3A Current Limited Load Switch with True Reverse Current Blocking

General Description

The HM9705 advanced load management switches target applications requiring a highly integrated solution it disconnects loads powered from DC Power Rail (<6V) with stringent off-state current targets and high load capacitances (up to 200μF). Each switch consists of slew-rate controlled low-impedance MOSFET Switch (29mΩ Typ) and other integrated analog features. The slew-rate controlled turn-on characteristic prevents inrush-current and the resulting excessive voltage droop on power rails.

The HM9705 has True Reverse Current Blocking(TRCB) function blocking unwanted reverse current from V_{OUT} to V_{IN} during ON/OFF state. These devices have exceptionally low off-state current drain (<1μA max) which facilitate compliance in very low stand-by power applications. The input voltage range operates from 1.5V to 6.0V DC to fulfill a wide range of applications in consumer, optical, medical, storage, portable, and industrial device power management. Switch control is managed by a logic input (Active HIGH) capable of interfacing directly with low voltage control signal/GPIO with no external pull-down resistor required.

HM9705 is in TDFN4 package of 1.2 mm by 1.6 mm.

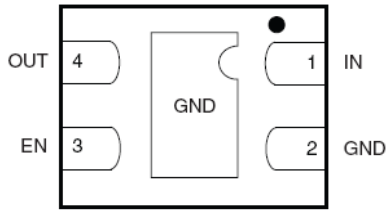
Features

- 1.5V to 6 V operation voltage range
- Slew Rate/Inrush Control with t_R:2.7ms (Typ)
- Typical $R_{DS(ON)}$:
  26mΩ at V_{IN}=5V
  29mΩ at V_{IN}=4.3V
  33mΩ at V_{IN}=3.6V
- Low quiescent current < 1 μA
- True Reverse Current Blocking (TRCB)

Application

- PDAs/smart phones
- Notebook/netbook computers
- Tablet PC
- Portable media players
- Digital camera
- GPS navigation devices
- Data storage devices
- Optical, industrial, medical, and healthcare devices

Pin Configuration

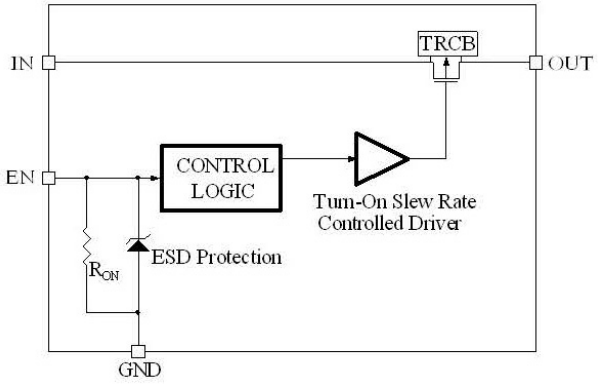


Bottom View

Pin Function

Pin Number	Name	Function
1	IN	This is the input pin of the switch
2	GND	Ground connection
3	EN	Enable input
4	OUT	This is the output pin of the switch

Block Diagram



Functional Description

The HM9705 is low-R_{ON} P-channel load switches with controlled turn-on and TRCB (True Reverse Current Blocking). The core of each device is a 29mΩ P-channel MOSFET and controller capable of functioning over a wide input operating range of 1.5-6.0V. The ON pin, an active HIGH GIOP/CMOS-compatible input, controls the state of the switch. TRCB functionality blocks unwanted reverse current during ON and OFF when higher Vout than Vin applied.

Input Capacitor

To limit the voltage drop on the input supply caused by transient inrush current when the switch turns on into a discharged load capacitor or short-circuit, a capacitor must be placed between the V_{IN} and GND pins. A 1μF ceramic capacitor, C_{IN}, placed close to the pins is usually sufficient. Higher-value C_{IN} can be used to reduce the voltage drop in higher-current applications.

