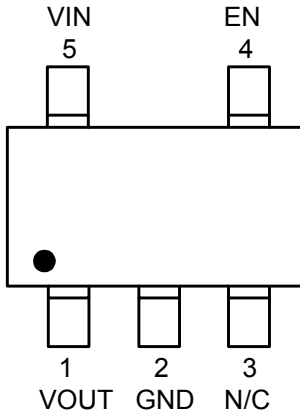
Several protection functions include soft start to limit inrush current during plug-in, current limiting at 0.55A to meet USB power requirement, and thermal shutdown to protect damage under over current conditions.

Typical Application Circuit



Pin Assignment

(TOP VIEW)



SOT-23-5

PIN Number SOT23- 5L	PIN Name	Function
1	VOUT	Output Pin
2	GND	Ground
3	N/C	No Used
4	EN	ON/OFF Control (High Enable)
5	VIN	Power Input

Absolute Maximum Ratings (Note 1)

Supply Voltage	7V
Chip Enable.....	-0.3V ~ 7V
Power Dissipation, P_D @ $T_A = 25^\circ\text{C}$	SOT-23-5 0.25W
Operating Junction Temperature Range.....	$-20^\circ\text{C} \sim 100^\circ\text{C}$
Storage Temperature Range.....	$-65^\circ\text{C} \sim 150^\circ\text{C}$
Package Thermal ResistanceSOT-23-5,	$289^\circ\text{C} / \text{W}$
VOUT ESD Level HBM (Human Body Mode)	4KV
MM (Machine Mode).....	400V
Junction Temperature	Internally Limited

Note 1. Stresses listed as the above “Absolute Maximum Ratings” may cause permanent damage to the device. These are for stress ratings. 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 for extended periods may remain possibility to affect device reliability.

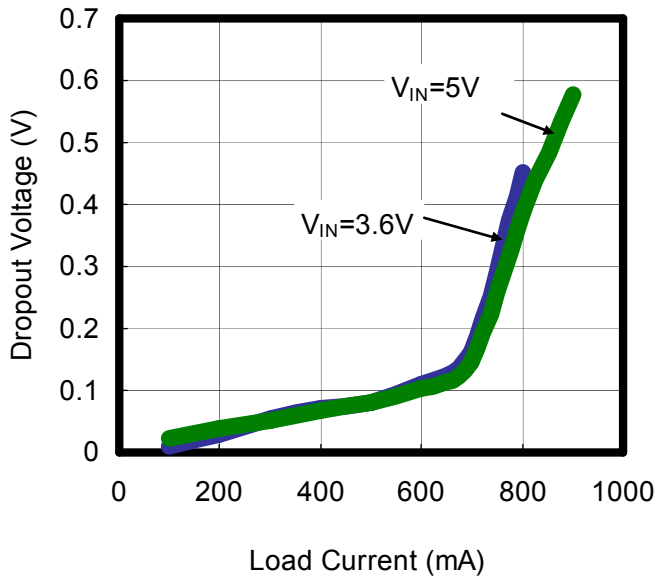
Electrical Characteristics

(VIN = 5V, CIN = 10μF, COUT = 1μF, TA = 25°C, unless otherwise specified)

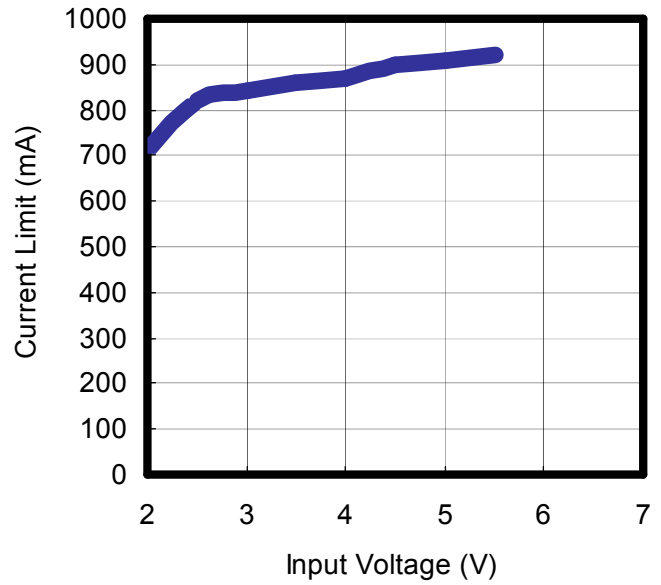
PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Input Voltage Range	V _{IN}		1.9		5.5	V
Output NMOFET R _{DS(ON)}	R _{DS(ON)}	V _{IN} =5V, I _{LOAD} = 500 mA		200		mΩ
Supply Current		V _{IN} =3V		46.5		μA
		V _{IN} =5V		72		
Output Turn-On Rising Time	T _R	R _L = 10Ω, 90% Settling		100		μs
Current Limit Threshold	I _{LIMIT}			550		mA
Short-circuit Fold Back Current	I _{OS}	V _{OUT} = 0V		30		mA
CE Input High Threshold			1.2	0.86		V
CE Input Low Threshold			0.6			
Shutdown Supply Current	I _{OFF}	CE = "0"		0.1	1	μA
Output Leakage Current	I _{LEAKAGE}	CE = "0", V _{OUT} = 0V		0.1	1	μA
V _{IN} Under Voltage Lockout	UVLO			1.7		V
V _{IN} Under Voltage Hysteresis				100		mV
Thermal Limit	T _{SD}			130		°C
Thermal Limit Hysteresis	ΔT _{SD}			20		°C

