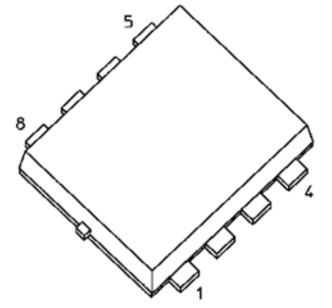
TOSHIBA Intelligent Power Device Silicon Monolithic Power MOS Integrated Circuit

TPD7104AF

1 channel High-Side N channel Power MOSFET Gate Driver

TPD7104AF is a 1channel high-side N channel power MOSFET gate driver. This IC contains a charge pump circuit, allowing easy configuration of a high-side switch for large-current applications.



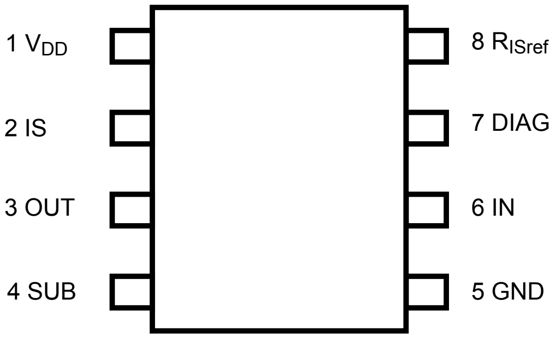
SON8-P-0303-0.65S

Weight: 0.017 g (Typ.)

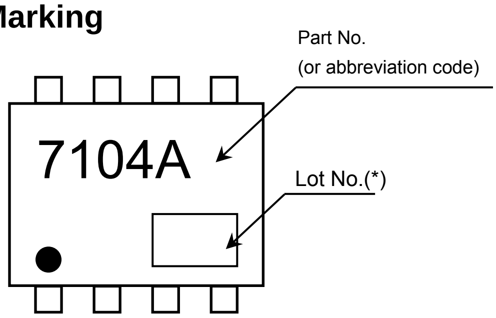
Features

- Charge pump circuit is built in
- Built-in short circuit and reverse battery protection
- Housed in the PS-8 package and supplied in embossed carrier tape

Pin Assignment (top view)



Marking



Note: ● on the lower left of the marking indicates Pin 1

*Weekly code: (Three digits)

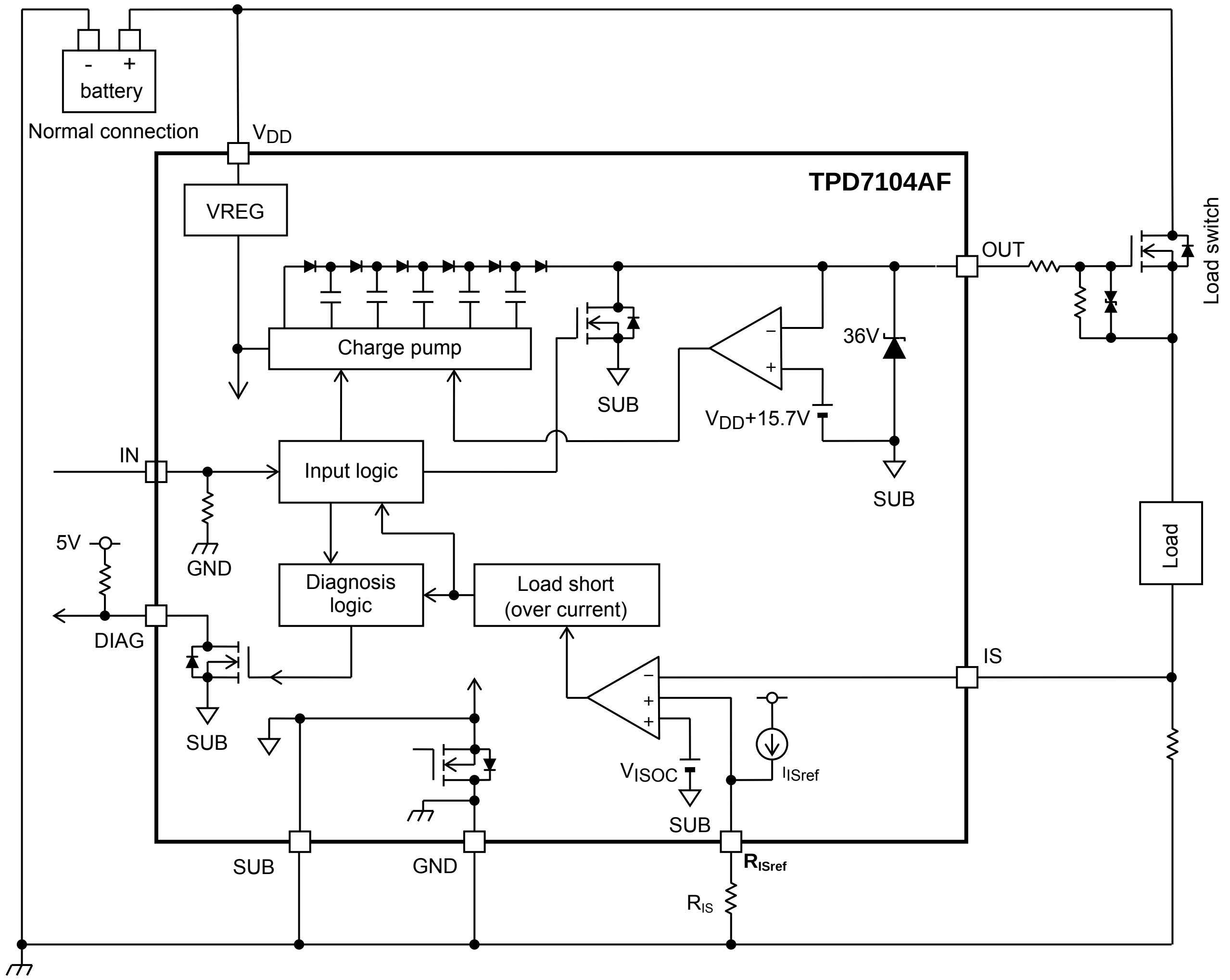
Week of manufacture

Year of manufacture
(The last digit of the calendar year)

