

Silicon N Channel MOS Type (U-MOS<sup>III</sup>)/Silicon Epitaxial Schottky Barrier Diode

# SSM5H10TU

## DC-DC Converter Applications

- 1.5-V drive
- Combined an N-ch MOSFET and a Schottky barrier diode in one package.
- Low R<sub>DS</sub> (ON) and Low V<sub>F</sub>

## Absolute Maximum Ratings

### MOSFET (Ta = 25°C)

Characteristic	Symbol	Rating	Unit
Drain-source voltage	V <sub>DSS</sub>	20	V
Gate-source voltage	V <sub>GSS</sub>	± 10	V
Drain current	DC	I <sub>D</sub>	1.6
	Pulse	I <sub>DP</sub>	3.2
Drain power dissipation	P <sub>D</sub> (Note1)	500	mW
Channel temperature	T <sub>ch</sub>	150	°C

### Schottky Barrier Diode (Ta = 25°C)

Characteristics	Symbol	Rating	Unit
Repetitive peak reverse voltage	V <sub>RRM</sub>	20	V
Average forward current	I <sub>F</sub> (AV)	0.7	A
Peak one cycle surge forward current	I <sub>FSM</sub>	2 (50Hz)	A
Junction temperature	T <sub>j</sub>	125	°C

### MOSFET and Diode (Ta = 25°C)

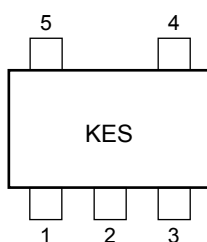
Characteristics	Symbol	Rating	Unit
Storage temperature range	T <sub>stg</sub>	-55 to 125	°C

Note: Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) are within the absolute maximum ratings.

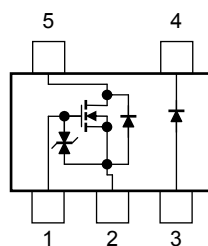
Please design the appropriate reliability upon reviewing the Toshiba Semiconductor Reliability Handbook ("Handling Precautions"/"Derating Concept and Methods") and individual reliability data (i.e. reliability test report and estimated failure rate, etc.).

Note 1: Mounted on FR4 board  
(25.4 mm × 25.4 mm × 1.6 mm, Cu pad: 645 mm<sup>2</sup>)

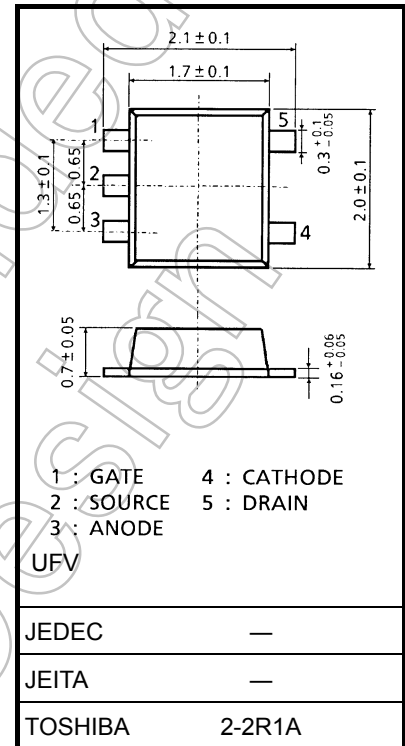
### Marking



### Equivalent Circuit (top view)



Unit: mm



Weight: 7 mg (typ.)

Start of commercial production  
2008-04

## MOSFET

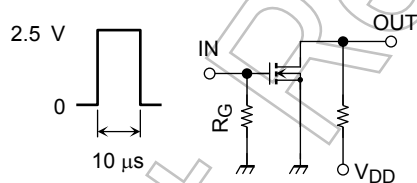
### Electrical Characteristics (Ta = 25°C)

