

## Ultrahigh Threshold Voltage Depletion-Mode Power MOSFET

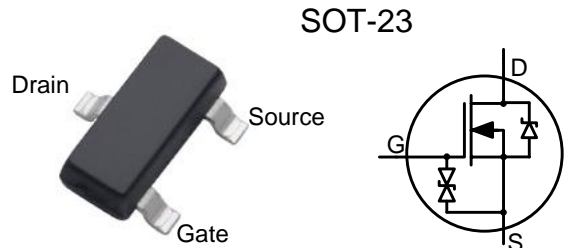
### General Features

- ESD improved Capability
- Depletion Mode (Normally On)
- Proprietary Advanced Planar Technology
- Proprietary Advanced Ultrahigh  $V_{th}$  Technology
- RoHS Compliant
- Halogen-free available

$BV_{DSX}$	$V_{GS(off),max}$	$I_{DSS,min}$
70V	-20V	120mA

### Applications

- Quick Charger
- Current Source
- Voltage Source
- Normally-on Switches



### General Description

This novel depletion mode MOSFET, developed and manufactured by ARK proprietary ultrahigh threshold voltage technology. By using the sub threshold characteristics, the depletion mode MOSFET can provide stably power to the load, and the voltage can be clamped to protect the load without Zener diode, and the circuit consumption is reduced.

### Ordering Information

Part Number	Package	Marking	Remark
HM1207E	SOT-23	0615	Halogen Free

### Absolute Maximum Ratings

$T_A=25^{\circ}\text{C}$  unless otherwise specified

Symbol	Parameter	HM1207E	Unit
$V_{DSX}$	Drain-to-Source Voltage <sup>[1]</sup>	70	V
$V_{DGX}$	Drain-to-Gate Voltage <sup>[1]</sup>	70	V
$I_D$	Continuous Drain Current	0.1	A
$I_{DM}$	Pulsed Drain Current <sup>[2]</sup>	0.4	
$P_D$	Power Dissipation	0.50	W
$V_{GS}$	Gate-to-Source Voltage	$\pm 30$	V
$V_{ESD(G-S)}$	Gate Source ESD IEC, C=150pF, R=330 $\Omega$	400	V
$T_L$	Soldering Temperature Distance of 1.6mm from case for 10 seconds	300	$^{\circ}\text{C}$
$T_J$ and $T_{STG}$	Operating and Storage Temperature Range	-55 to 150	

Caution: Stresses greater than those listed in the "Absolute Maximum Ratings" may cause permanent damage to the device.

### Thermal Characteristics

Symbol	Parameter	HM1207E	Unit
$R_{\theta JA}$	Thermal Resistance, Junction-to-Ambient	250	K/W

## Electrical Characteristics

### OFF Characteristics

$T_A = 25^\circ\text{C}$  unless otherwise specified

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions
$BV_{DSX}$	Drain-to-Source Breakdown Voltage	70	--	--	V	$V_{GS} = -30\text{V}$ , $I_D = 250\mu\text{A}$
$I_{D(OFF)}$	Drain-to-Source Leakage Current	--	--	10	$\mu\text{A}$	$V_{DS} = 70\text{V}$ , $V_{GS} = -30\text{V}$
		--	--	1.0	mA	$V_{DS} = 70\text{V}$ , $V_{GS} = -30\text{V}$ $T_J = 125^\circ\text{C}$
$I_{GSS}$	Gate-to-Source Leakage Current	--	--	20	$\mu\text{A}$	$V_{GS} = +30\text{V}$ , $V_{DS} = 0\text{V}$
		--	--	20		$V_{GS} = -30\text{V}$ , $V_{DS} = 0\text{V}$

### ON Characteristics

$T_A = 25^\circ\text{C}$  unless otherwise specified

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions
$I_{DSS}$	Saturated Drain-to-Source Current	120	--	--	mA	$V_{GS} = 0\text{V}$ , $V_{DS} = 25\text{V}$
$R_{DS(ON)}$	Static Drain-to-Source On-Resistance	--	10	15	$\Omega$	$V_{GS} = 0\text{V}$ , $I_D = 100\text{mA}$ [3]
$V_{GS(OFF)}$	Gate-to-Source Cut-off Voltage	-13	-16.5	-20	V	$V_{DS} = 20\text{V}$ , $I_D = 8\mu\text{A}$
gfs	Forward Transconductance	--	130	--	mS	$V_{DS} = 20\text{V}$ , $I_D = 5\text{mA}$