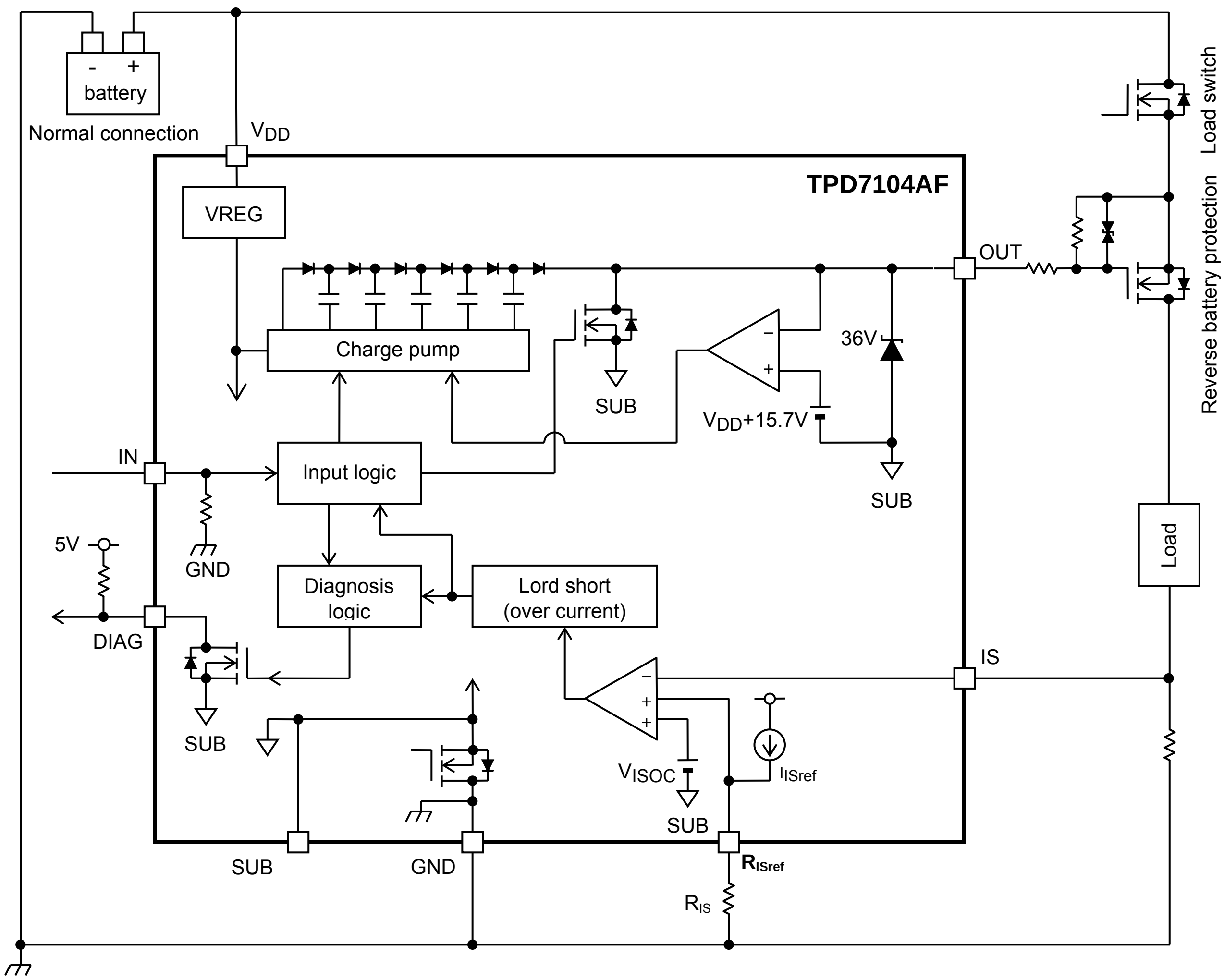
Note: That because of its MOS structure, this product is sensitive to static electricity

Start of commercial production
2015-08

Block Diagram / Application circuit 1 (load switch circuit Reverse battery protection un-corresponding)



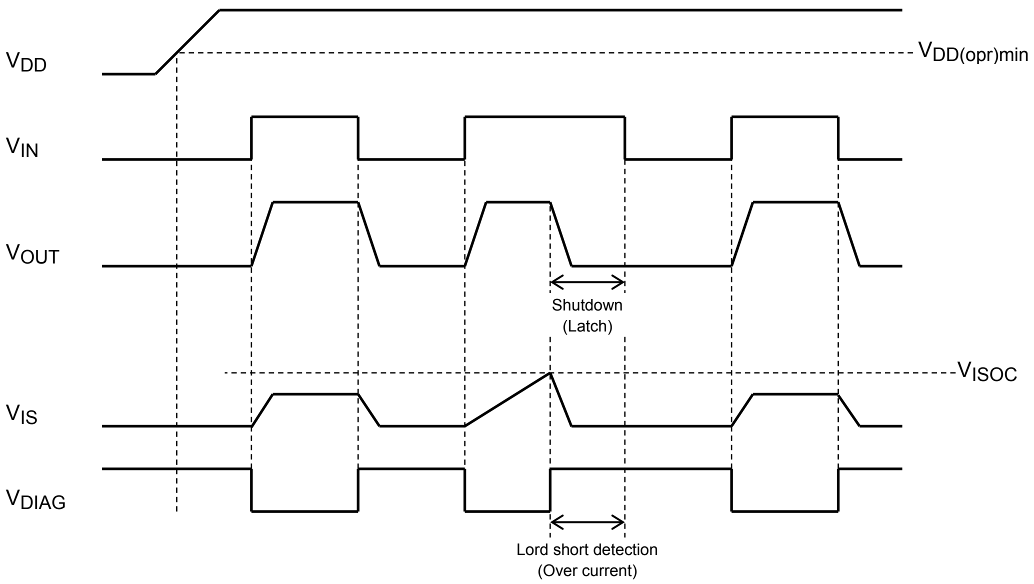
Application circuit 2 (Reverse battery protection circuit “ FET off”)



Pin Description

Pin No.	Symbol	Function
1	V_{DD}	Power supply pin.
2	IS	Detection pin for short circuit. If short circuit detection is not used, IS pin connect to GND.
3	OUT	Output pin for an external MOSFET drive. State is off if detect short circuit.
4	SUB	Please use open if use protection for reverse connection of power supply. If protection for reverse connection of power supply is not used, SUB pin connect to GND.
5	GND	Ground pin.
6	IN	Input pin. IN has a pull-down resistor.
7	DIAG	Diagnosis detection pin. It is open drain composition. Output is inverted if detect short circuit.
8	R_{ISref}	Adjust pin for sense level for short circuit detection. If R_{ISref} is not used, R_{ISref} pin is open.

Timing Chart



Note: Output shut down when it detects short circuit and becomes latch state and protects outside MOSFET.
DIAG becomes H-state, and makes input L-state when reset the latch circuit.

Truth Table

V_{IN}	V_{OUT}	Charge pump	V_{IS} (Note 1)	V_{DIAG}	Mode
L	L	Charge pump stop (oscillation is stopped)	L	H (Note 2)	Normal
H	H	Charge pump operation.	L	L	
L	L	Charge pump stop (oscillation is stopped)	H	H (Note 2)	Lord short
H	L	Charge pump stop (oscillation is stopped)	H	H (Note 2)	
-	Hz (Note 3)	-	-	Hz (Note 3)	Reverse batttery (SUB pin open)

Note 1: V_{IS} : Load short detection voltage.

Note 2: The Diag Output is a Nch open drain and it is OFF state at the time of V_{DIAG} = “H”.