Typical Operating Characteristics

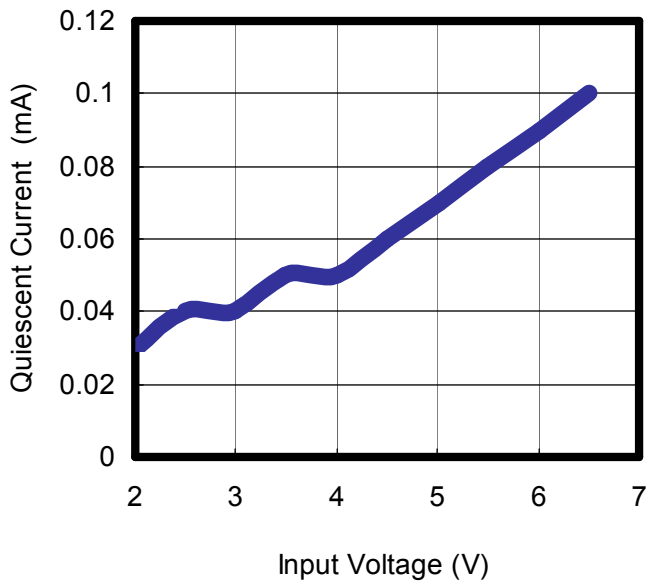
Dropout Voltage vs. Load Current



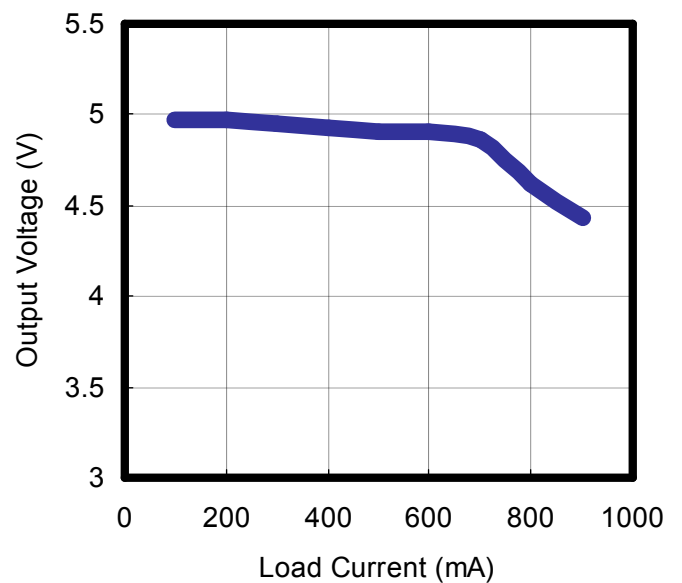
Current Limit vs. Input Voltage



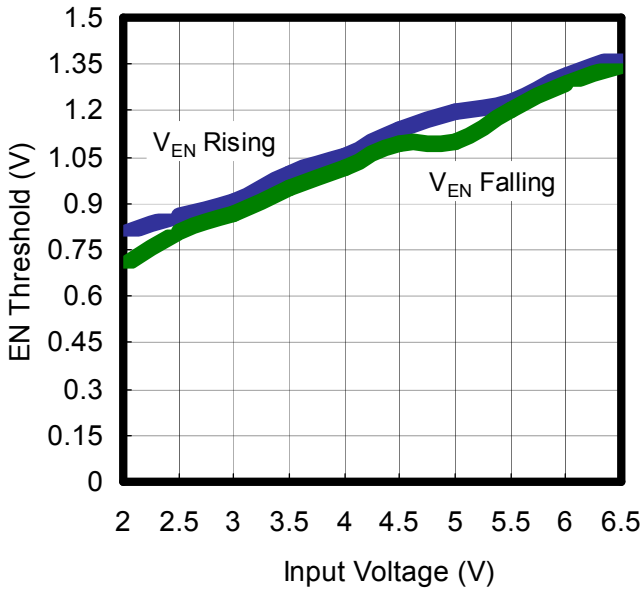