Output Capacitor

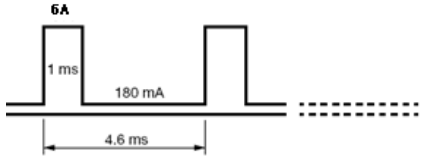
A 0.1μF capacitor, C_{OUT}, should be placed between the V_{OUT} and GND pins. This capacitor prevents parasitic board inductance from forcing V_{OUT} below GND when the switch is on. C_{IN} greater than C_{OUT} is highly recommended. C_{OUT} greater than C_{IN} can cause V_{OUT} to exceed V_{IN} when the system supply is removed. This could result in current flow through the body diode from V_{OUT} to V_{IN}.

Board Layout

For best performance, all traces should be as short as possible. To be most effective, the input and output capacitors should be placed close to the device to minimize the effect that parasitic trace inductance may have on normal and short-circuit operation. Using wide traces or large copper planes for all pins (V_{IN}, V_{OUT}, ON, and GND) helps minimize the parasitic electrical effects along with minimizing the case ambient thermal impedance.

Pulse Current Capability

The device is mounted on the evaluation board shown in the PCB layout section. It is loaded with pulses of 6 A and 1 ms for periods of 4.6 ms.



The HM9705 can safely support 6A pulse current repetitively at 25 °C.

Switch Non-Repetitive Pulsed Current

The HM9705 can withstand inrush current of up to 15A for 100 μs at 25 °C when heavy capacitive loads are connected and the part is already enabled.

Aboute Maximum Ratings

Parameter	Limit	Unit
Supply Input Voltage (V_{IN})	- 2 to 7	V
Enable Input Voltage (V_{EN}) , Input resistance is greater than 1kΩ	- 2 to 7	
Output Voltage (V_{OUT})	- 2 to 7	
Maximum Continuous Switch Current ($I_{max.}$)[c]	3.5	A
Maximum Repetitive Pulsed Current (1 ms, 10 % Duty Cycle)[c]	6	
Maximum Non-Repetitive Pulsed Current (100 μs, EN = Active)[c]	15	
ESD Rating (HBM)	8000	V
Junction Temperature (T_J)	- 40 to 150	℃
Thermal Resistance (θ_{JA})[a]	170	℃/W
Power Dissipation (P_D)[b]	735	mW

Notes:

a. Device mounted with all leads and power pad soldered or welded to PC board.

b. Derate 5.9 mW/°C above T_A = 25 °C.

c. T_A = 25 °C.

Recommended Operating Range

Parameter	Limit	Unit
Input Voltage Range (V_{IN})	1.5 to 6	V
Operating Junction Temperature Range (T_J)	- 40 to 125	℃

Electrical Characteristics

V_{IN} = 5 V, T_A = - 40 °C to 85 °C (Typical values are at T_A = 25 °C)

Parameter	Symbol	Test Conditions	Limit			Unit
			min	typ	max	
Operating Voltage[c]	V_{IN}		1.5		6	V
Quiescent Current	I_Q	V_{IN} = 1.8 V, EN = active		4	5	uA
		V_{IN} = 2.5 V, EN = active		6	7	
		V_{IN} = 3.6 V, EN = active		8	10	
		V_{IN} = 4.3 V, EN = active		10	12	
		V_{IN} = 5 V, EN = active		11	14	
Off Supply Current	$I_{Q(off)}$	EN = inactive, OUT = open			1	
Off Switch Current	$I_{DS(off)}$	EN = inactive, OUT = GND			1.2	
On-Resistance	$R_{DS(on)}$	V_{IN} = 1.8 V, I_L = 100 mA, T_A = 25 °C[(a)]		68		mΩ
		V_{IN} = 2.5 V, I_L = 100 mA, T_A = 25 °C[(a)]		46		
		V_{IN} = 3.6 V, I_L = 100 mA, T_A = 25 °C[(a)]		33	39	
		V_{IN} = 4.3 V, I_L = 100 mA, T_A = 25 °C[(a)]		29	34	
		V_{IN} = 5 V, I_L = 100 mA, T_A = 25 °C[(a)]		26	30	
EN Input Low Voltage[c]	V_{IL}	V_{IN} = 1.8 V			0.4	V
		V_{IN} = 2.5V			0.5	
		V_{IN} = 3.6 V			0.6	
		V_{IN} = 4.3 V			0.7	
		V_{IN} = 5 V			0.8	
EN Input High Voltage[c]	V_{IH}	V_{IN} = 1.8 V	1.2			
		V_{IN} = 2.5V	1.4			
		V_{IN} = 3.6 V	1.6			
		V_{IN} = 4.3 V	1.7			
		V_{IN} = 5 V	1.8			
EN Input Leakage	I_{SINK}	V_{EN} = 5.5 V	-1		1	uA
R_{ON_PD}	Pull-Down Resistance at ON pin	V_{IN}=1.5V to 6.0V,T_A= -40 to+ 85℃		1		MΩ
V_{T_RCB}	RCB Protection Trip Point	V_{OUT} - V_{IN}		45		mV
V_{R_RCB}	RCB Protection	V_{IN} - V_{OUT}		25		mV