Characteristics	Symbol	Test Conditions	Min	Typ.	Max	Unit	
Drain-source breakdown voltage	$V_{(BR)DSS}$	$I_D = 1 \text{ mA}, V_{GS} = 0 \text{ V}$	20	—	—	V	
	$V_{(BR)DSX}$	$I_D = 1 \text{ mA}, V_{GS} = -10 \text{ V}$	12	—	—		
Drain cutoff current	$I_{DSS}$	$V_{DS} = 20 \text{ V}, V_{GS} = 0 \text{ V}$	—	—	1	$\mu\text{A}$	
Gate leakage current	$I_{GSS}$	$V_{GS} = \pm 10 \text{ V}, V_{DS} = 0 \text{ V}$	—	—	$\pm 1$	$\mu\text{A}$	
Gate threshold voltage	$V_{th}$	$V_{DS} = 3 \text{ V}, I_D = 1 \text{ mA}$	0.35	—	1.0	V	
Forward transfer admittance	$ Y_{fs} $	$V_{DS} = 3 \text{ V}, I_D = 1 \text{ A}$ (Note 2)	2.5	5.0	—	S	
Drain-source ON-resistance	$R_{DS(ON)}$	$I_D = 1 \text{ A}, V_{GS} = 4.0 \text{ V}$ (Note 2)	—	87	119	m $\Omega$	
		$I_D = 1 \text{ A}, V_{GS} = 2.5 \text{ V}$ (Note 2)	—	105	139		
		$I_D = 0.8 \text{ A}, V_{GS} = 1.8 \text{ V}$ (Note 2)	—	125	190		
		$I_D = 0.3 \text{ A}, V_{GS} = 1.5 \text{ V}$ (Note 2)	—	145	247		
Input capacitance	$C_{iss}$	$V_{DS} = 10 \text{ V}, V_{GS} = 0 \text{ V}, f = 1 \text{ MHz}$	—	260	—	pF	
Output capacitance	$C_{oss}$		—	45	—		
Reverse transfer capacitance	$C_{rss}$		—	37	—		
Total Gate Charge	$Q_g$	$V_{DS} = 10 \text{ V}, I_D = 1.6 \text{ A}, V_{GS} = 4 \text{ V}$	—	7.5	—	nC	
Gate-Source Charge	$Q_{gs}$		—	5.6	—		
Gate-Drain Charge	$Q_{gd}$		—	1.9	—		
Switching time	Turn-on time	$t_{on}$	$V_{DD} = 10 \text{ V}, I_D = 0.5 \text{ A}$ $V_{GS} = 0 \text{ to } 2.5 \text{ V}, R_G = 4.7 \Omega$	—	8.3	—	ns
	Turn-off time	$t_{off}$		—	11.5	—	
Drain-source forward voltage	$V_{DSF}$	$I_D = -1.6 \text{ A}, V_{GS} = 0 \text{ V}$ (Note 2)	—	-0.8	-1.2	V	

Note 2: Pulse test

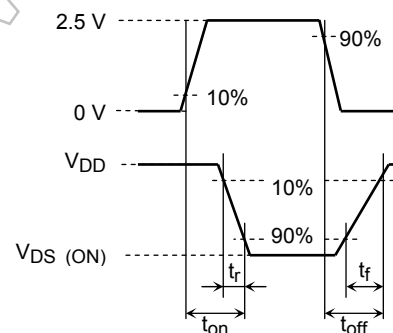
### Switching Time Test Circuit

(a) Test Circuit



$V_{DD} = 10 \text{ V}$   
 $R_G = 4.7 \Omega$   
 Duty  $\leq 1\%$   
 $V_{IN}$ :  $t_r, t_f < 5 \text{ ns}$   
 Common Source  
 $T_a = 25^\circ\text{C}$

(b)  $V_{IN}$



(c)  $V_{OUT}$

### Precaution

$V_{th}$  can be expressed as voltage between gate and source when the low operating current value is  $I_D = 1 \text{ mA}$  for this product. For normal switching operation,  $V_{GS(ON)}$  requires a higher voltage than  $V_{th}$  and  $V_{GS(OFF)}$  requires a lower voltage than  $V_{th}$ .

(The relationship can be established as follows:  $V_{GS(OFF)} < V_{th} < V_{GS(ON)}$ )

Be sure to take this into consideration when using the device.

## Schottky Barrier Diode

## Electrical Characteristics (Ta = 25°C)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Peak forward voltage	V <sub>FM</sub> (1)	I <sub>F</sub> = 0.5 A	—	0.32	0.39	V
	V <sub>FM</sub> (2)	I <sub>F</sub> = 0.7 A	—	0.36	0.43	V
Repetitive peak reverse current	I <sub>RRM</sub>	V <sub>R</sub> = 6 V	—	25	150	μA
Junction capacitance	C <sub>T</sub>	V <sub>R</sub> = 0 V, f = 1 MHz	—	143	—	pF

## Precaution

The Schottky barrier diode in this device has large reverse current leakage compared to typical switching diodes. Thus, excessive operating temperature or voltage may cause thermal runaway. To avoid this problem, be sure to take both forward and reverse loss into consideration.