Quiescent Current vs. Input Voltage



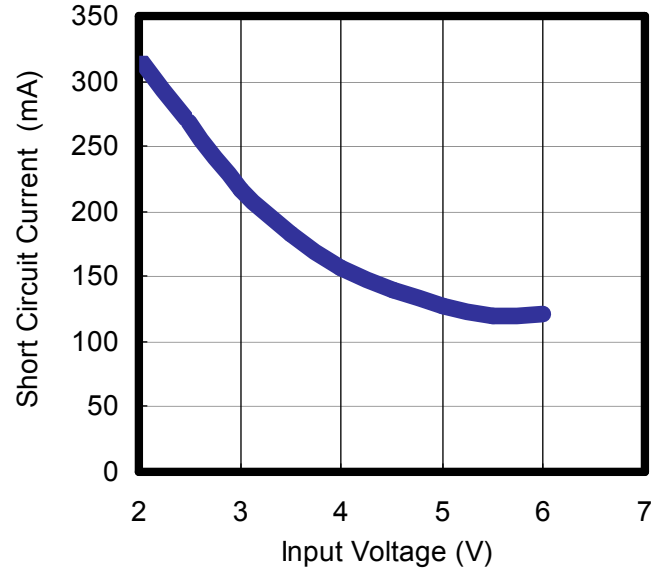
Output Voltage vs. Load Current



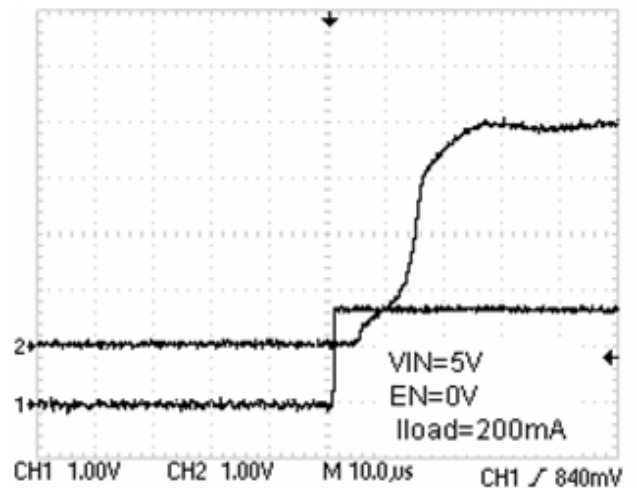
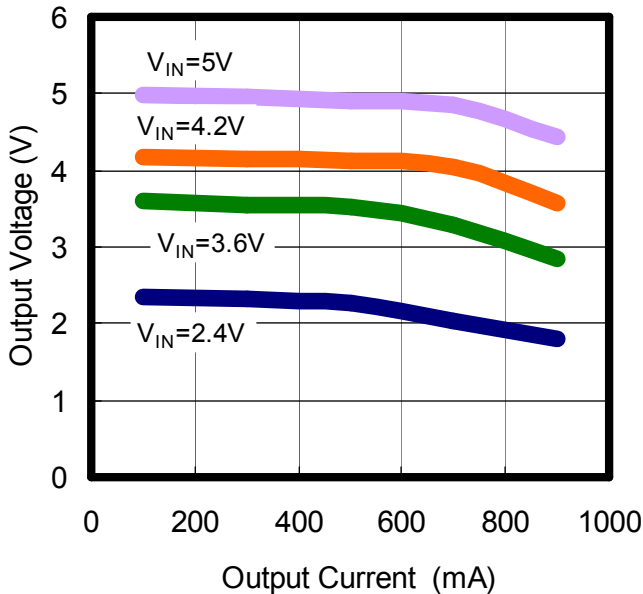
EN Threshold vs. Input Voltage