### Dynamic Characteristics

Essentially independent of operating temperature

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions
$C_{ISS}$	Input Capacitance	--	--	--	pF	$V_{GS} = -30\text{V}$ $V_{DS} = 25\text{V}$ $f = 1.0\text{MHz}$
$C_{OSS}$	Output Capacitance	--	--	--		
$C_{RSS}$	Reverse Transfer Capacitance	--	--	--		
$Q_G$	Total Gate Charge	--	--	--	nC	$V_{GS} = -10\text{V} \sim 0\text{V}$ $V_{DS} = 30\text{V}$ , $I_D = 100\text{mA}$
$Q_{GS}$	Gate-to-Source Charge	--	--	--		
$Q_{GD}$	Gate-to-Drain (Miller) Charge	--	--	--		

### Resistive Switching Characteristics

Essentially independent of operating temperature

Symbol	Parameter	Min.	Typ.	Max.	Unit	Test Conditions
$t_{d(ON)}$	Turn-on Delay Time	--	--	--	ns	$V_{GS} = -30\text{V} \sim -20\text{V}$ $V_{DD} = 35\text{V}$ , $I_D = 100\text{mA}$ $R_G = 20\Omega$
$t_{rise}$	Rise Time	--	--	--		
$t_{d(OFF)}$	Turn-off Delay Time	--	--	--		
$t_{fall}$	Fall Time	--	--	--		

### Source-Drain Diode Characteristics

$T_A = 25^\circ\text{C}$  unless otherwise specified

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
$V_{SD}$	Diode Forward Voltage	--	--	1.2	V	$I_{SD} = 100\text{mA}$ , $V_{GS} = -30\text{V}$

NOTE:

[1]  $T_J = +25^\circ\text{C}$  to  $+150^\circ\text{C}$

[2] Repetitive rating, pulse width limited by maximum junction temperature.

[3] Pulse width  $\leq 380\mu\text{s}$ ; duty cycle  $\leq 2\%$ .

Figure 1. Maximum Power Dissipation vs. Case Temperature

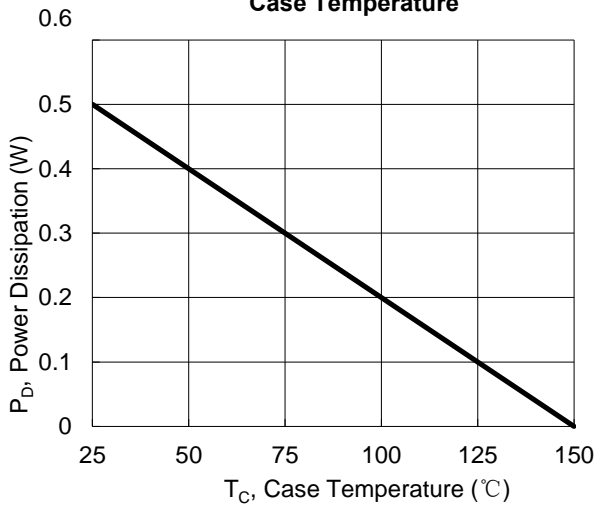
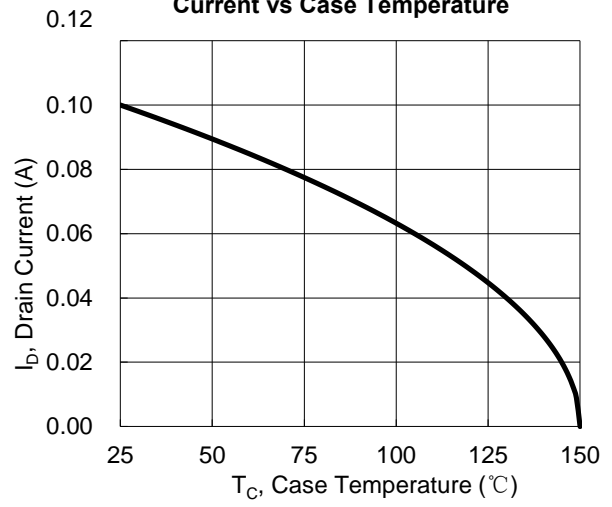


Figure 2. Maximum Continuous Drain Current vs Case Temperature



## Application Highlight

Depletion mode MOSFET has the function of providing power for IC in circuit, as shown in Figure 3.