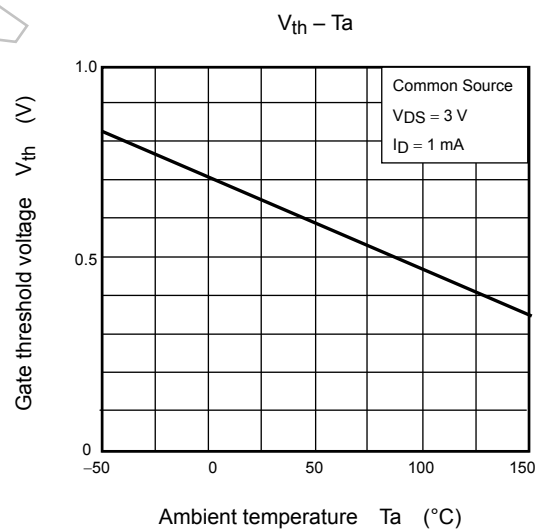
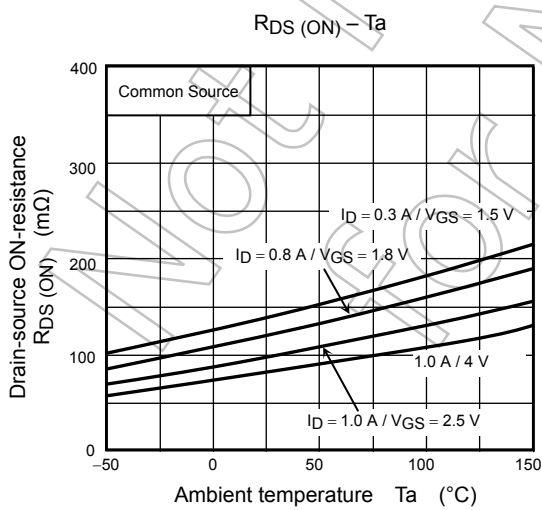
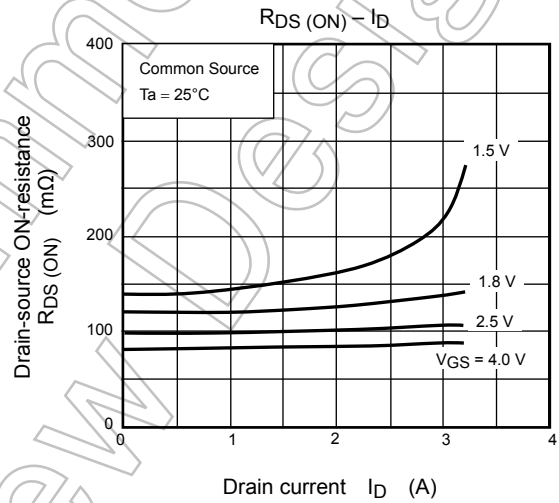
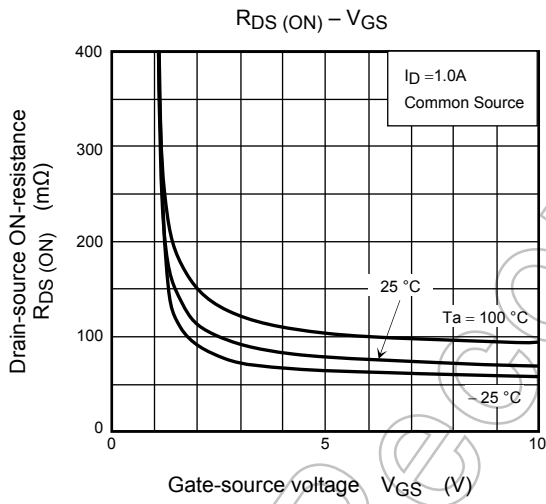
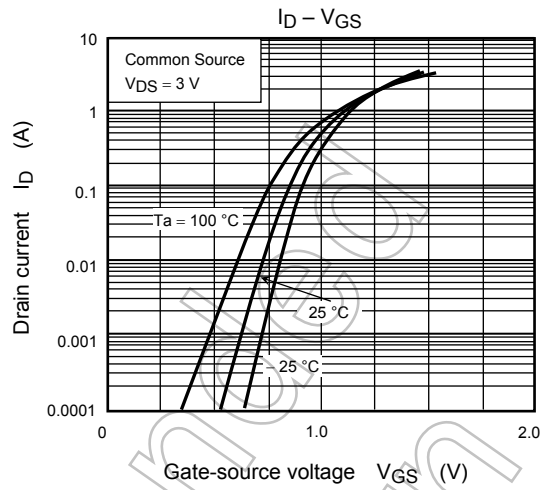
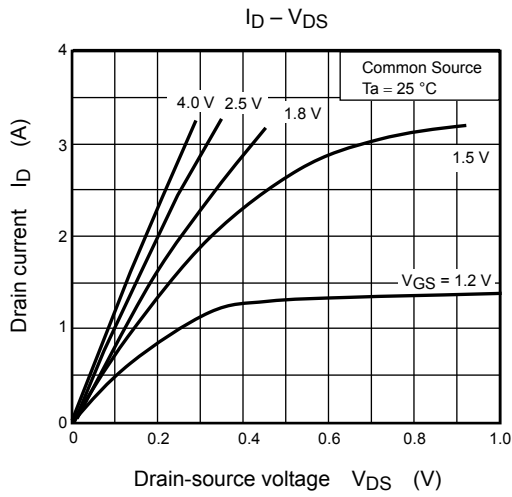
## Handling Precaution