Note 3: Hz : High impedance.

Absolute Maximum Ratings (Ta = 25°C)

Characteristics		Symbol	Rating	Unit	Remarks
Power supply voltage	DC	$V_{DD(1)}$	-0.3 to 24	V	-
	Pulse	$V_{DD(2)}$	40	V	t=300ms single pulse
Power supply reverse connection		$-V_{DD(3)}$	18	V	SUB open
Input voltage		V_{IN}	-0.3 to 6	V	-
Output source current		$I_{OUT(-)}$	Internal capacity	mA	Source current
Output sink current		$I_{OUT(+)}$	5	mA	Sink current
IS pin voltage		V_{IS}	-0.3 to 6	V	-
Diagnosis output voltage		V_{DIAG}	-0.3 to 6	V	-
Diagnosis pin current		I_{DIAG}	5	mA	-
Power dissipation (Note1-a)		$P_{D(1)}$	0.7	W	-
Power dissipation (Note1-b)		$P_{D(2)}$	0.35	W	-
Operateing temperature		T_{opr}	-40 to 125	°C	-
Junction temperature		T_j	150	°C	-
Strage temerature		T_{stg}	-55 to 150	°C	-

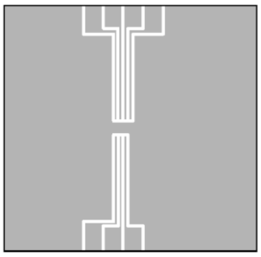
Note: Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.)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

Thermal Resistance

Characteristics	Symbol	Rating	unit
Thermal resistance, junction to ambient	$R_{th\ (j\text{–}a)}$	178.6(Note 1-a)	°C / W
		357.2(Note 1-b)	

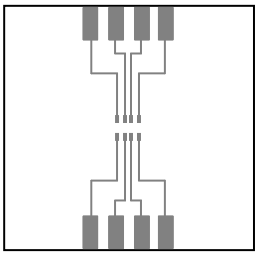
Note 1:

(Note 1-a) Glass epoxy board



Glass epoxy board
Material: FR-4
25.4mm×25.4mm×0.8mm

(Note 1-b) Glass epoxy board



Glass epoxy board
Material: FR-4
25.4mm×25.4mm×0.8mm

Electrical Characteristics (Unless otherwise specified, T_j = -40 to 125°C, V_{DD} = 5 to 18V)

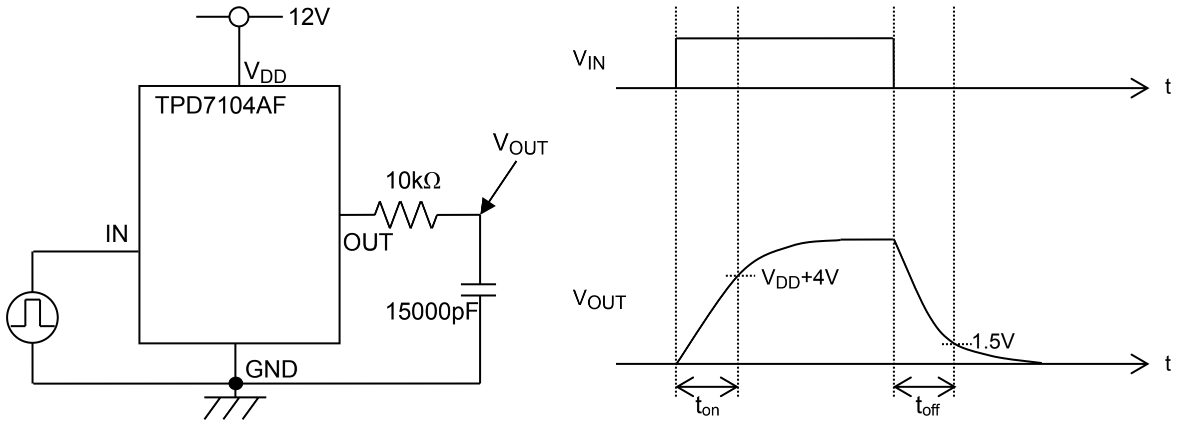
Characteristics	Symbol	Pin	Test Condition	Min	Typ.	Max	Unit
Operating supply voltage	$V_{DD(opr)}$	V_{DD}	-	5	12	18	V
Supply current	$I_{DD(off)}$	V_{DD}	V_{DD} = 12V, V_{IN} = V_{IL}, T_j=25°C	-	0.7	3	mA
	$I_{DD(on)}$	V_{DD}	V_{IN} = V_{IH}, output is open circuit	-	-	5	mA
Input voltage	V_{IH}	IN	-	2.5	-	-	V
	V_{IL}		-	-	-	1.5	
Input current	I_{IH}	IN	V_{IN} = 5V	-	19	50	μA
	I_{IL}		V_{IN} = 0V	-1	-	1	
Output voltage	V_{OUTH1}	OUT	V_{DD} = 5V, V_{IN} = V_{IH}, I_{OUT} = -100μA	V_{DD} +8	V_{DD} +13	V_{DD} +18	V
	V_{OUTH2}	OUT	V_{DD} = 8 to 18V, V_{IN} = V_{IH}, I_{OUT} = -100μA	V_{DD} +10	V_{DD} +15.7	V_{DD} +18	V
Output clamp voltage	V_{clamp}	OUT	V_{IN} = V_{IH}	31	36	40	V
Output resistance	R_{SINK}	OUT	V_{IN} = V_{IL} , I_{OUT} = 1mA	-	510	800	Ω
Diagnosis output leakage current	I_{DIAGH}	DIAG	V_{IN} = V_{IL}, V_{DIAG} = 5V	-	-	10	μA
Diagnosis output voltage	V_{DIAGL}	DIAG	V_{IN} = V_{IH}, I_{DIAG} = 500μA	-	0.22	0.4	V
Short circuit detection voltage	V_{ISOC}	R_{ISref}	V_{DD} = 12V, R_{ISref} pin is open circuit	0.8	1.02	1.2	V
R_{ISref} pin output current	$I_{ISref(1)}$	R_{ISref}	V_{RISref} = 0.2V	-60	-38	-20	μA
	$I_{ISref(2)}$	R_{ISref}	V_{RISref} = 0.4V	-60	-38	-20	μA
	$I_{ISref(3)}$	R_{ISref}	V_{RISref} = 0.6V	-60	-38	-20	μA
Switching time	t_{on}	OUT	Refer to Test circuit 1 , T_j = 25°C	-	450	800	μs
	t_{off}			-	480	800	
Output current for reverse connection	$I_{REV(1)}$	OUT	Refer to Test circuit 2 V_{DD}=-5 to -18V, T_j = 25°C	-1	-	-	μA
	$I_{REV(2)}$	OUT	Refer to Test circuit 2 V_{DD}=-5 to -18V, T_j = -40 to 125°C	-10	-	-	μA

Note2 : Typical condition is V_{DD}=12V, T_j=25°C.

