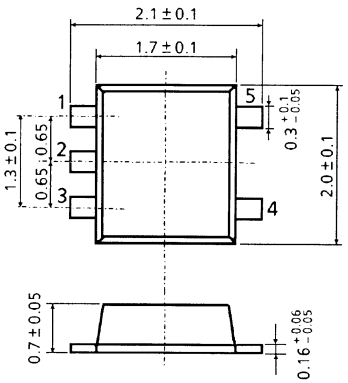
Silicon N Channel MOS Type (U-MOSⅢ)/Silicon Epitaxial Schottky Barrier Diode

SSM5H12TU

DC-DC Converter Applications

- 1.8-V drive
- Combined an N-ch MOSFET and a Schottky barrier diode in one package.
- Low $R_{DS\ (ON)}$ and Low V_F

Unit: mm



1 : GATE 4 : CATHODE
2 : SOURCE 5 : DRAIN
3 : ANODE

UFV

JEDEC	—
JEITA	—
TOSHIBA	2-2R1A

Weight: 7 mg (typ.)

Absolute Maximum Ratings

MOSFET (Ta = 25°C)

Characteristic		Symbol	Rating	Unit
Drain-source voltage		V_{DSS}	30	V
Gate-source voltage		V_{GSS}	± 12	V
Drain current	DC	I_D	1.9	A
	Pulse	I_{DP}	3.8	
Power dissipation		P_D (Note 1)	0.5	W
		t = 10s	0.8	
Channel temperature		T_{ch}	150	°C

Schottky Barrier Diode (Ta = 25°C)

Characteristics	Symbol	Rating	Unit
Repetitive peak reverse voltage	V_{RRM}	30	V
Average forward current	$I_{F(AV)}$	0.7	A
Peak one cycle surge forward current	I_{FSM}	2 (50Hz)	A
Junction temperature	T_j	125	°C

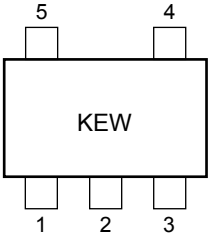
MOSFET and Diode (Ta = 25°C)

Characteristics	Symbol	Rating	Unit
Storage temperature range	T_{stg}	−55 to 125	°C

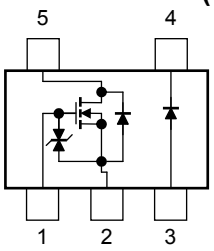
Note: Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) 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^2)

Marking



Equivalent Circuit (top view)



MOSFET

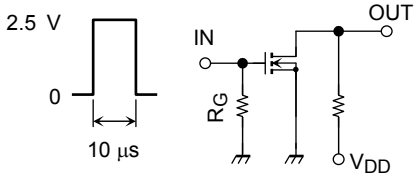
Electrical Characteristics (Ta = 25°C)

Characteristic		Symbol	Test Conditions	Min	Typ.	Max	Unit
Drain-source breakdown voltage		$V_{(BR)\ DSS}$	I_D = 1 mA, V_{GS} = 0 V	30	—	—	V
		$V_{(BR)\ DSX}$	I_D = 1 mA, V_{GS} = −12 V	18	—	—	
Drain cut-off current		I_{DSS}	V_{DS} = 30 V, V_{GS} = 0 V	—	—	1	μA
Gate leakage current		I_{GSS}	V_{GS} = ± 12 V, V_{DS} = 0 V	—	—	±1	μA
Gate threshold voltage		V_{th}	V_{DS} = 3 V, I_D = 1 mA	0.4	—	1.0	V
Forward transfer admittance		$\|Y_{fs}\|$	V_{DS} = 3 V, I_D = 1.0 A (Note 2)	2.0	3.9	—	S
Drain–source ON-resistance		$R_{DS\ (ON)}$	I_D = 1.0 A, V_{GS} = 4.0 V (Note 2)	—	103	133	mΩ
			I_D = 0.8 A, V_{GS} = 2.5 V (Note 2)	—	125	177	
			I_D = 0.5 A, V_{GS} = 1.8 V (Note 2)	—	165	296	
Input capacitance		C_{iss}	V_{DS} = 15V, V_{GS} = 0 V, f = 1 MHz	—	123	—	pF
Output capacitance		C_{oss}		—	43	—	
Reverse transfer capacitance		C_{rss}		—	18	—	
Total gate charge		Q_g	V_{DS} = 15V, I_D = 1.9 A, V_{GS} = 4 V	—	1.9	—	nC
Gate-source charge		Q_{gs}		—	1.1	—	
Gate-drain charge		Q_{gd}		—	0.8	—	
Switching time	Turn-on time	t_{on}	V_{DD} = 15 V, I_D = 1.0 A, V_{GS} = 0 to 2.5 V, R_G = 4.7 Ω	—	9.2	—	ns
	Turn-off time	t_{off}		—	6.4	—	
Drain-source forward voltage		V_{DSF}	I_D = -1.9 A, V_{GS} = 0 V (Note 2)	—	-0.83	-1.2	V