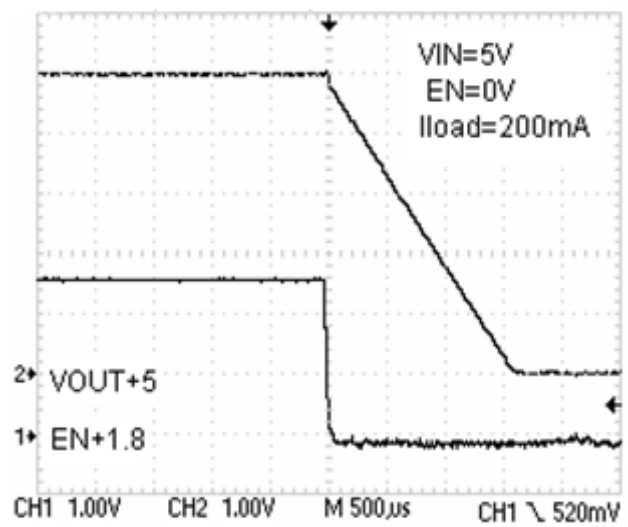
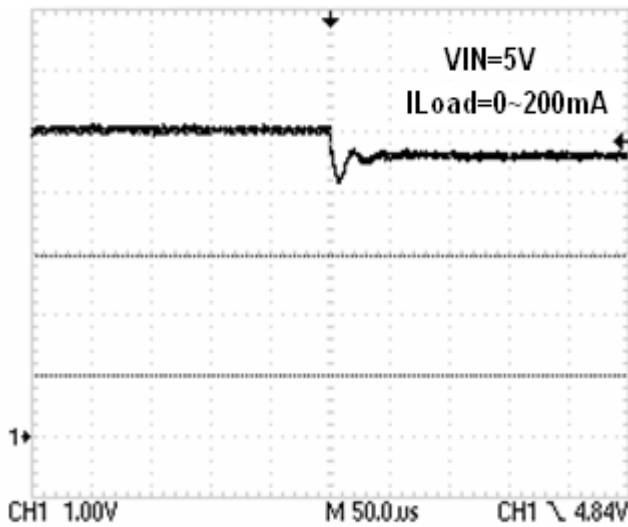


Short Circuit Current vs. Input Voltage



Output Voltage vs. Output Current





Application Information

PIN ASSIGNMENT

VOUT (Pin 1): Ideal Diode Cathode and Output. Bypass VOUT with ESR capacitor. However stability improves with higher ESRs.

GND (Pin 2): Power and Signal Ground for the IC.

N/C (Pin 3): No used.

EN (Pin 4): Status Condition Indicator. This pin indicates the conducting status of the TCS9708. If the part is forward biased ($V_{IN} > V_{OUT} + V_{FWD}$) this pin will be Hi-Z. If the part is reverse biased ($V_{OUT} > V_{IN} + V_{RTO}$), then this pin will pull down 10mA through an open-drain. When terminated to a high voltage through a 470k resistor, a high voltage indicates diode conducting. May be left floating or grounded when not in use.

VIN (Pin 5): Ideal Diode Anode and Positive Power Supply for TCS9708. When operating TCS9708 as a switch it must be bypassed with a low ESR ceramic capacitor.

Functional Description

The TCS9708 is a high-side single switch with active-highenable input.

Input and Output

V_{IN} (input) is the power supply connection to the circuitry and the drain of the output MOSFET. V_{OUT} (output) is the source of the output MOSFET. In a typical circuit, current flows through the switch from V_{IN} to V_{OUT} toward the load. Both V_{OUT} pins must be short on the board and connected to the load and so do both V_{IN} pins but connected to the power source.

Thermal Shutdown

Thermal shutdown shuts off the output MOSFET if the die temperature exceeds 130°C and 20°C of hysteresis forces the switch turning off until the die temperature drops to 110°C.

Filtering

To limit the input voltage drop during hot-plug events connect a 10μF ceramic capacitor from V_{IN} to GND. However, higher capacitor values will further reduce the voltage drop at the input.

Connect a sufficient capacitor from V_{OUT} to GND. This capacitor helps to prevent inductive parasitics from pulling V_{OUT} negative during turn-off or EMI damage to other components during the hot detachment. It is also necessary for meeting the USB specification during hot plug-in operation. If

TCS9708 is implanted in device end application, minimum 1μF capacitor from V_{OUT} to GND is recommended and higher capacitor values are also preferred.

In choosing these capacitors, special attention must be paid to the Effective Series Resistance, ESR, of the capacitors to minimize the IR drop across the capacitor's ESR. A lower ESR on this capacitor can get a lower IR drop during the operation.

Ferrite beads in series with all power and ground lines are recommended to eliminate or significantly reduce EMI. In selecting a ferrite bead, the DC resistance of the wire used must be kept to a minimum to reduce the voltage drop.

Soft Start

In order to eliminate the upstream voltage droop caused by the large inrush current during hot-plug events, the "soft-start" feature effectively isolates power supplies from such highly capacitive loads.

Under-voltage Lockout

UVLO prevents the MOSFET switch from turning on until input voltage exceeds 1.7V (typical). If input voltage drops below 1.7V (typical), UVLO shuts off the MOSFET switch.

