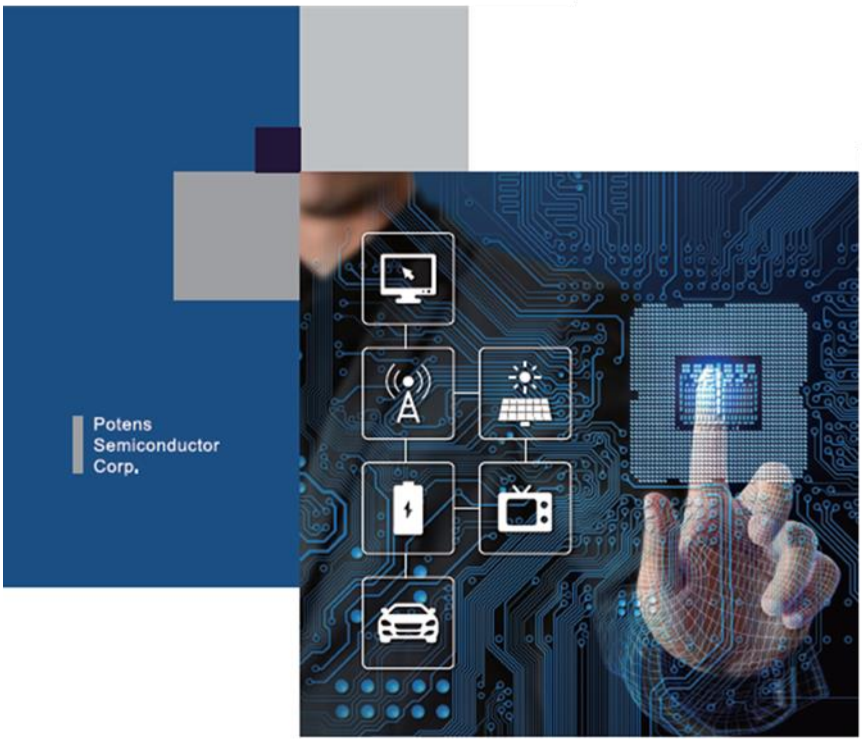
Application Information

Application for Load Switch



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The load switch is mainly used to turn on and turn off the power source. It is commonly used in the input terminal of electronic products or the connection between electronic products. For example, the display screen is connected to the notebook computer to transmit signals through the USB Type-C port. At the same time, it provides charging power to the laptop. Therefore, the power source needs a load switch to perform power transmission and power off. There are two kinds of the load switches using the MOSFET. One is N-channel MOSFET with extra control IC or complicated driving circuit. Fig. 1 shows the basic load switch circuit of the N-channel MOSFET. Another is P-channel MOSFET with resistors, capacitors and MOSFET or bipolar junction transistor. Fig. 2 shows the P-channel MOSFET load switch and it is popular and inexpensive design for the load switch application. This application information is focus on the circuit parameter design of P-channel MOSFET load switch application for the gate driving.

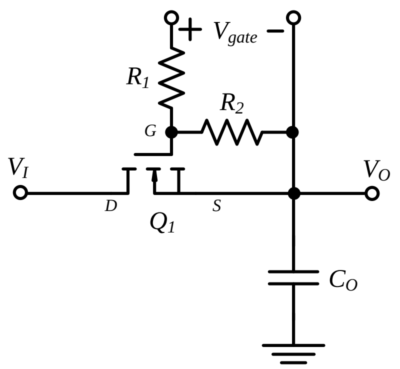
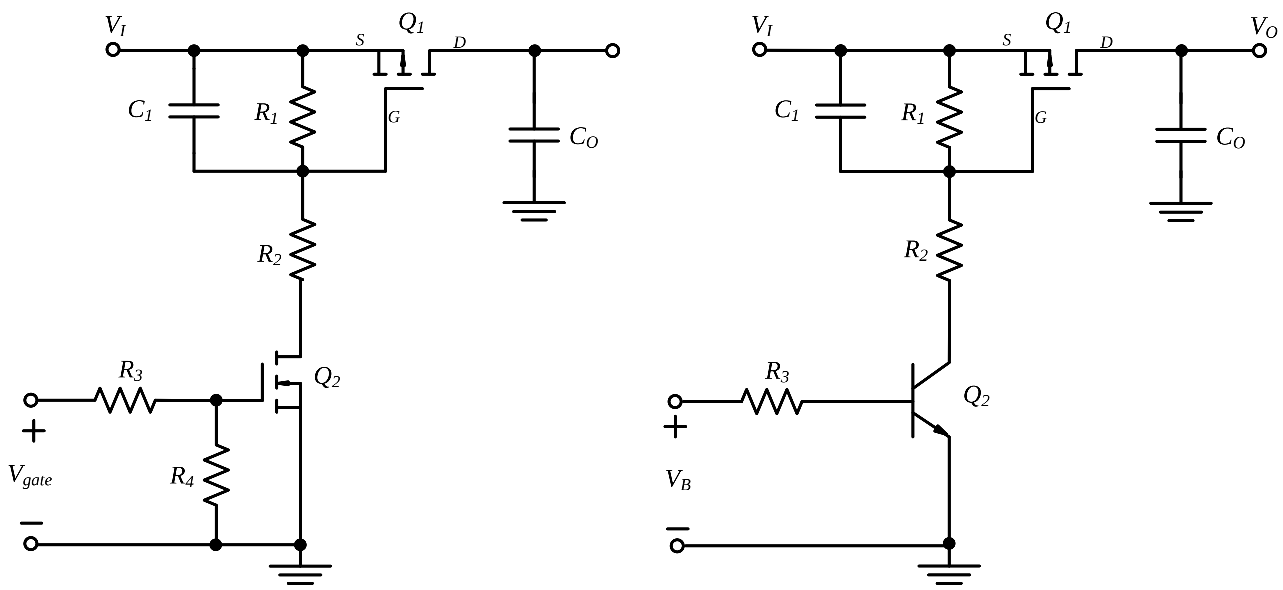