When handling individual devices that are not yet mounted on a circuit board, make sure that the environment is protected against electrostatic discharge. Operators should wear antistatic clothing, and containers and other objects that come into direct contact with devices should be made of antistatic materials.

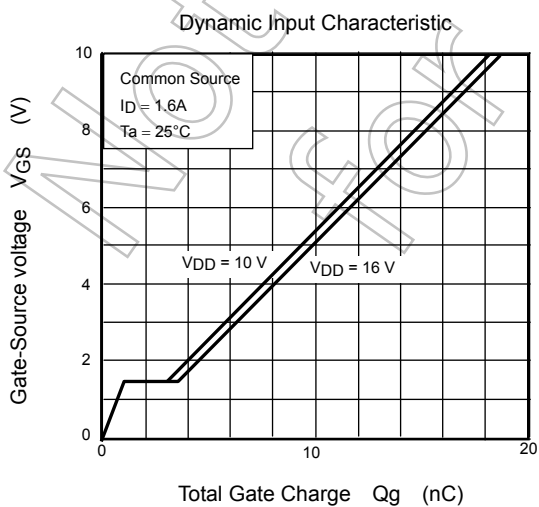
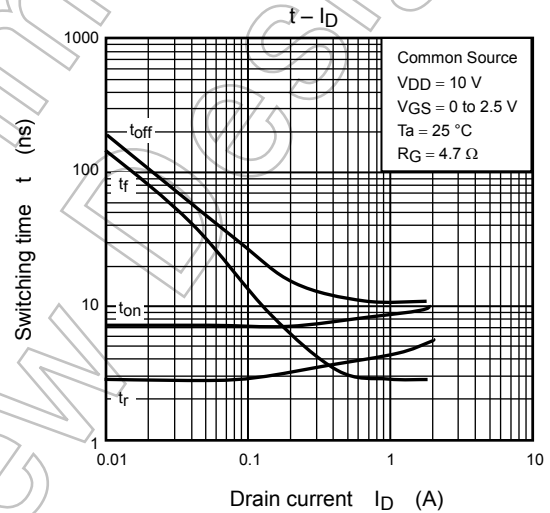
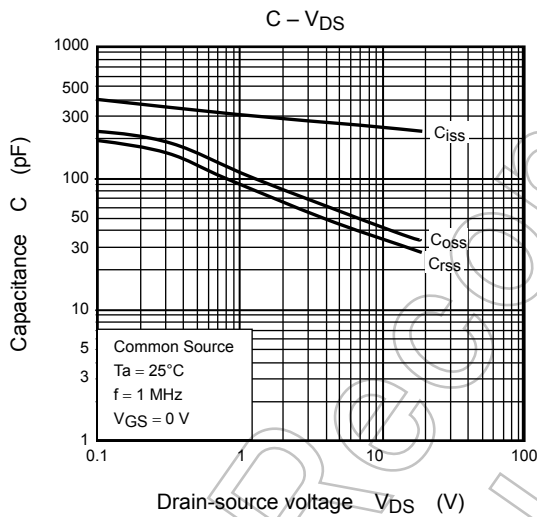
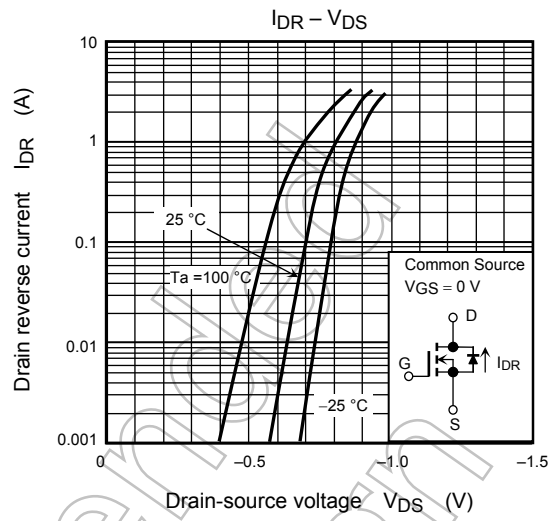
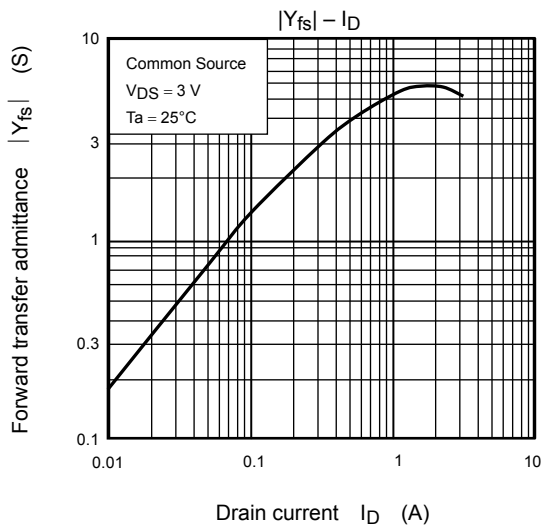
The Channel-to-Ambient thermal resistance R<sub>th(ch-a)</sub> and the drain power dissipation P<sub>D</sub> vary according to the board material, board area, board thickness and pad area. When using this device, be sure to take heat dissipation fully into account.

