FEATURES

- Integrated 60mΩ Power MOSFET
- 1uA Typical at Switch Off State
- Wide Input Voltage Range:2.5V to 5.5V
- Fast Transient Response:8us
- 0.1mS Typical Rise Time
- Reverse Current Flow Blocking
- Automatic output discharge at shutdown
- Thermal Shutdown Protection
- Hot Plug-In Application (Soft-Start)
- SOT-23-5 Package

GENERAL DESCRIPTION

The TCS9163 is a cost-effective, single P-MOSFET load switch with ultra-low $R_{DS(ON)}$, optimized for self-powered and bus-powered Universal Serial Bus (USB) applications. Input voltage from 2.5V to 5.5V, making it ideal for both 3V and 5V systems. A built-in P-channel MOSFET with true shutdown function to eliminate any reversed current flow across the switch. When output voltage is higher than input voltage, power switch is turned off.

The TCS9163 offers a programmable current limit threshold between 400mA to2.4A via an external resistor.

APPLICATIONS

- USB Bus/Self Powered Hubs
- Battery-Charger Circuits
- Personal Communication Devices
- Notebook Computers

TYPICAL APPILCATION

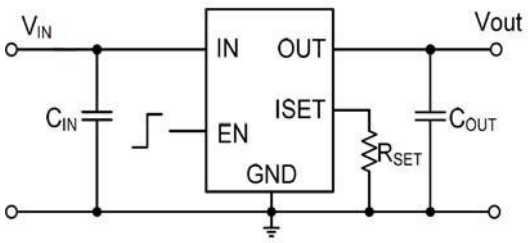
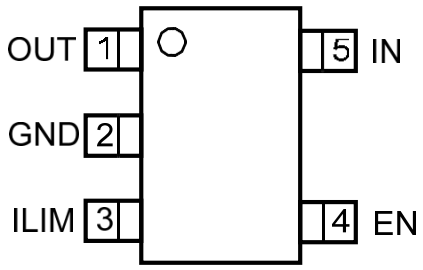


Figure 1. TCS9163 Application Circuit

ABSOLUTE MAXIMUM RATINGS (Note 1)

Description	Value	Unit
IN Input Voltage Range	-0.3~7	V
All other pins Voltage Range	-0.3 to (VIN+0.3)	V
Junction Temperature	-40~160	°C
Storage Temperature Range	-65~150	°C
Junction-to-ambient Thermal Resistance	260(SOT23-5)	°C/W
Junction-to-case Thermal Resistance	120(SOT23-5)	°C/W
Lead TemperatureSoldering,10Sec	260	°C

PIN CONFIGURATION



Part Number	Package	Top mark	Quantity/ Reel
TCS9163	SOT-23-5		3000

PIN FUNCTIONS

TCS9163 **SOT23-**	**Name**	**Function**
1	OUT	Switch Output Pin.
2	GND	Ground Pin
4	EN	High Enable.
5	IN	Power Input Pin
3	ILIM	Current limit Set Pin

ESD RATINGS

Items	**Description**	**Value**	**Unit**
V_{ESD}	Human Body Model for all pins	±2000	V

JEDEC specification JS-001

RECOMMENDED OPERATING CONDITIONS

Items	**Description**	**Min**	**Max**	**Unit**
Voltage Range	IN	2.5	5.5	V
TA	Operating Temperature Range	-40	85	°C

ELECTRICAL CHARACTERISTICS

(V_{IN}=5V , C_{IN}=1μF, C_{OUT}=1μF, T_A = 25°C.)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{IN}	Input Voltage		2.5		5.5	V
I_Q	Quiescent Supply Current	V_{IN}=5.0V, nEN=L, No load		30	60	uA
I_{SHDN}	Shutdown Input Current	V_{IN}=5.0V, nEN=H, No load		0.1	1	uA
I_{REV}	Reverse Leakage Current	V_{OUT}=5.0V, V_{IN}=0V		2	5	uA
V_{UVLO}	UVLO Threshold	V_{IN} rising		2	2.3	V
V_{UVLO_HY}	UVLO Hysteresis	V_{IN}falling		100		mV
nEN Section						
V_{nEN_H}	nEN Rising Threshold	V_{IN}=5.0V	1.5			V
V_{nEN_L}	nEN Falling Threshold	V_{IN}=5.0V			0.8	V
I_{nEN}	nEN Input Current	V_{EN}=5.0V or 0V	-0.5	5	10	uA
OUT Section						
I_{LIM}	Limit Current	R_{ILIM}=6.8kΩ	0.8	1	1.2	A
$V_{REVERSE}$	Reverse Voltage Protection	V_{OUT}-V_{IN}	5	20	50	mV
T_{RISE}	Output Rise Time	CL=1uF, RL=100ohm		0.1		ms
T_{FALL}	Output Fall Time	CL=1uF, RL=100ohm		0.3		ms
T_{IOS}	Short Circuit Response time			12		us
R_{DIS}	OUT Discharge Resistance			10		Ω

