To all our customers

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Renesas Technology Corp.
Customer Support Dept.
April 1, 2003

RENESAS
Renesas Technology Corp.

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Keep safety first in your circuit designs!

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HAT2028R/HAT2028RJ

Silicon N Channel Power MOS FET
High Speed Power Switching

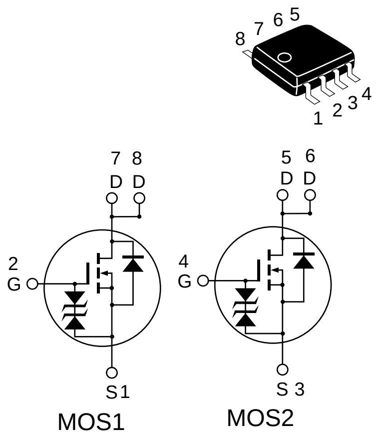
ADE-208-524C (Z)
4th. Edition
Feb. 1999

Features

- For Automotive Application (at Type Code “J “)
- Low on-resistance
- Capable of 4 V gate drive
- High density mounting

Outline

SOP–8



1, 3	Source
2, 4	Gate
5, 6, 7, 8	Drain

Absolute Maximum Ratings (Ta = 25°C)

Item		Symbol	Ratings	Unit
Drain to source voltage		V_{DSS}	60	V
Gate to source voltage		V_{GSS}	± 20	V
Drain current		I_D	4	A
Drain peak current		$I_{D(pulse)}$ Note1	32	A
Body-drain diode reverse drain current		I_{DR}	4	A
Avalanche current	HAT2028R	I_{AP} Note4	—	—
	HAT2028RJ		4	A
Avalanche energy	HAT2028R	E_{AR} Note4	—	—
	HAT2028RJ		1.37	mJ
Channel dissipation		Pch Note2	2	W
Channel dissipation		Pch Note3	3	W
Channel temperature		Tch	150	°C
Storage temperature		Tstg	– 55 to + 150	°C

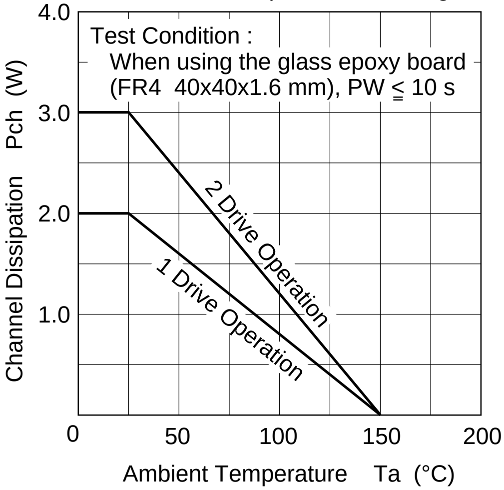
Note:
1. PW ≤ 10µs, duty cycle ≤ 1 %
2. 1 Drive operation : When using the glass epoxy board (FR4 40 x 40 x 1.6 mm), PW≤ 10s
3. 2 Drive operation : When using the glass epoxy board (FR4 40 x 40 x 1.6 mm), PW≤ 10s
4. Value at Tch=25°C, Rg≥50Ω

Electrical Characteristics (Ta = 25°C)