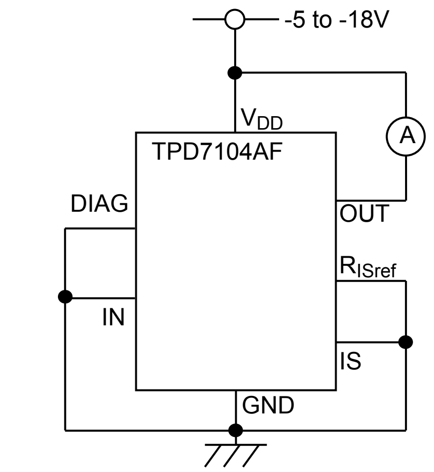
Note3 : The current detection voltage is controllable, when connecting resistance to R_{ISref} pin.
But, when V_{RISref}(R_{IS}×I_{ISref}) is over V_{ISOC}, the current detection voltage is V_{ISOC}.

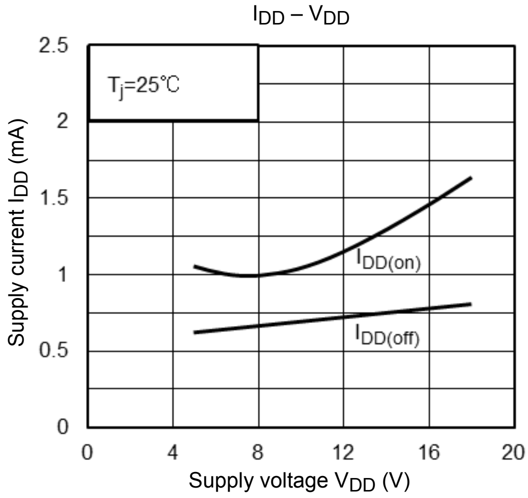
Note4 : About the charge pump voltage
So as not to apply over-voltage to the gate-source voltage(V_{GS}) of external power MOSFET, and so as to become the best driving voltage, the clamping circuit is built into.
And it doesn't output over 36V(Typ.), because of protection of itself.

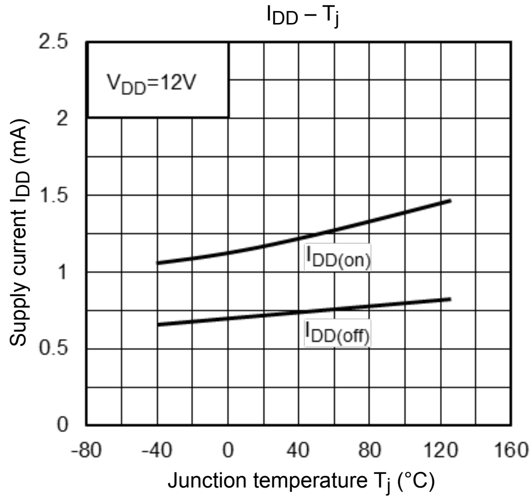
Test circuit 1 for switching time

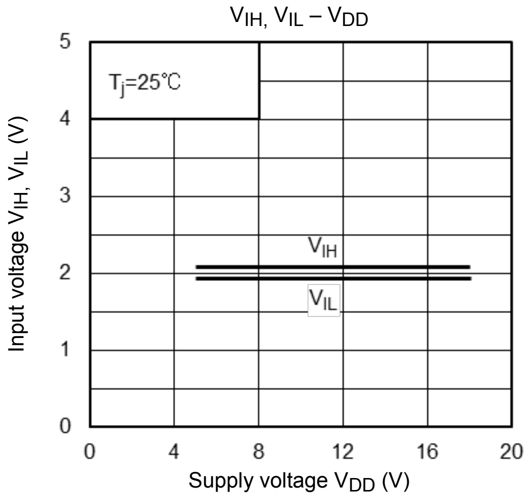


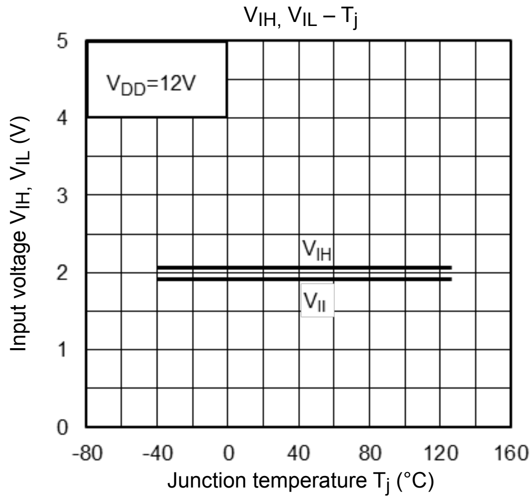
Test circuit 2 for Output current for reverse connection

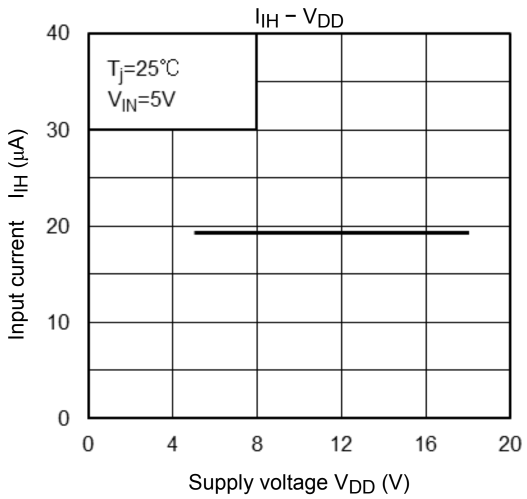


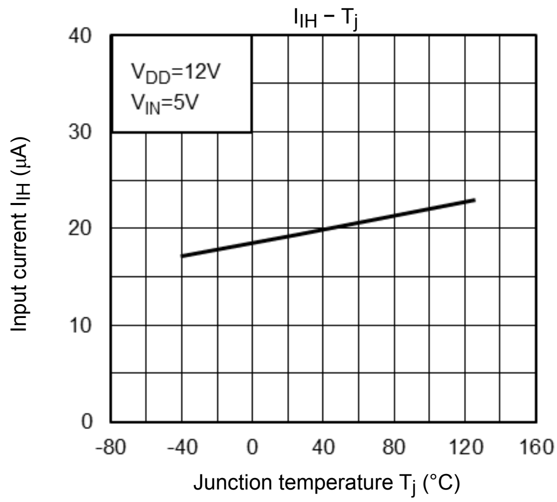

IDD – VDD
Tj=25℃
Supply current IDD (mA)
2.5
2
1.5
1
0.5
0
IDD(on)
IDD(off)
0
4
8
12
16
20
Supply voltage VDD (V)