Note 2: Pulse test

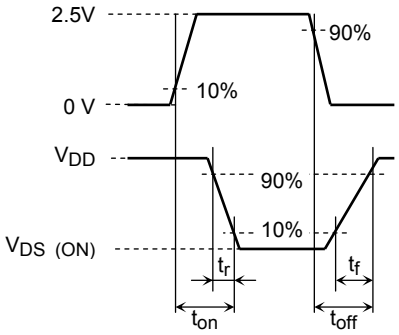
Switching Time Test Circuit

(a) Test Circuit



V_{DD} = 15 V
R_G = 4.7 Ω
Duty ≤ 1%
V_{IN}: t_r, t_f < 5 ns
Common Source
Ta = 25°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 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	$V_{FM\ (1)}$	I_F = 0.5 A	—	0.34	0.41	V
	$V_{FM\ (2)}$	I_F = 0.7 A	—	0.37	0.44	V
Repetitive peak reverse current	I_{RRM}	V_R = 15 V	—	60	200	μA
Total capacitance	C_T	V_R = 0 V, f = 1 MHz	—	139	—	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.

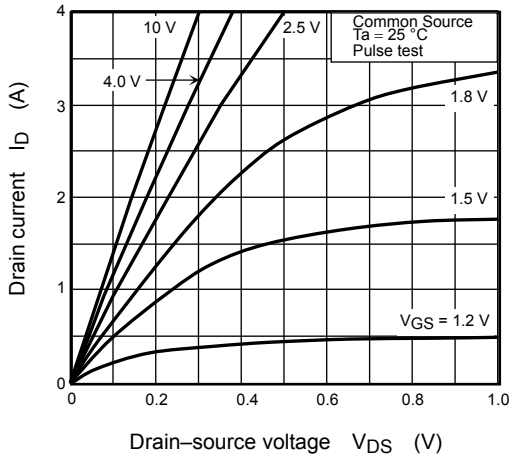
Handling Precaution

When handling individual devices (which are not yet mounted on a circuit board), ensure that the environment is protected against static electricity. Operators should wear anti-static clothing, and containers and other objects that come into direct contact with devices should be made of anti-static materials.

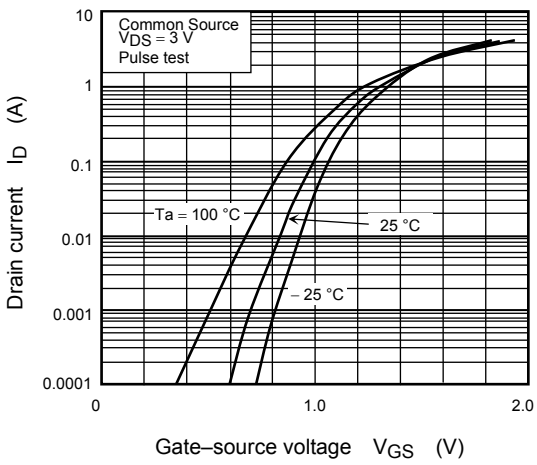
Thermal resistance $R_{th\ (j\text{-}a)}$ and power dissipation P_D vary depending on board material, board area, board thickness and pad area. When using this device, please take heat dissipation into consideration.