Note 1: Absolute Maximum Ratings are those values beyond which the life of a device may be impaired.
Note 2: TJ is calculated from the ambient temperature TA and power dissipation PD according to the following formula: TJ = TA + (PD) x (250°C/W).
Note3: 100% production test at +25°C. Specifications over the temperature range are guaranteed by design and characterization.

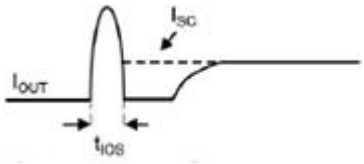


Figure 2

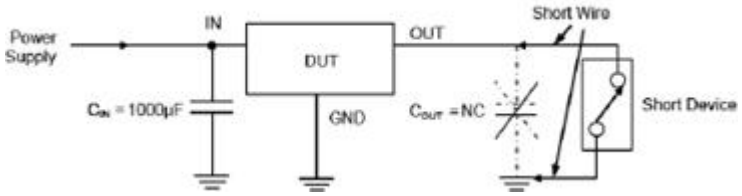


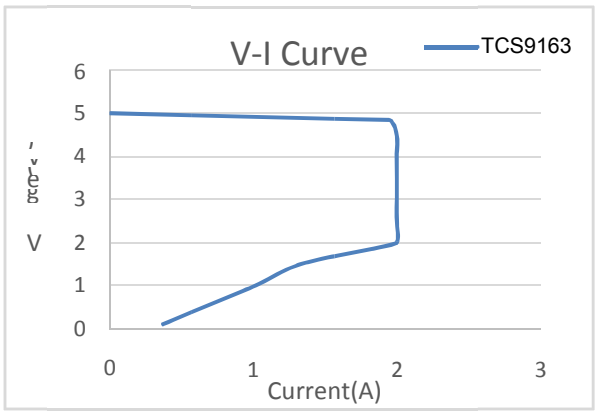
Figure 3

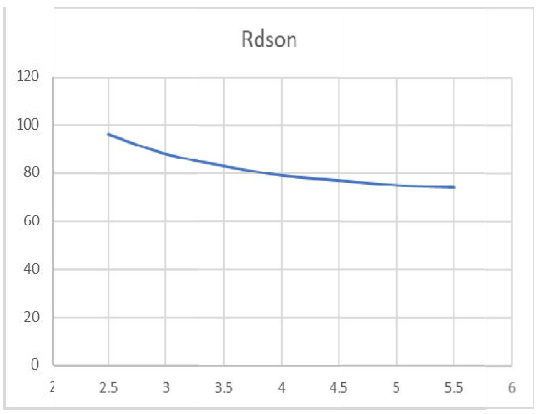
Note:
To exactly identify the short circuit characteristic of IC, avoid the test result interfered by parasitic inductor, output capacitor, and contact resistor. It is necessary to follow the recommendation as follows.
Please,
1. Add 1000µF of capacitor between VIN and GND, and close to IC.
2. Remove output capacitor.
3. Shorter the short circuit device wire.
4. Measure output current (IOUT).

TYPICAL PERFORMANCE CHARACTERISTICS

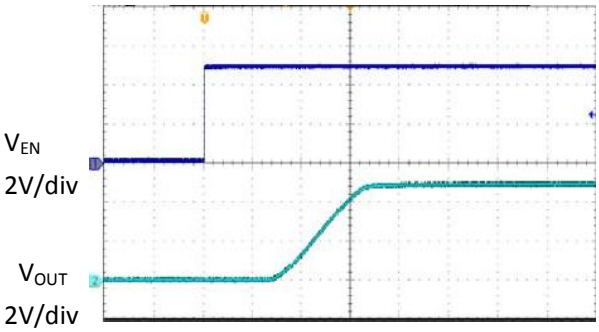
(Condition: V_{IN}=5V, C_{IN}=1uF,C_{OUT}=10uF)