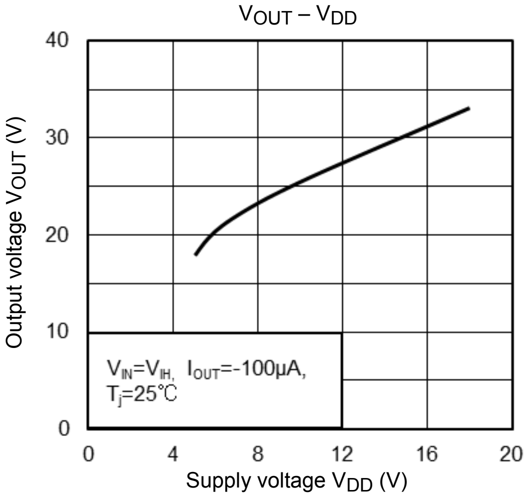

IDD – Tj
VDD=12V
Supply current IDD (mA)
2.5
2
1.5
1
0.5
0
IDD(on)
IDD(off)
-80
-40
0
40
80
120
160
Junction temperature Tj (°C)

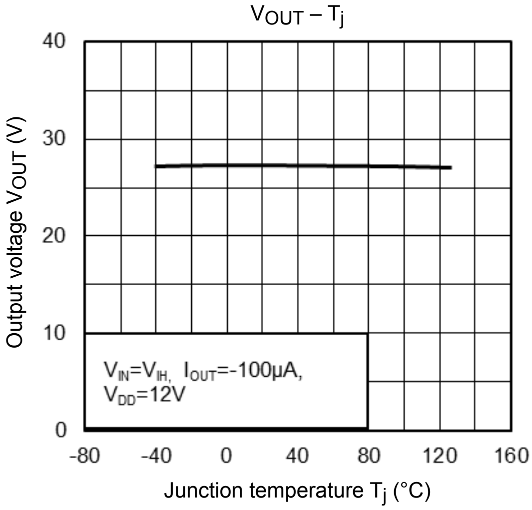

VIH, VIL – VDD
Tj=25℃
Input voltage VIH, VIL (V)
5
4
3
2
1
0
VIH
VIL
0
4
8
12
16
20
Supply voltage VDD (V)

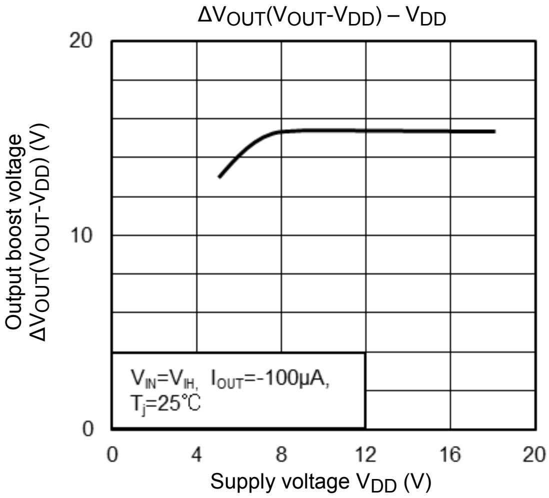

VIH, VIL – Tj
VDD=12V
Input voltage VIH, VIL (V)
5
4
3
2
1
0
VIH
VII
-80
-40
0
40
80
120
160
Junction temperature Tj (°C)

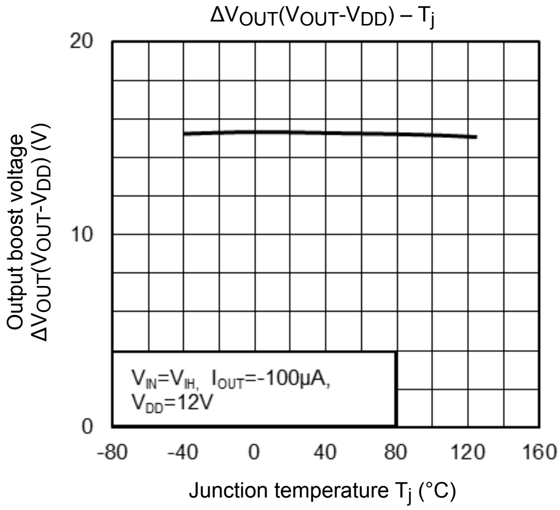

IIH – VDD
Tj=25℃
VIN=5V
Input current IIH (μA)
40
30
20
10
0
0
4
8
12
16
20
Supply voltage VDD (V)

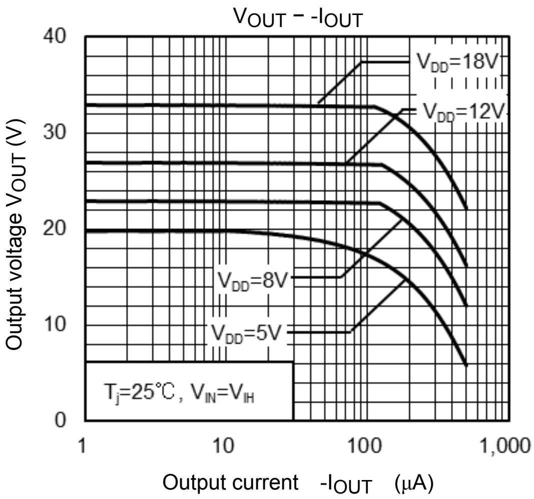

IIH – Tj
VDD=12V
VIN=5V
Input current IIH (μA)
40
30
20
10
0
-80
-40
0
40
80
120
160
Junction temperature Tj (°C)


VOUT – VDD
Output voltage VOUT (V)
Supply voltage VDD (V)
VIN=VIH, IOUT=-100μA,
Tj=25°C
0
10
20
30
40
0
4
8
12
16
20

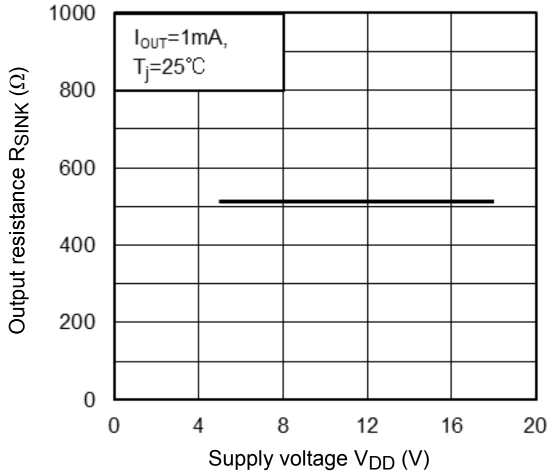

VOUT – Tj
Output voltage VOUT (V)
Junction temperature Tj (°C)
VIN=VIH, IOUT=-100μA,
VDD=12V
0
10
20
30
40
-80
-40
0
40
80
120
160


ΔVOUT(VOUT-VDD) – VDD
Output boost voltage
ΔVOUT(VOUT-VDD) (V)
Supply voltage VDD (V)
VIN=VIH, IOUT=-100μA,
Tj=25°C
0
10
20
0
4
8
12
16
20