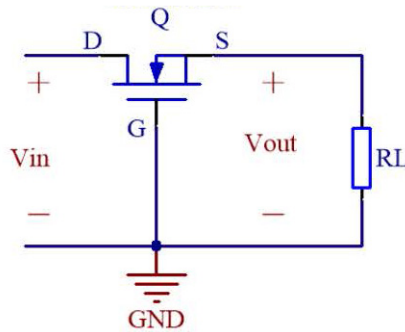


Figure 3

The parameters of the depletion mode MOSFET and the resistance ( $R_L$ ) of the IC are jointly determined the voltage ( $V_{out}$ ) and current ( $I_D$ ) supplied to the IC.

$$I_D = I_{DSS}(1 + I_D R_L / V_{GS(OFF)})^2$$

$$V_{out} = -V_{GS} = I_D R_L$$

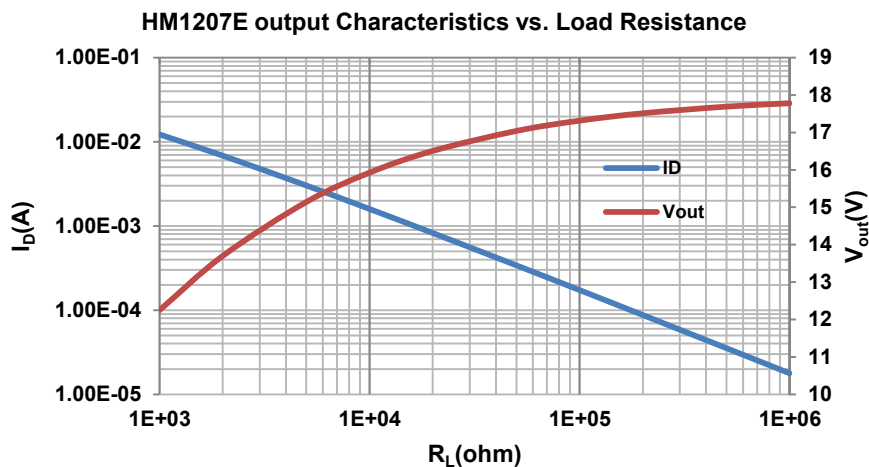


Figure 4

By this way, the depletion mode MOSFET operate in sub-threshold region, the gate voltage ( $V_{GS}$ ) is always at or below threshold voltage ( $V_{GS(OFF)}$ ), even when the input voltage ( $V_{in}$ ) is increased or the peak voltage occurs also so. Therefore, in addition to provide power for IC, the device can clamp voltage, the IC is protected. The  $V_{out}$  and  $V_{in}$  have the following formula:

$$\text{If } V_{in} < |V_{GS(OFF)}|, \text{ then } V_{out} \approx V_{in}$$

$$\text{If } V_{in} \geq |V_{GS(OFF)}|, \text{ then } V_{out} \leq V_{GS(OFF)}$$

The Ultrahigh Threshold Voltage Depletion-Mode Power MOSFET--HM1207E, was developed by **ARK Microelectronics** using proprietary technology. The threshold voltage of HM1207E exceeds -16V, can provide sufficient voltage for IC.

**Typical applications:**

In the QC2.0/3.0 and Type-C charger circuits, using the depletion mode MOSFET can make the PWM IC power supply circuit more simplified, as shown below:

In Figure 5, the transistor Q3 is used to provide power, and the zener diode ZD is used to clamp voltage, the power supply circuit of IC is composed of several components.