Fig. 1 the basic load switch circuit of the N-channel MOSFET



(a)MOSFET driving (b) bipolar junction transistor driving

Fig. 2 the load switch circuits of the P-channel MOSFET

For example, there is a P-channel MOSFET load switch circuit as shown in Fig. 2 (a). The input voltage V_I is 30 Volts and the part number of P-channel MOSFET is PDD6903 (60V, 35A, 28mΩ). The gate drive voltage V_{sg} is set as 10 Volts (> $2 \times V_{GS(th)}$) and R_2 is selected as 56kΩ. Then R_1 can be derived as by voltage divider rule:

$$\frac{R_1}{R_1+56k} \times 30V = 10V \quad \Rightarrow \quad R_1 = 28k\Omega \qquad (1)$$

C_1 is related to the turn on/off speed of the load switch. The following equation is recommended for the setting of rise/fall time by 5 time constants:

$$t_{rise/fall} \cong 5 \times R_1 \times (C_1 + C_{iss}) \qquad (2)$$

Where C_{iss} is the input capacitance. The switching speed is related to the inrush current while the speed turns on. Therefore, SOA should be checked after the setting of the circuit parameters. The test setup of SOA check is shown in Fig. 3. We recommend that the input voltage is supplied by isolated power supply and PE connection is removed from oscilloscope to avoid short-circuit. V_{GS} and V_{DS} are measured by passive probe and S pin is the common point. Let the measurement of V_{GS} and V_{DS} be the shortest loop to reduce the noise. Fig. 4 is the turn-on waveforms of V_{DS} and I_D and Fig. 5 is the SOA check waveform and it shows that the operation of the load switch is within SOA.

Table I. Main Electrical Characteristics of PDD6903

Dynamic and switching Characteristics

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
C_{iss}	Input Capacitance	V_{DS}=-25V, V_{GS}=0V, f=1MHz		2595	3900	pF