MOSFET

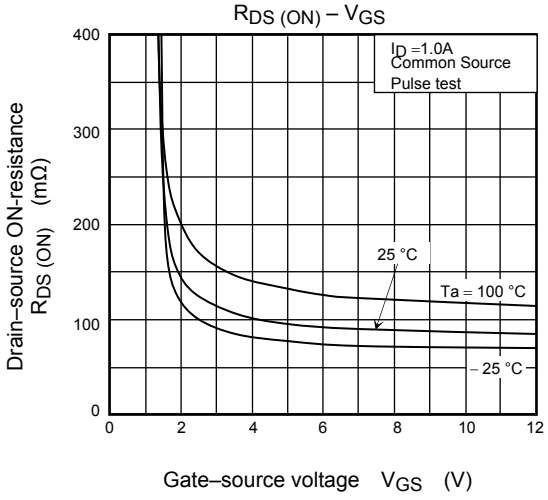
$I_D - V_{DS}$



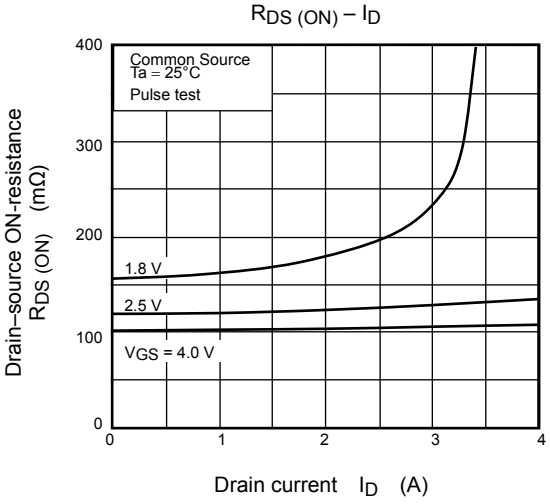
$I_D - V_{GS}$



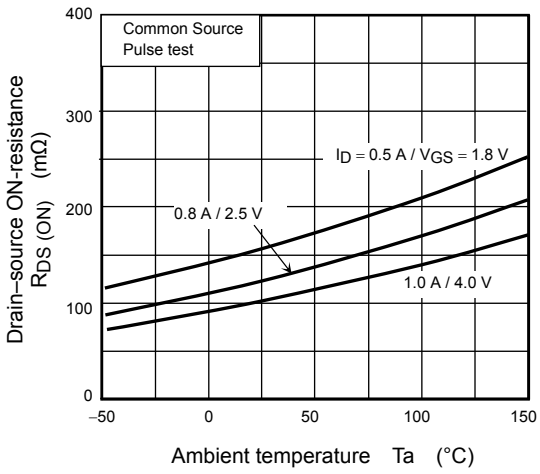
$R_{DS\ (ON)} - V_{GS}$



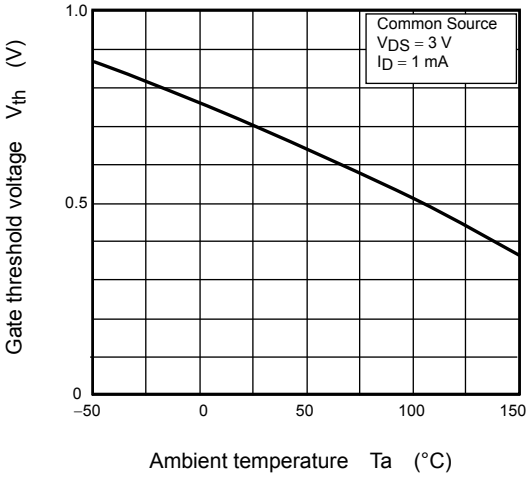
$R_{DS\ (ON)} - I_D$



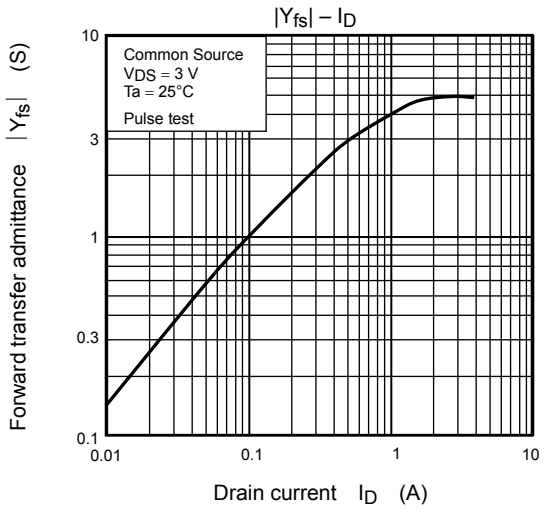
$R_{DS\ (ON)} - Ta$