	Release Trip Point					
	RCB Hysteresis			70		mV
I_{SD_OUT}	V_{OUT} Shutdown Current	V_{ON}=0V, V_{OUT}=6.0V, V_{IN} =Short to GND			2	μA
T_{RCB_ON}	RCB Response Time when Device ON	V_{OUT} - V_{IN} =100mV V_{ON}=High		4.0		μs
T_{RCB_OFF}	RCB Response Time Device OFF	V_{OUT} - V_{IN} =100mV V_{ON}=Low		2.5		μs
t_{DON}	Turn-On Delay[a.b]	V_{IN} =4.5V, R_L=5Ω, C_L=100μF, T_A=25℃		1		ms
t_R	V_{OUT} Rise Time[a,b]			2		ms
t_{ON}	Turn-On Time[a,c]			3		ms
t_{DON}	Turn-On Delay[a,b]	V_{IN} =4.5V, R_L=150Ω, C_L=100μF, T_A=25℃		1		ms
t_R	V_{OUT} Rise Time[a,b]			1.5		ms
t_{ON}	Turn-On Time[a,c]			2.5		ms
t_{DOFF}	Turn-Off Delay[a,b]	V_{IN} =4.5V, R_L=150Ω, C_L=100μF, T_A=25℃		1.8		ms
t_F	V_{OUT} Fall Time[a,b]			34		ms
t_{OFF}	Turn-Off Time[a,d]			35		ms

Notes:

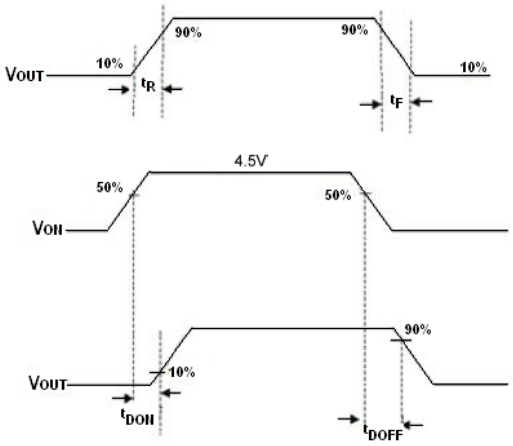
a. Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.

b. t_{DON}/t_{DOFF}/t_R/t_F are defined in Figure 3.