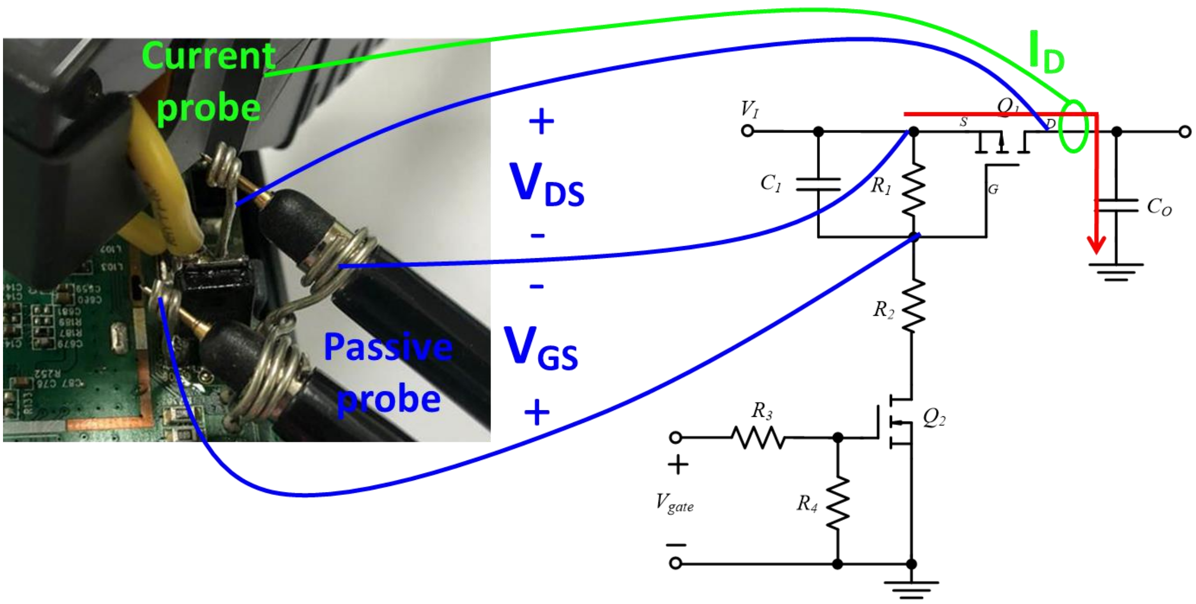


Fig. 3 the setup of SOA check for load switch

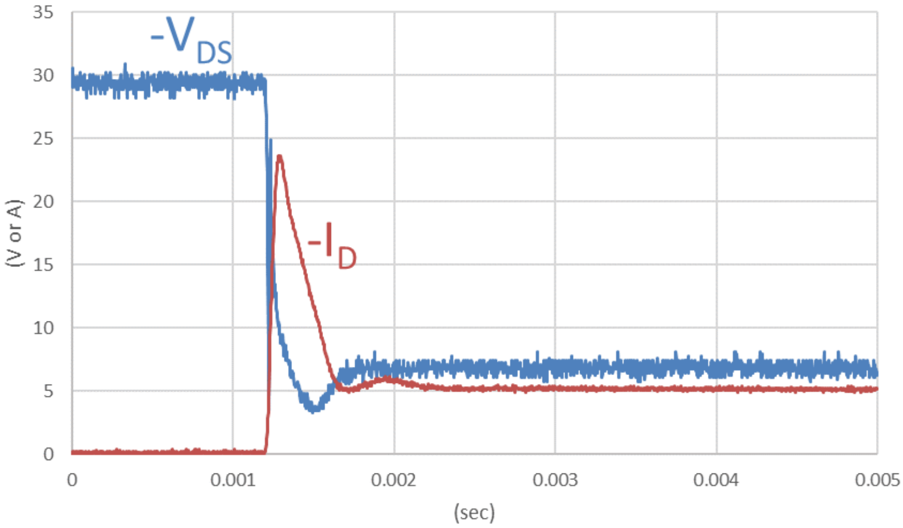


Fig. 4 the turn-on waveforms

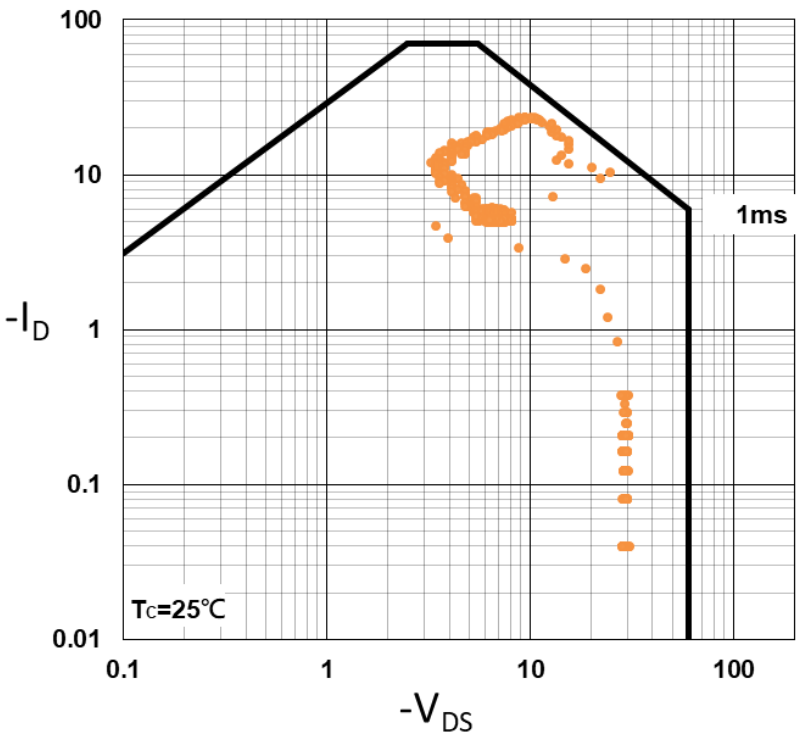


Fig. 5 the SOA check waveform

Reference

[1] Potens Semiconductor, "60V P-channel MOSFET," PDD6903 datasheet. https://www.potens-semi.c4m/upload/product/PDD6903.pdf.