R_{DSON} VS. Input Voltage

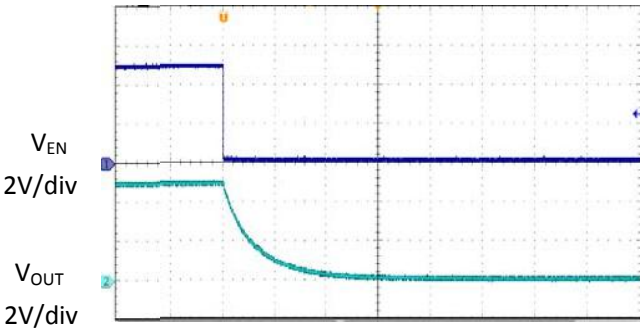




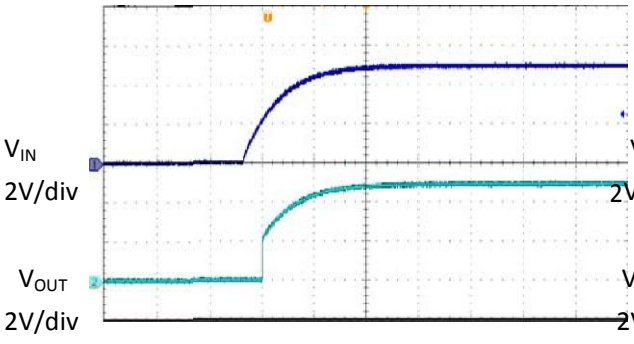
Enable Response



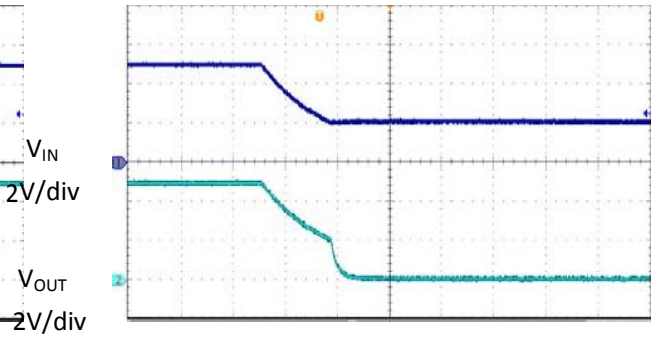
Disable Response



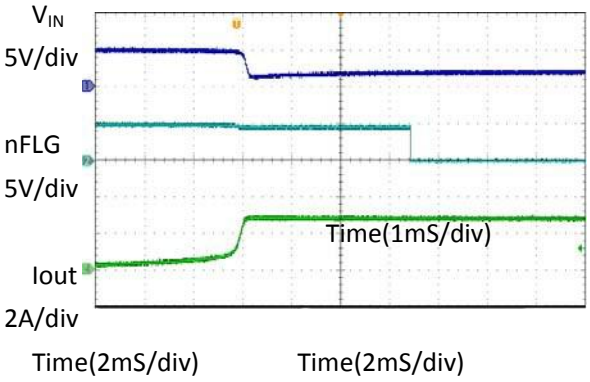
Power On(UVLO)



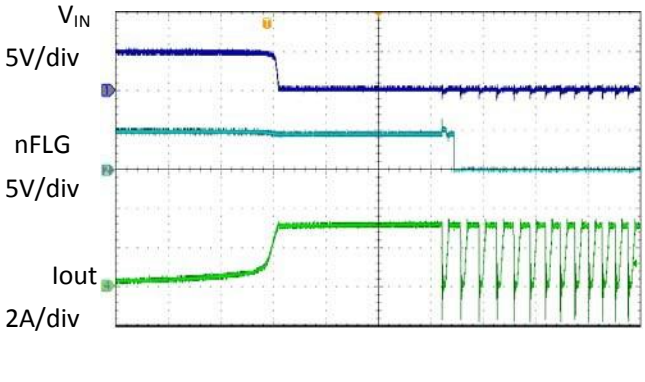
Power Off(UVLO)