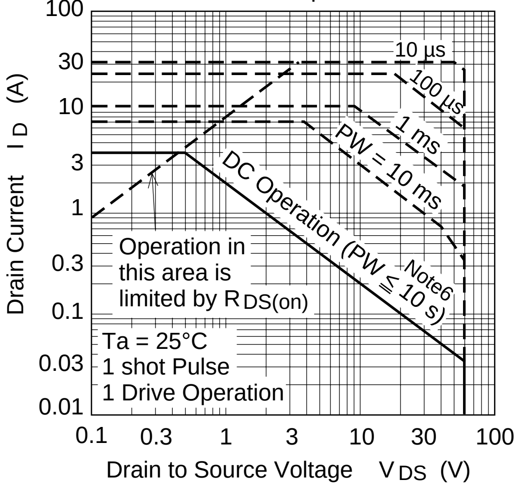
Item		Symbol	Min	Typ	Max	Unit	Test Conditions
Drain to source breakdownvoltage		$V_{(BR)DSS}$	60	—	—	V	I_D = 10 mA, V_{GS} = 0
Gate to source breakdownvoltage		$V_{(BR)GSS}$	± 20	—	—	V	I_G = ± 100 µA, V_{DS} = 0
Gate to source leak current		I_{GSS}	—	—	± 10	µA	V_{GS} = ± 16 V, V_{DS} = 0
Zero gate voltage	HAT2028R	I_{DSS}	—	—	1	µA	V_{DS} = 60 V, V_{GS} = 0
drain current	HAT2028RJ	I_{DSS}	—	—	0.1	µA	
Zero gate voltage	HAT2028R	I_{DSS}	—	—	—	µA	V_{DS} = 48 V, V_{GS} = 0
drain current	HAT2028RJ	I_{DSS}	—	—	10	µA	Ta = 125°C
Gate to source cutoff voltage		$V_{GS(off)}$	1.3	—	2.3	V	V_{DS} = 10 V, I_D = 1 mA
Static drain to source on state resistance		$R_{DS(on)}$	—	0.08	0.1	Ω	I_D = 2 A, V_{GS} = 10 V Note5
		$R_{DS(on)}$	—	0.12	0.16	Ω	I_D = 2 A, V_{GS} = 4 V Note5
Forward transfer admittance		$\|y_{fs}\|$	3.3	5	—	S	I_D = 2 A, V_{DS} = 10 V Note5
Input capacitance		Ciss	—	280	—	pF	V_{DS} = 10 V
Output capacitance		Coss	—	150	—	pF	V_{GS} = 0
Reverse transfer capacitance		Crss	—	55	—	pF	f = 1MHz
Turn-on delay time		$t_{d(on)}$	—	15	—	ns	V_{GS} = 4 V, I_D = 2 A
Rise time		t_r	—	100	—	ns	V_{DD} ≅ 30 V
Turn-off delay time		$t_{d(off)}$	—	35	—	ns	
Fall time		t_f	—	45	—	ns	
Body–drain diode forwardvoltage		V_{DF}	—	0.88	1.15	V	IF = 4 A, V_{GS} = 0 Note5
Body–drain diode reverse recovery time		t_{rr}	—	40	—	ns	IF = 4 A, V_{GS} = 0 diF/ dt = 50 A/µs