Not Recommended for New Design

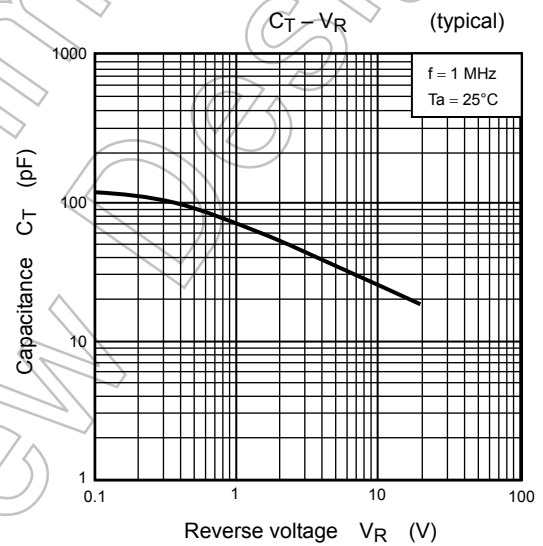
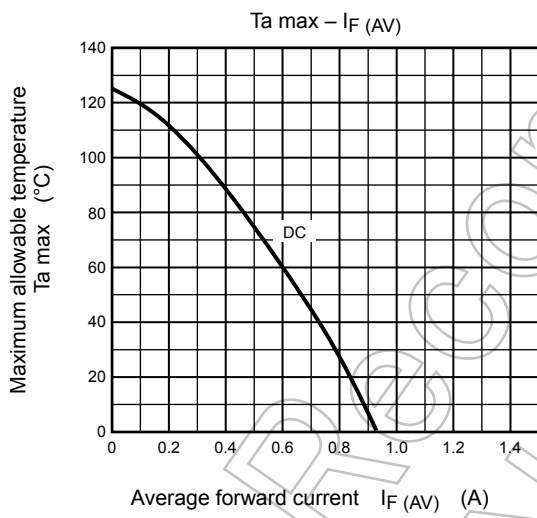
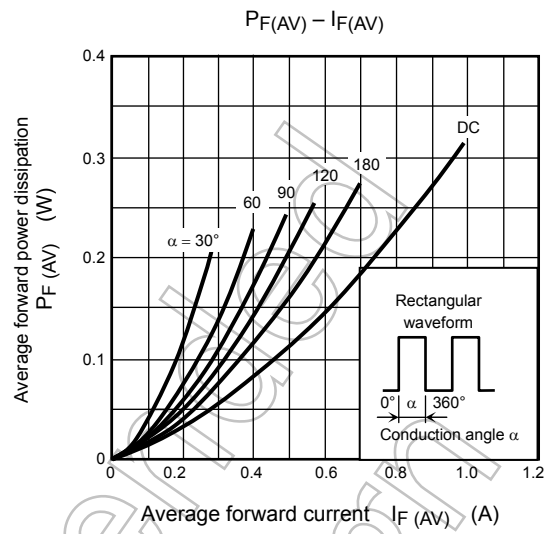
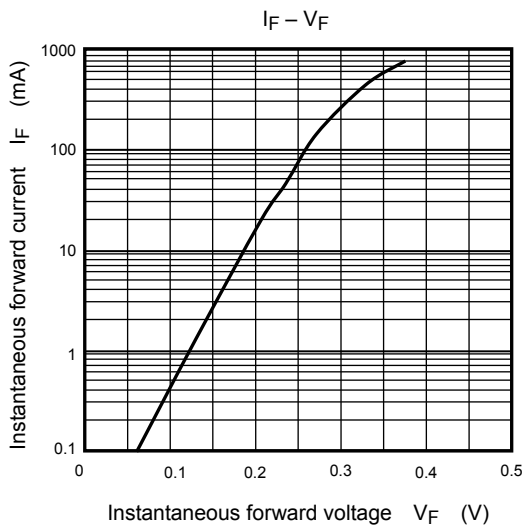
## MOSFET