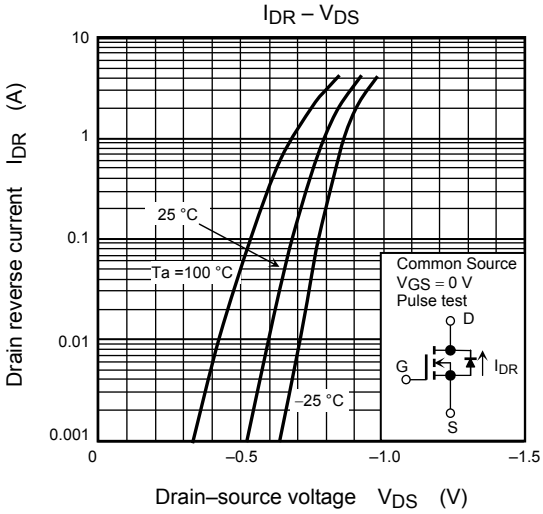


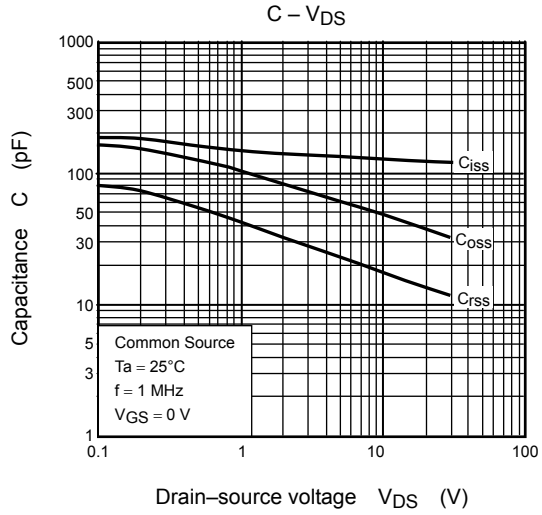
$V_{th} - Ta$

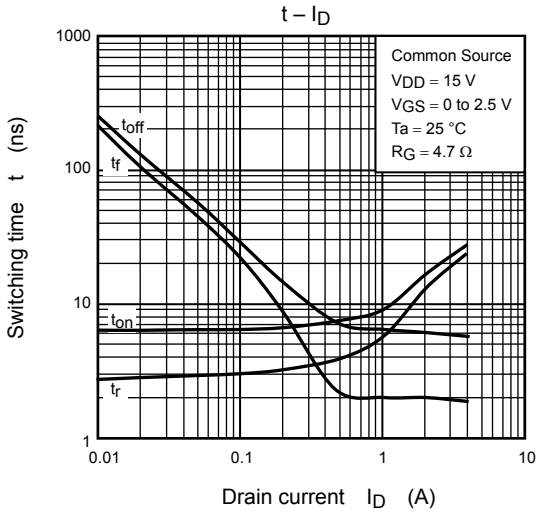


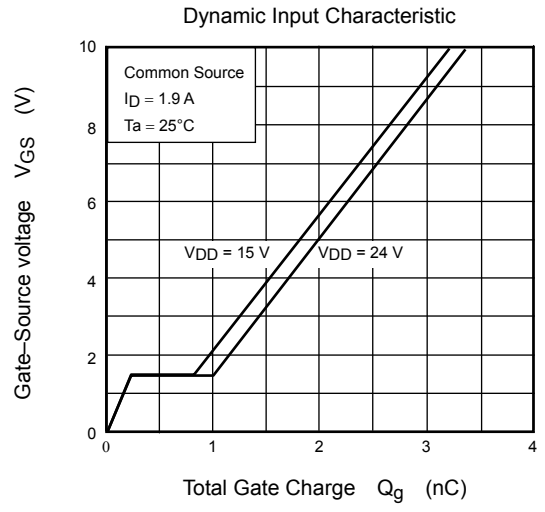
MOSFET


|Yfs| – ID
Common Source
VDS = 3 V
Ta = 25°C
Pulse test
Forward transfer admittance |Yfs| (S)
Drain current ID (A)
10
3
1
0.3
0.1
0.01
0.1
1
10