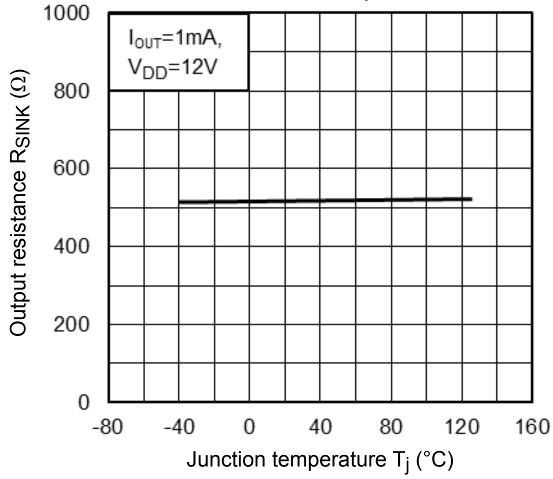

ΔVOUT(VOUT-VDD) – Tj
Output boost voltage
ΔVOUT(VOUT-VDD) (V)
Junction temperature Tj (°C)
VIN=VIH, IOUT=-100μA,
VDD=12V
0
10
20
-80
-40
0
40
80
120
160


VOUT – -IOUT
Output voltage VOUT (V)
Output current -IOUT (μA)
VDD=18V
VDD=12V
VDD=8V
VDD=5V
Tj=25°C, VIN=VIH
0
10
20
30
40
1
10
100
1,000