c. t_{ON}=t_R + t_{DON}

d. t_{OFF}=t_F + t_{DOFF}

Timing Diagram



Typical Characteristics

Internally regulated, 25 °C, unless otherwise noted

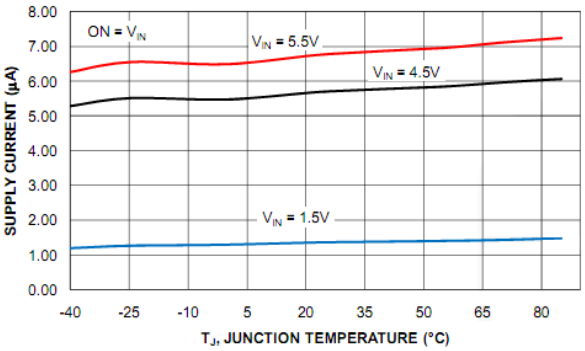


Figure 1. Supply Current vs Temperature

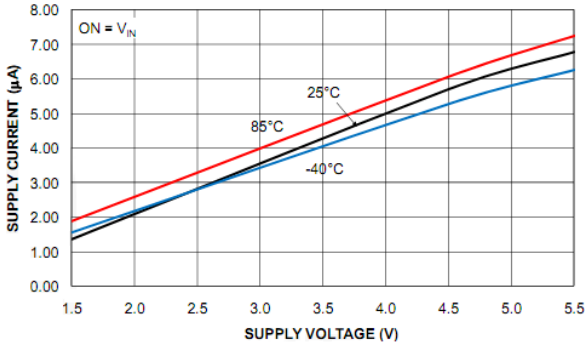


Figure 2. Supply Current vs Supply Voltage

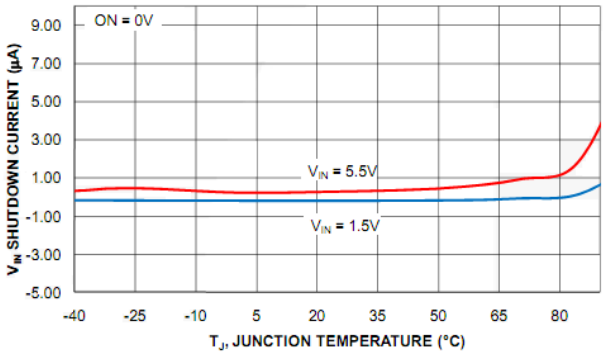


Figure 3. Shutdown Current vs Temperature

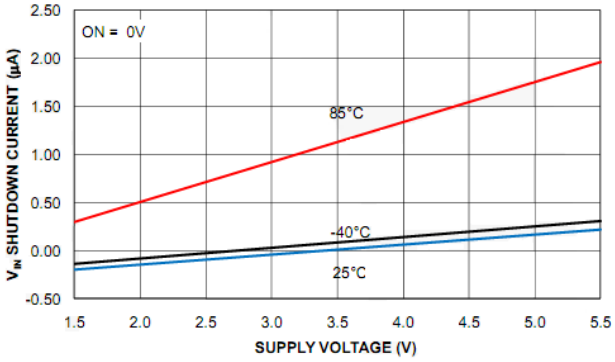


Figure 4. Shutdown Current vs Supply Voltage

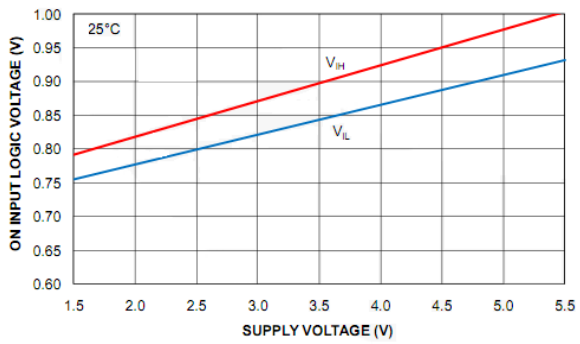