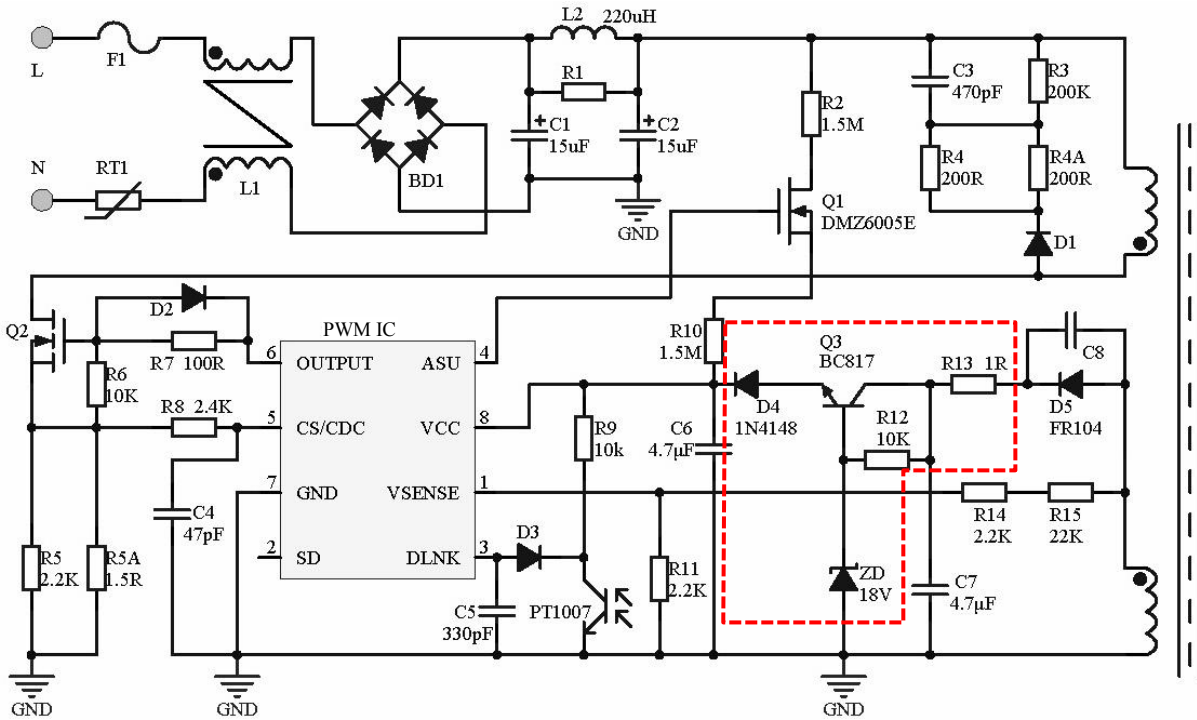


Figure 5

In figure 6, providing power and clamp voltage use only one device-HM1207E, the circuit is simplified.

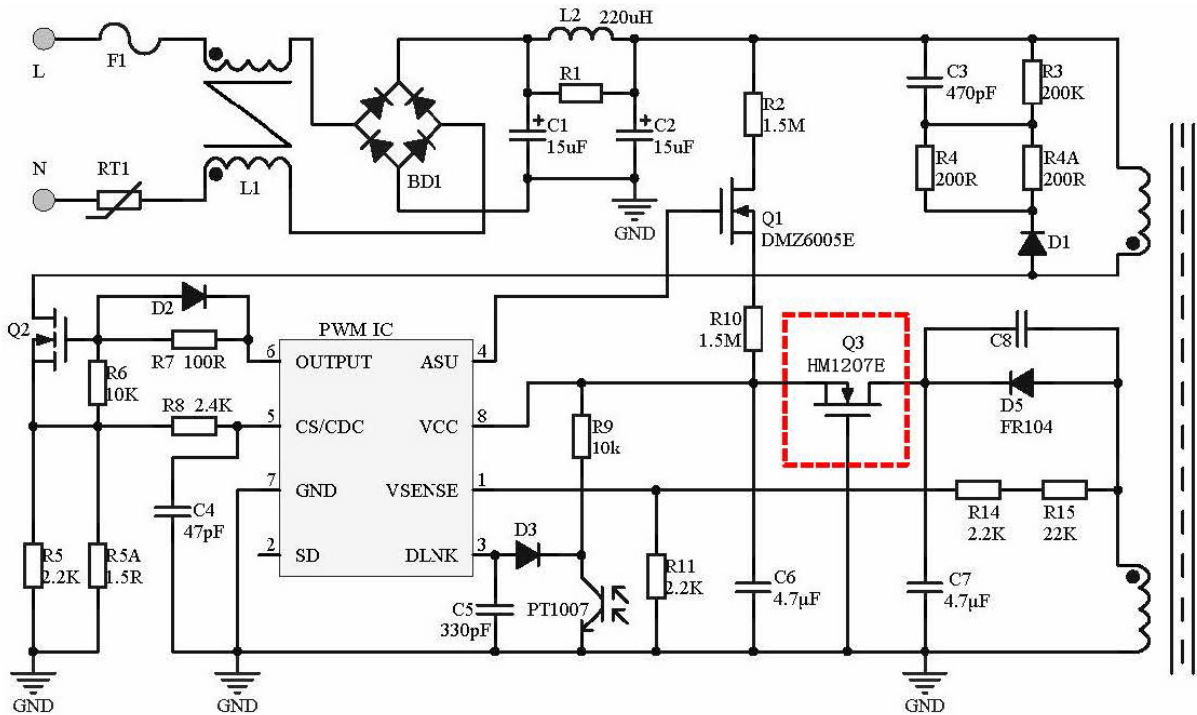


Figure 6

Package Dimensions

SOT-23