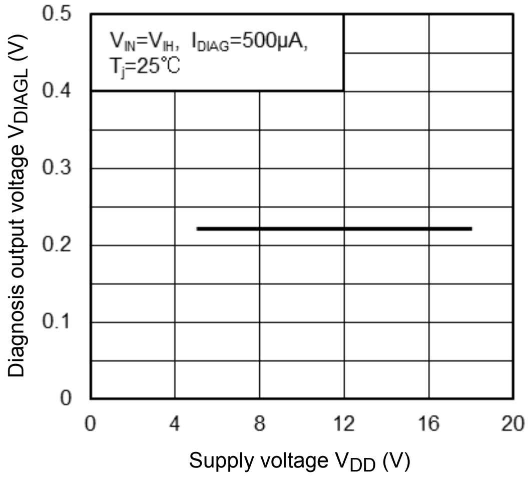
R_{SINK} – V_{DD}



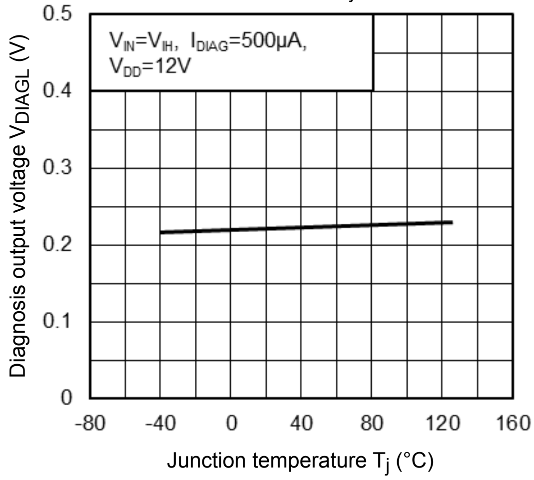
R_{SINK} – T_j



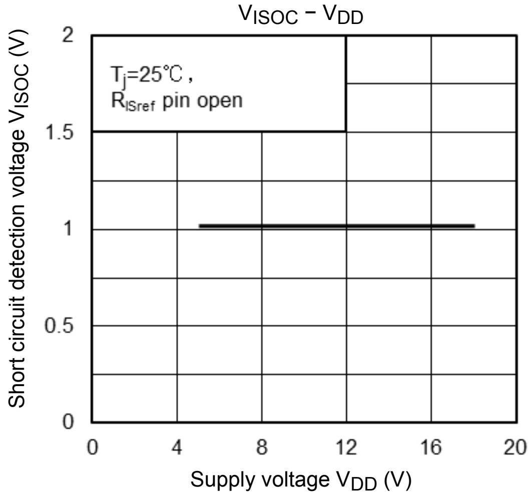
V_{DIAGL} – V_{DD}



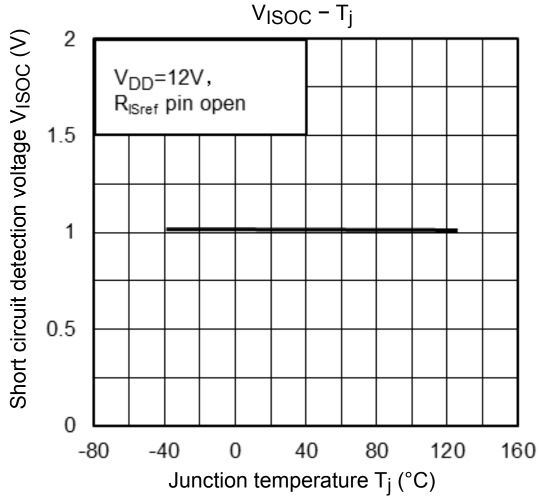
V_{DIAGL} – T_j



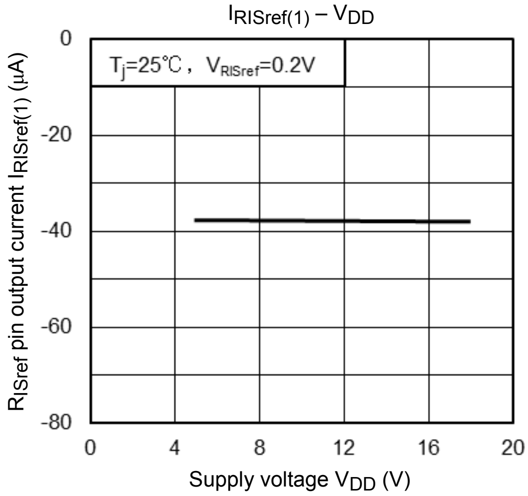
V_{ISOC} – V_{DD}



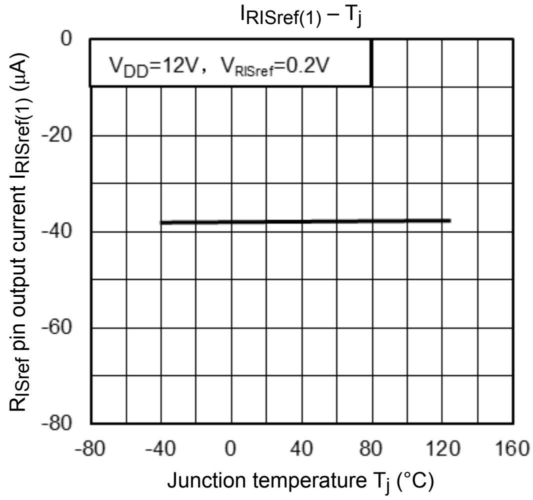
V_{ISOC} – T_j



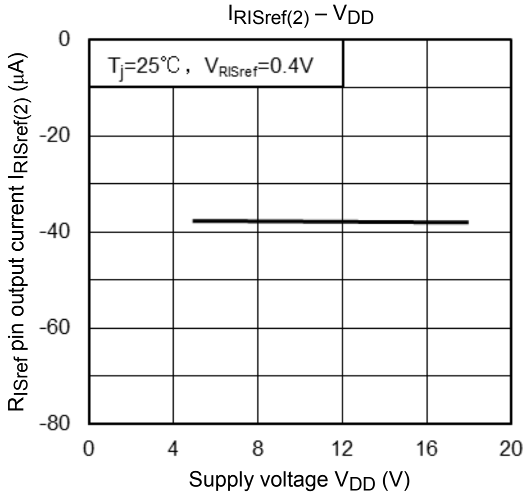
$I_{RISref(1)} – V_{DD}$



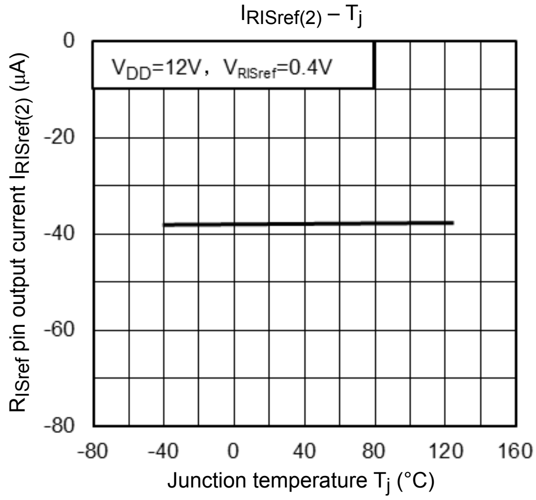
$I_{RISref(1)} – T_j$



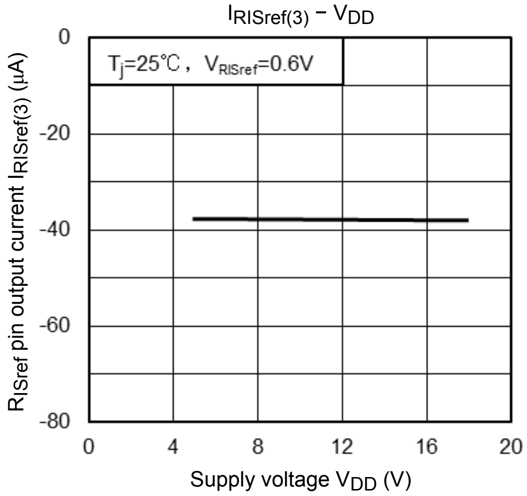
$I_{RISref(2)} – V_{DD}$



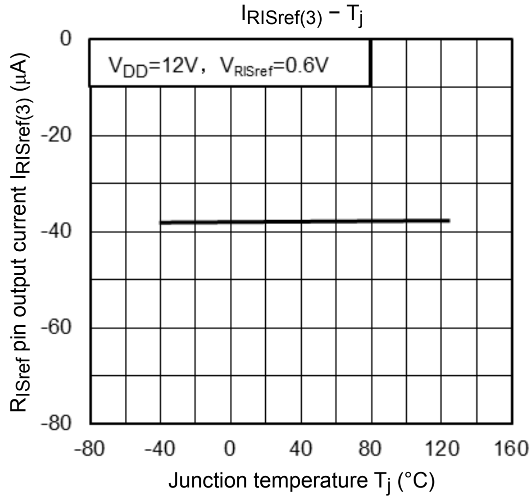
$I_{RISref(2)} – T_j$

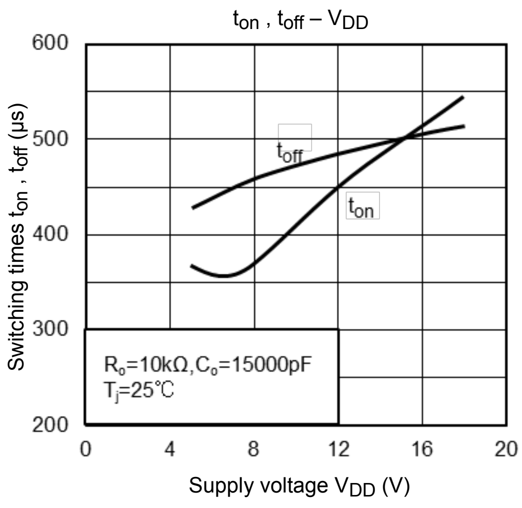


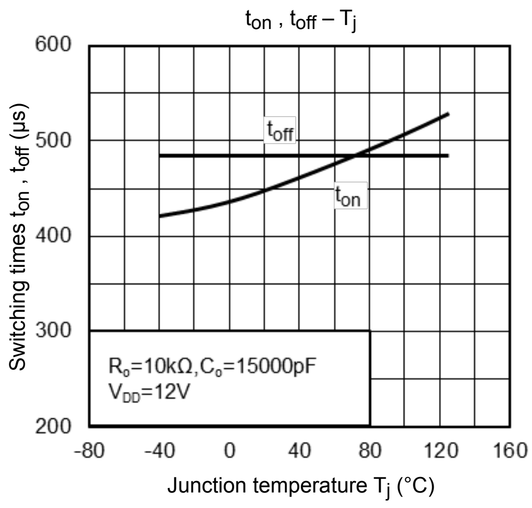
$I_{RISref(3)} – V_{DD}$

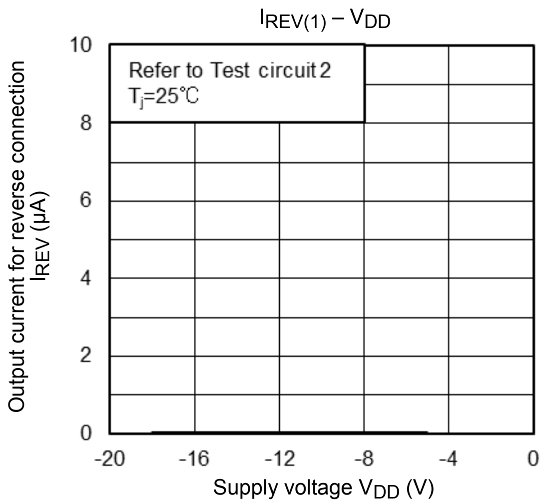


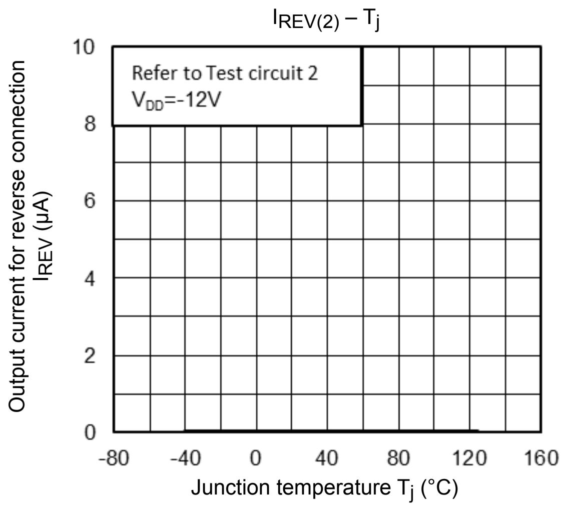
$I_{RISref(3)} – T_j$

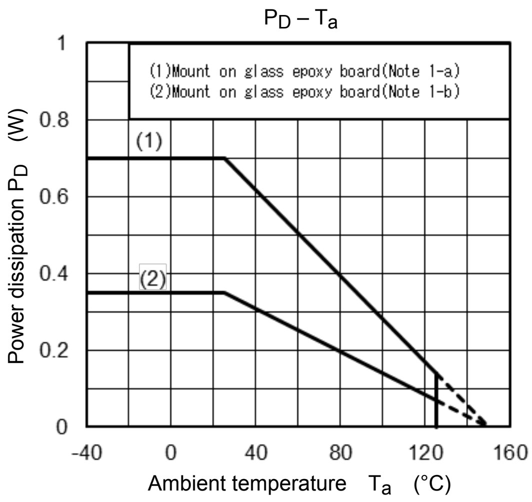



t_{on} , t_{off} – V_{DD}
Switching times t_{on} , t_{off} (μs)
600
500
400
300