nFLG Response during Over Load



nFLG Response during Short Circuit



FUNCTIONAL BLOCK DIAGRAM

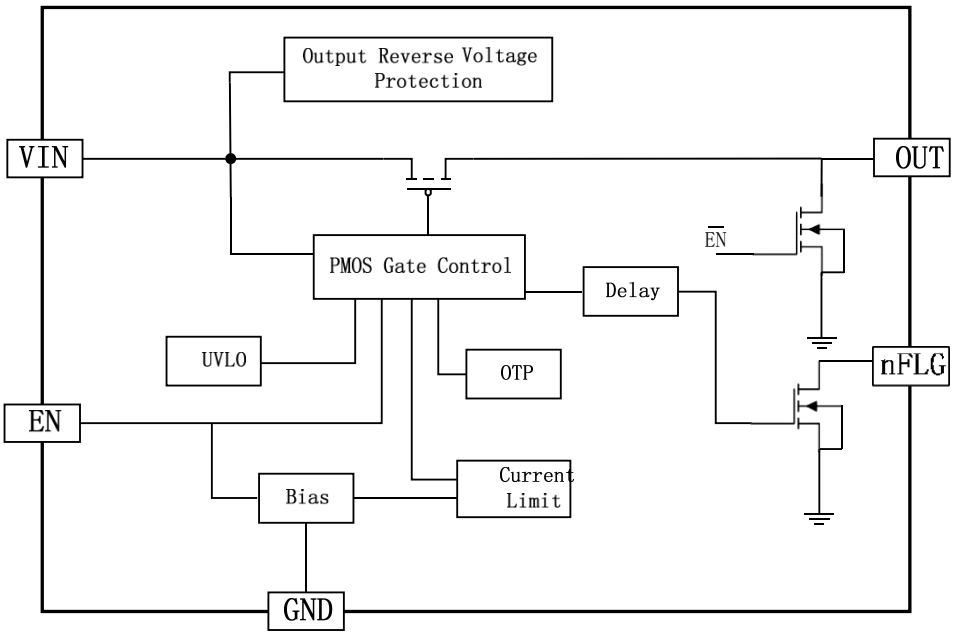


Figure 4. TCS9163 Block Diagram

APPLICATION INFORMATION

The TCS9163 is current-limited,power distribution switches using P-channel MOSFETs for applications where short circuits or heavy capacitive loads will be encountered and provide up to 2.4A of continuous load current. Additional device shutdown features include over temperature protection and reverse-voltage protection. The driver controls the gate voltage of the power switch. The driver incorporates circuitry that controls the rise and fall times of the output voltage to limit large current and voltage surges and provides built-in soft-start functionality. The TCS9163 enters constant current mode when the load exceeds the current-limit threshold.

Input and Output

IN (input) is the power supply connection to the logic circuitry and the drain of the output MOSFET. OUT(output) is the source of the output MOSFET. In a typical application, current flows through the switch from IN to OUT toward the load. OUT pin must be connected together to the load.

Soft Start for Hot Plug-In Applications

In order to eliminate the upstream voltage droop caused by the large inrush current during hot-plug events, the “soft-start” feature effectively isolates the power source from extremely large capacitive loads, satisfying the USB voltage droop requirements.

Setting Current Limit Only

The over-current threshold is user programmable via an external resistor. The TCS9163 use an internal regulation loop to provide a regulated voltage on the ILIM pin. The current-limit threshold is proportional to the current sourced out of ILIM. The recommended 1% resistor range for R_{ILIM} is 2.5kΩ ≤ RILIM ≤17kΩ to ensure stability of the internal regulation loop. Many applications require that the minimum current limit is above a certain current level or that the maximum current limit is below a certain current level, so it is important to consider the tolerance of the overcurrent threshold when selecting a value for R_{ILIM}. The following Figure 6 can be used to select the resulting type over-current threshold for a given external resistor value (R_{ILIM}).

$$I_{LIMT}=6800/R_{ILIM}$$

TCS9163 ensure that maximum Current Limit threshold is below 3A, it is important to avoid current limiting upstream power supplies causing the input voltage bus to drop