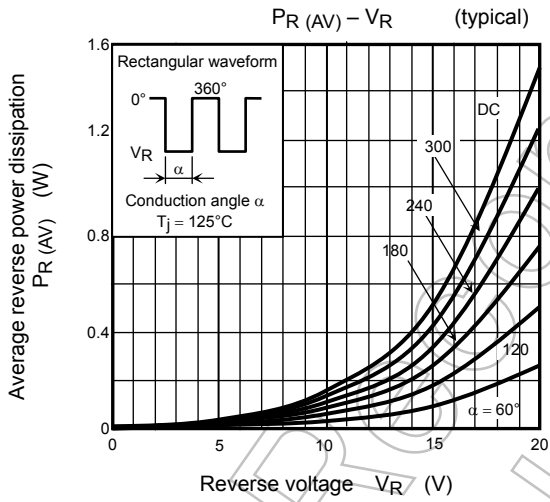
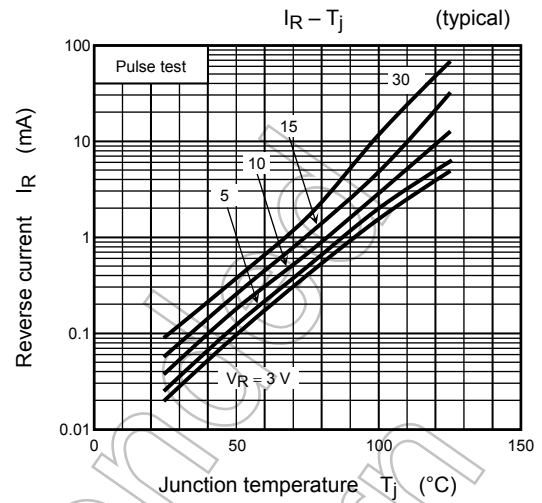
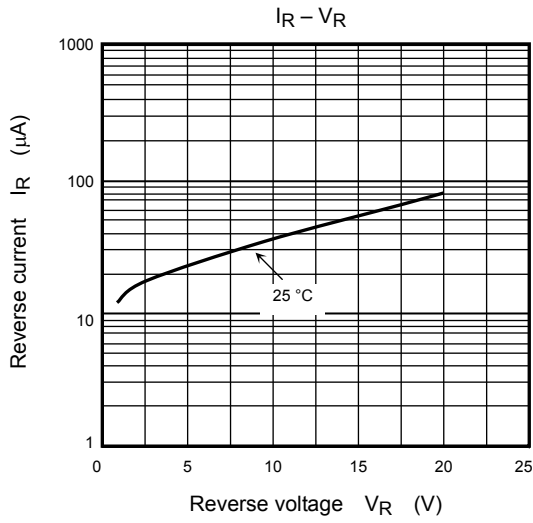
## MOSFET



## Schottky Barrier Diode



**Schottky Barrier Diode**



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