Current Limiting and Short Protection

The current limit circuit is designed to protect the system supply, the MOSFET switch and the load from

damage caused by excessive currents. The current limit threshold is set internally to allow a minimum of 550mA through the MOSFET but limits the output current to approximately 500mA typical. When the output is short to ground, it will limit to a constant current 30mA until thermal shutdown or short condition removed.

Reverse current preventing

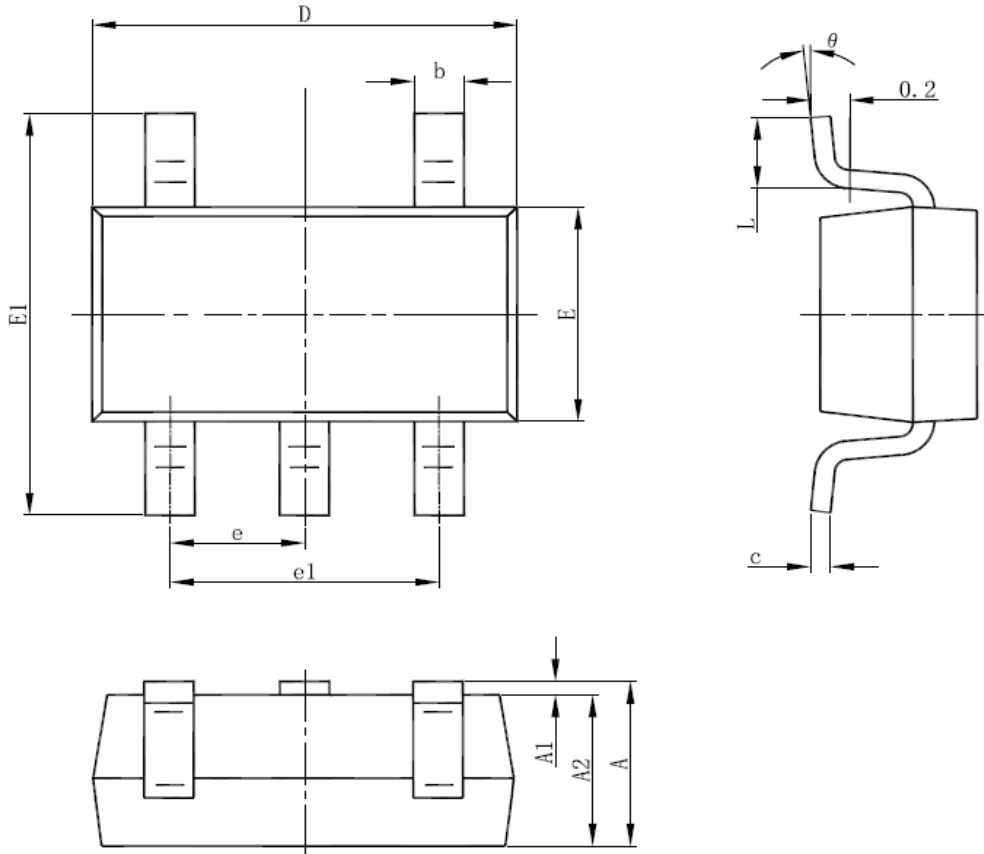
The output MOSFET and driver circuitry are also designed to allow the MOSFET source to be externally forced to a higher voltage than the drain ($V_{OUT} > V_{IN} \geq 0$). To prevent reverse current from such condition, TCS9708 will automatically shut off the MOSFET.

Layout and Thermal Dissipation

1. Place the switch as close to the USB connector as possible. Keep all traces as short as possible to reduce the effect of undesirable parasitic Inductance.
2. Place the output capacitor and ferrite beads as close to the USB connector as possible. If ferrite beads are used, use wires with minimum resistance and large solder pads to minimize connection resistance.
3. If ferrite beads are used, use wires with minimum resistance and large solder pads to minimize connection resistance.
4. If the package is with dual VOUT or VIN pins, short both the same function pins to reduce the internal turn-on resistance. If the output power will be delivered to two individual ports, it is especially necessary to short both VOUT pin at the switch output side in order to protect the switch when each port is plug-in separately.
5. Under normal operating conditions, the package can dissipate the channel heat away. Wide power bus planes connected to VIN and VOUT and a ground plane in contact with the device will help dissipate additional heat.

Package Information

SOT-23-5 Package Outline Dimension



Symbol	Dimensions In Millimeters		Dimensions In 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	0.500	0.012	0.020
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	0.950(BSC)		0.037(BSC)	
e1	1.800	2.000	0.071	0.079
L	0.300	0.600	0.012	0.024
theta	0°	8°	0°	8°