Figure 5. On Pin Threshold vs Supply Voltage

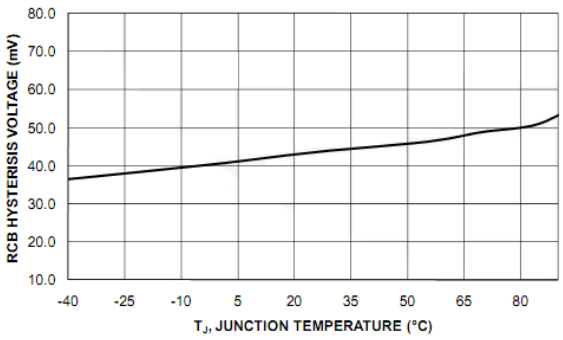


Figure 6. RCB Hysteresis vs Temperature

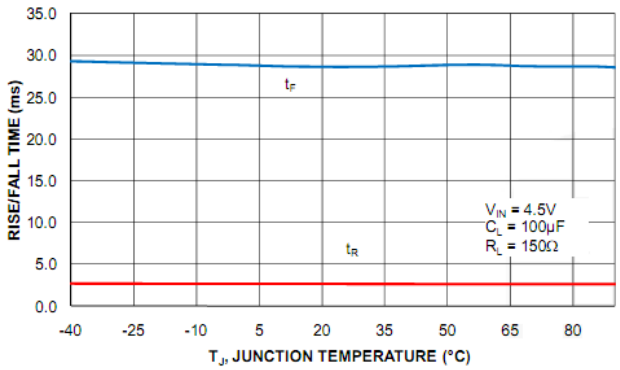


Figure 7. t_R /t_F vs Temperature

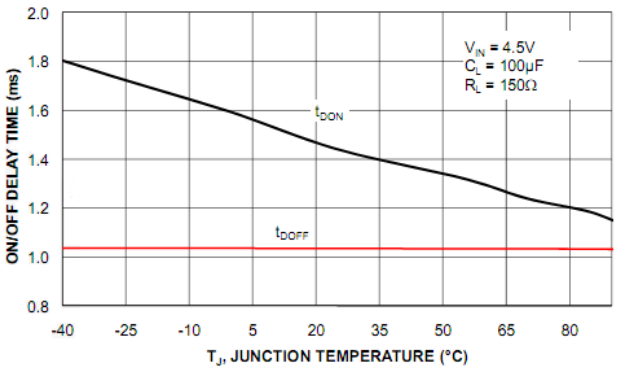


Figure 8. t_{DON} vs Temperature

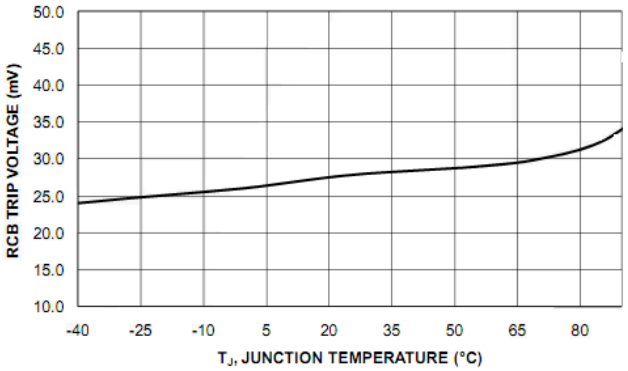


Figure 9. RCB Trip vs Temperature

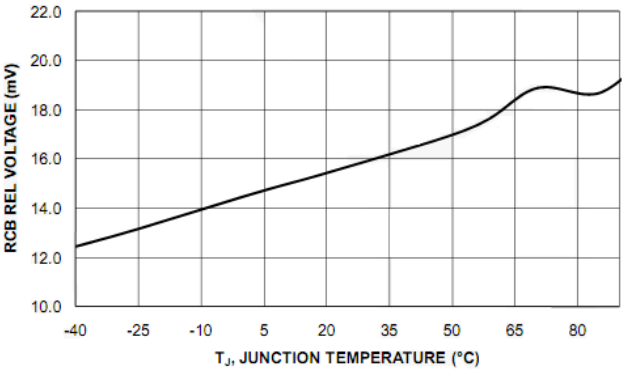
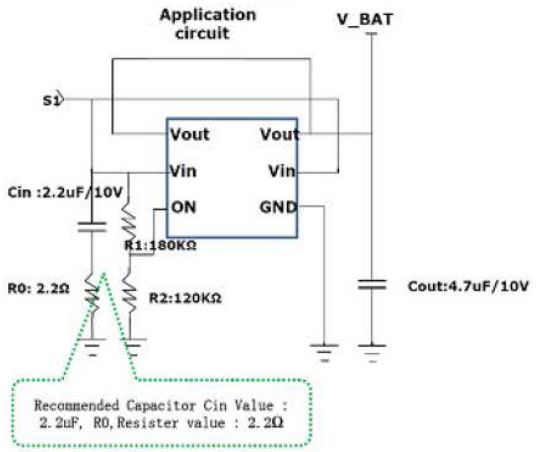


Figure 10. RCB Release vs Temperature

Application Circuits



Package Dimension