IDR – VDS
Common Source
VGS = 0 V
Pulse test
25 °C
Ta =100 °C
–25 °C
D
G
S
IDR
Drain reverse current IDR (A)
Drain–source voltage VDS (V)
10
1
0.1
0.01
0.001
0
–0.5
–1.0
–1.5

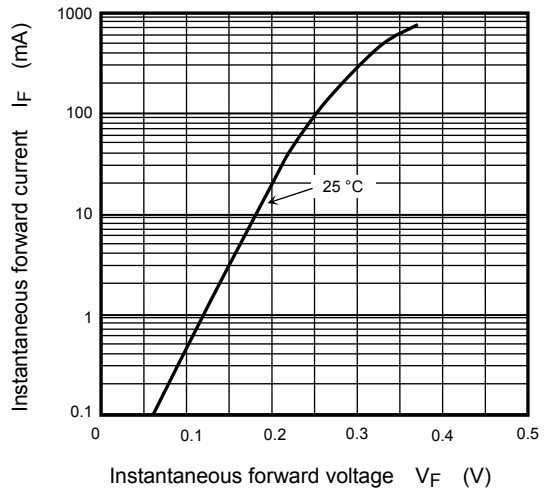

C – VDS
Common Source
Ta = 25°C
f = 1 MHz
VGS = 0 V
Ciss
Coss
Crss
Capacitance C (pF)
Drain–source voltage VDS (V)
1000
500
300
100
50
30
10
5
3
1
0.1
1
10
100


t – ID
Common Source
VDD = 15 V
VGS = 0 to 2.5 V
Ta = 25 °C
RG = 4.7 Ω
toff
tf
ton
tr
Switching time t (ns)
Drain current ID (A)
1000
100
10
1
0.01
0.1
1
10

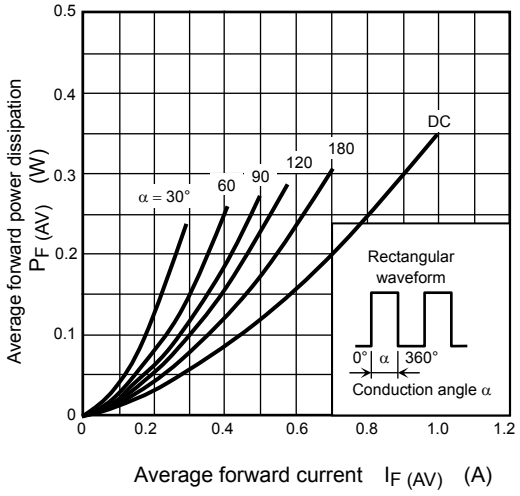

Dynamic Input Characteristic
Common Source
ID = 1.9 A
Ta = 25°C
VDD = 15 V
VDD = 24 V
Gate–Source voltage VGS (V)
Total Gate Charge Qg (nC)
10
8
6
4
2
0
0
1
2
3
4