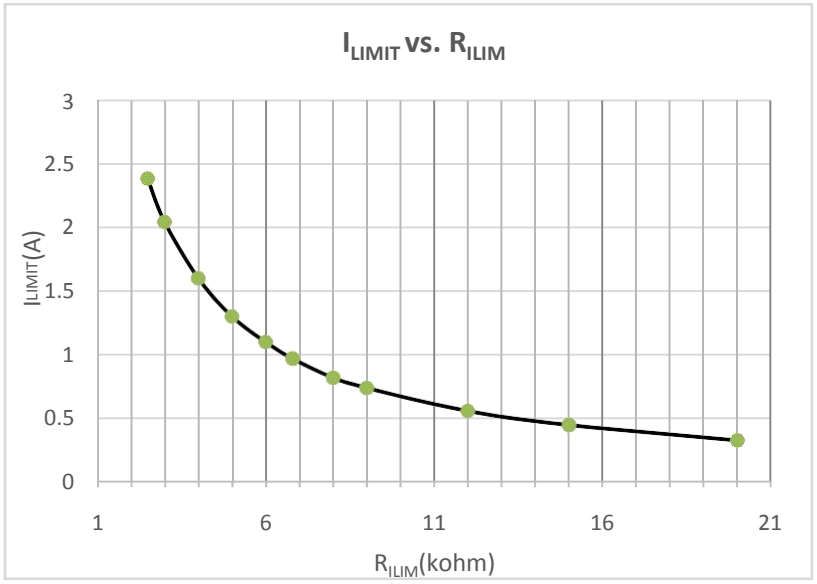


Figure 6. I_{LIMIT} vs. R_{ILIMIT}

Thermal Considerations

The TCS9163 protects itself with two independent thermal sensing circuits that monitor the operating temperature of the power-switch and disables operation if thetemperature exceeds recommended operating conditions. The device operates in constant-current mode during an over-current conditions,which increases the voltage drop across power-switch. The power dissipation in the package is proportional to the voltage drop across the power-switch, so the junction temperature rises during an over-current condition. The first thermal sensor turns off the power-switch when the die temperature exceeds 130°C and the part is in current limit. The second thermal sensor turns off the power-switch when the die temperature exceeds 150°C regardless of whether the power-switch is in current limit. Hysteresis is built into both thermal sensors, and the switch turns on after the device has cooled approximately 20°C(Thermal shutdown threshold hysteresis in current-limit is 20°C). The switch continues to cycle off and on until the fault is removed. The open-drain is asserted (active low) immediately during an over temperature shutdown condition.

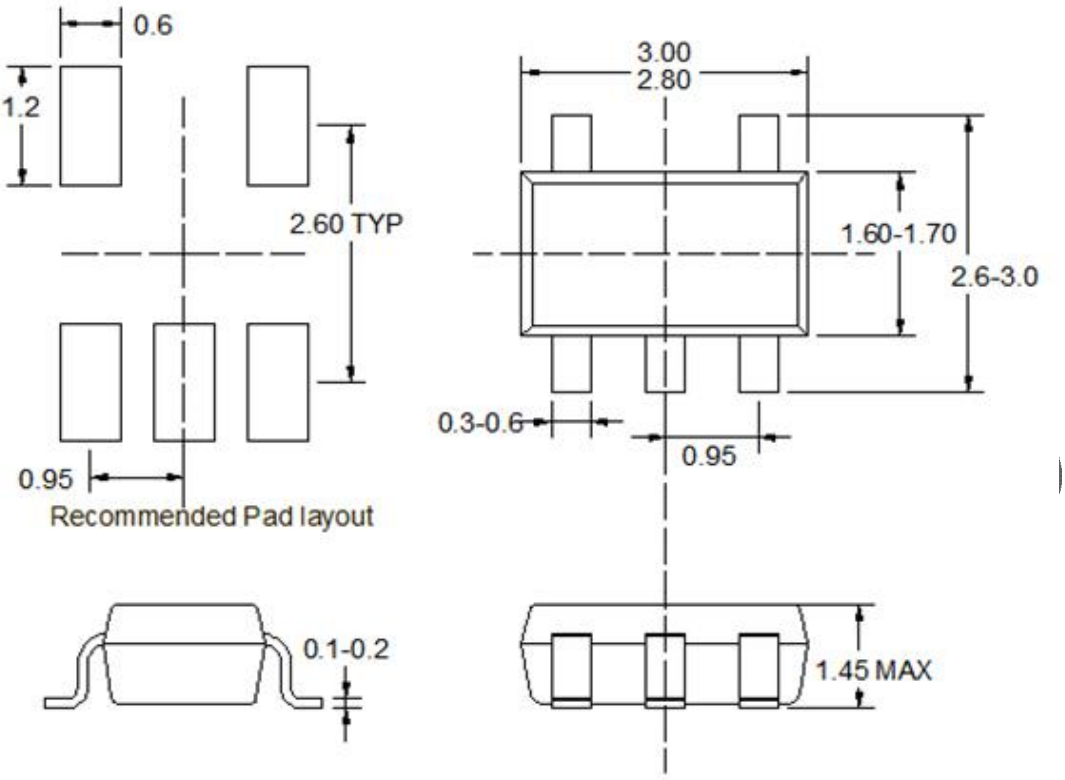
EN/nEN, the Enable Input

EN/nEN must be driven logic high or logic low for a clearly defined input. Floating the input may cause unpredictable operation.

Layout Consideration

For best performance of theTCS9163 ,the following guidelines must be strictly followed.

- Input and output capacitors should be placed close to the IC and connected to ground plane to reduce noise coupling.
- The GND should be connected to a strong ground plane for heat sink.
- Keep the main current traces as possible as short and wide.


0.6
1.2
2.60 TYP
0.95
Recommended Pad layout
3.00
2.80
1.60-1.70
2.6-3.0
0.3-0.6
0.95
0.1-0.2
1.45 MAX

SOT23-5