200
t_{off}
t_{on}
R_o=10kΩ,C_o=15000pF
T_j=25℃
0 4 8 12 16 20
Supply voltage V_{DD} (V)


t_{on} , t_{off} – T_j
Switching times t_{on} , t_{off} (μs)
600
500
400
300
200
t_{off}
t_{on}
R_o=10kΩ,C_o=15000pF
V_{DD}=12V
−80 −40 0 40 80 120 160
Junction temperature T_j (°C)


$I_{REV(1)}$ – V_{DD}
Output current for reverse connection I_{REV} (μA)
10
8
6
4
2
0
Refer to Test circuit 2
T_j=25℃
-20 -16 -12 -8 -4 0
Supply voltage V_{DD} (V)

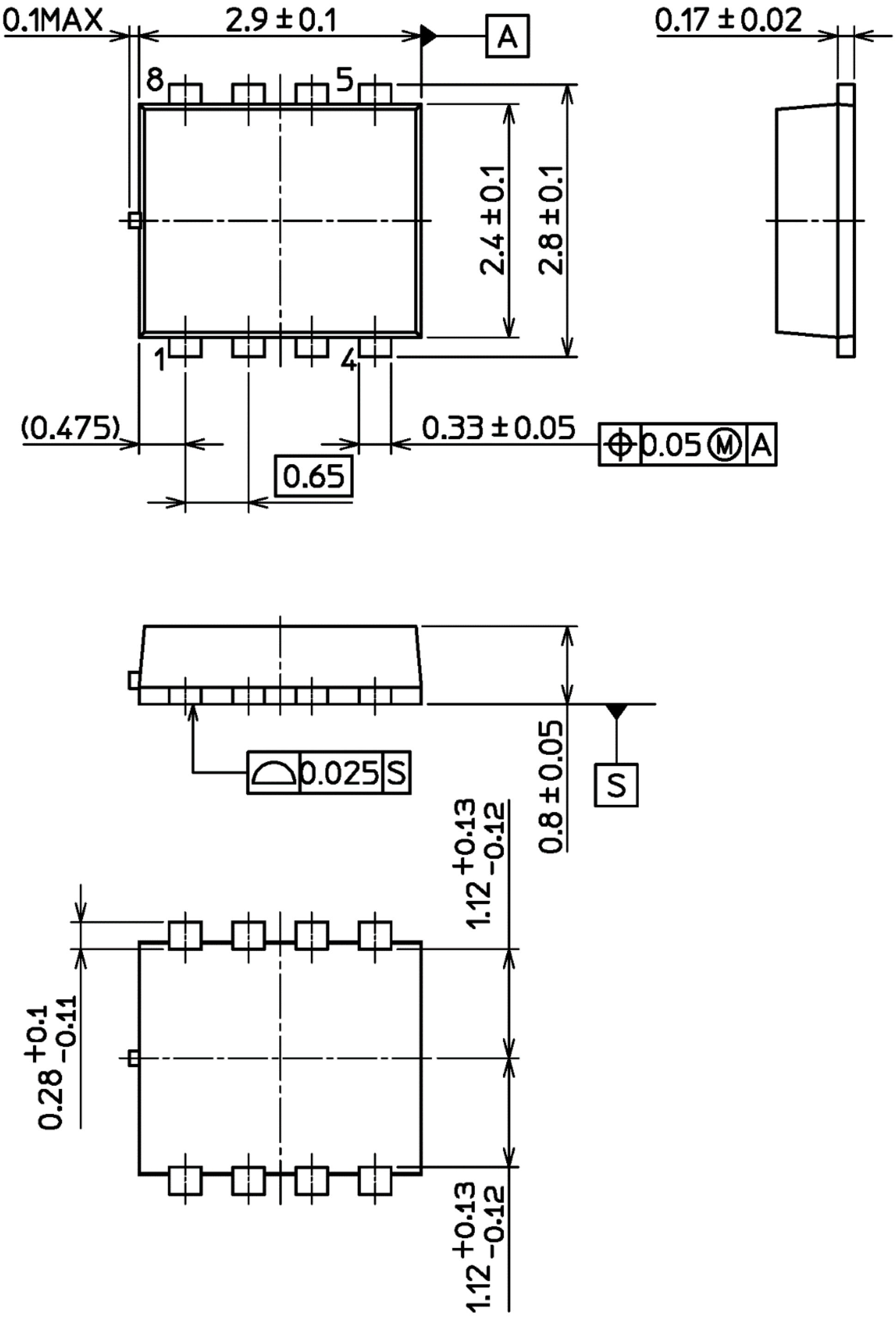

$I_{REV(2)}$ – T_j
Output current for reverse connection I_{REV} (μA)
10
8
6
4
2
0
Refer to Test circuit 2
V_{DD}=-12V
−80 −40 0 40 80 120 160
Junction temperature T_j (°C)


P_D – T_a
Power dissipation P_D (W)
1
0.8
0.6
0.4
0.2
0
(1)Mount on glass epoxy board(Note 1-a)
(2)Mount on glass epoxy board(Note 1-b)
(1)
(2)
-40 0 40 80 120 160
Ambient temperature T_a (°C)

Package Dimensions

SON8-P-0303-0.65S

Unit: mm



Weight: 0.017g(typ.)

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