Schottky Barrier Diode

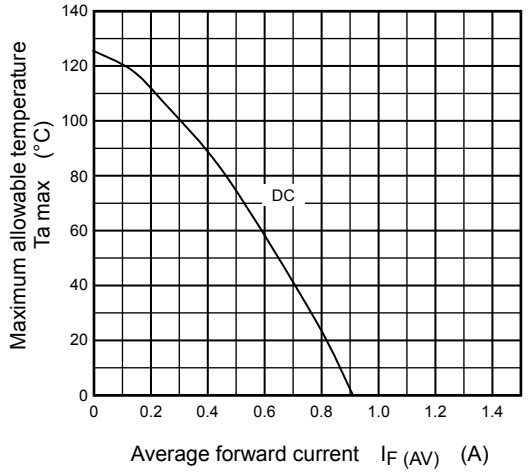
$I_F - V_F$



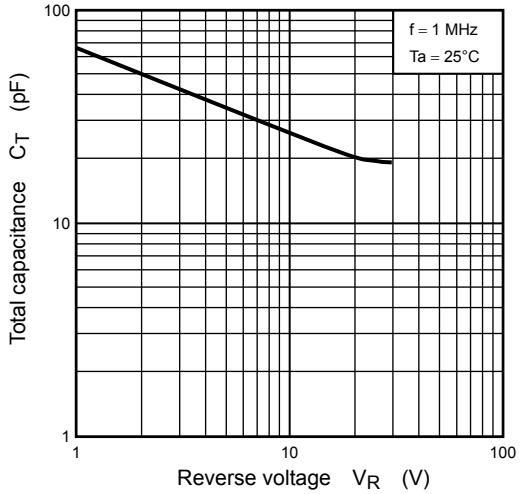
$P_{F(AV)} - I_{F(AV)}$



Ta max – $I_{F(AV)}$

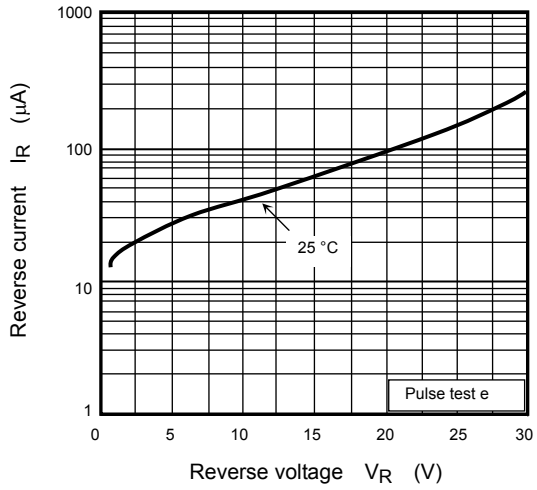


$C_T - V_R$ (typical)

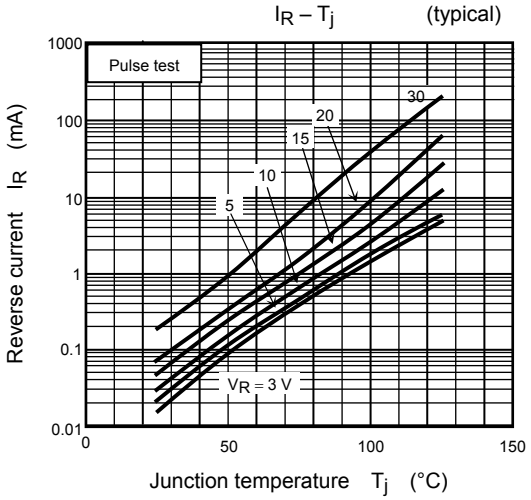


Schottky Barrier Diode

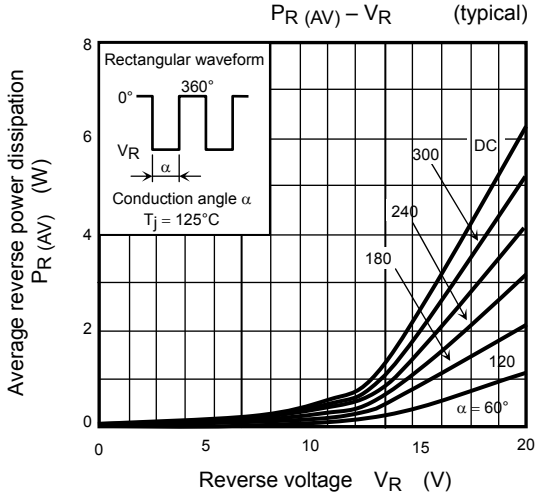
$I_R – V_R$



$I_R – T_j$ (typical)



$P_{R\ (AV)} – V_R$ (typical)



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