Note: 5. Pulse test

Main Characteristics

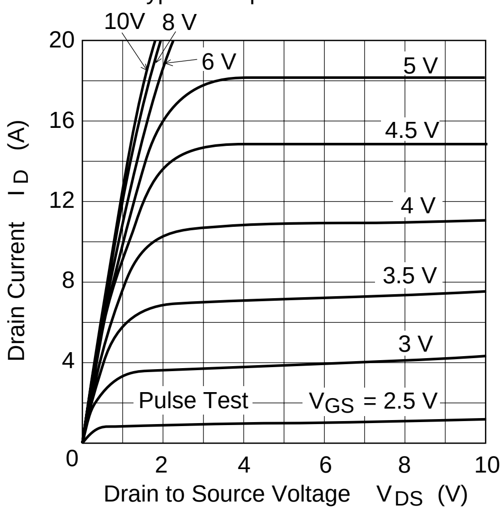


Power vs. Temperature Derating

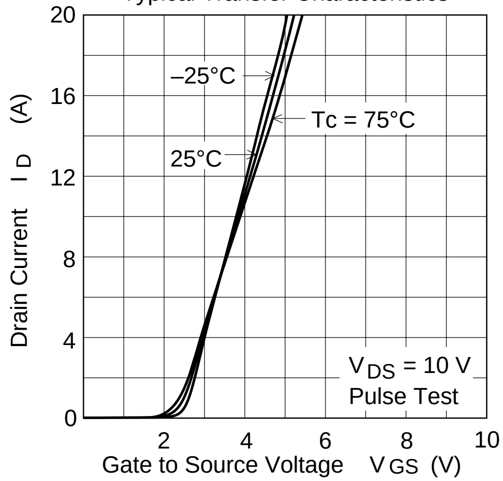


Maximum Safe Operation Area

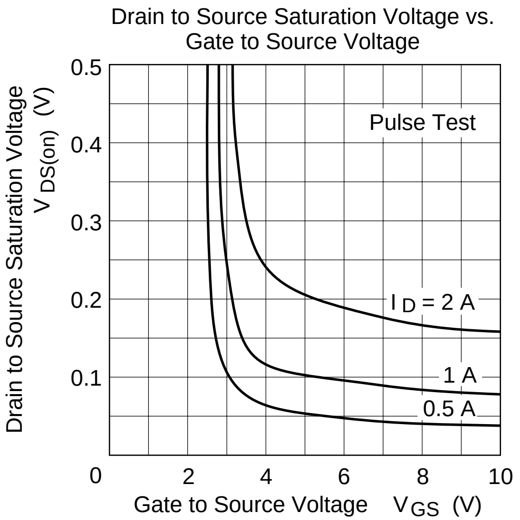
Note 6 :
When using the glass epoxy board
(FR4 40x40x1.6 mm)

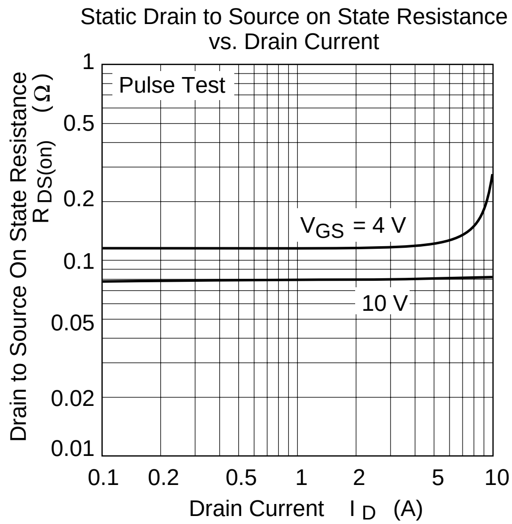


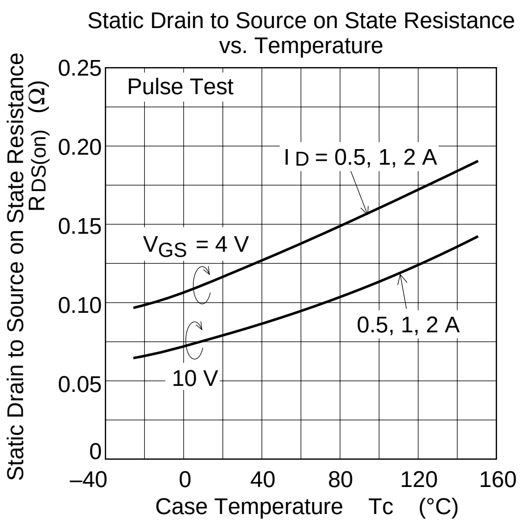
Typical Output Characteristics

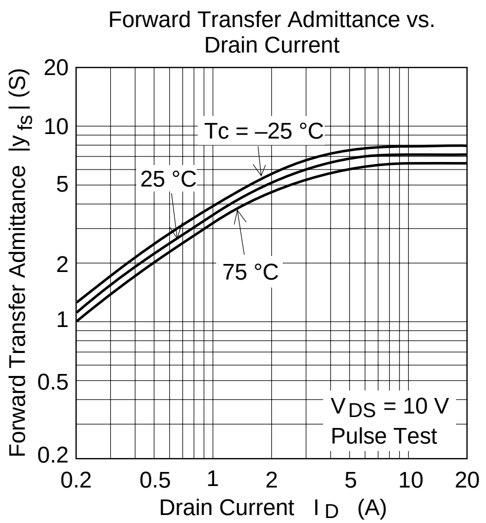


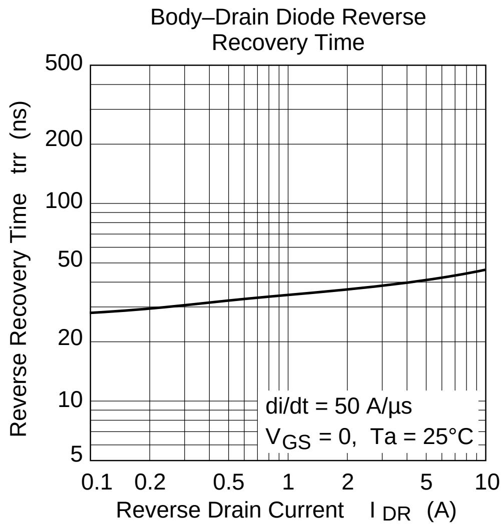
Typical Transfer Characteristics

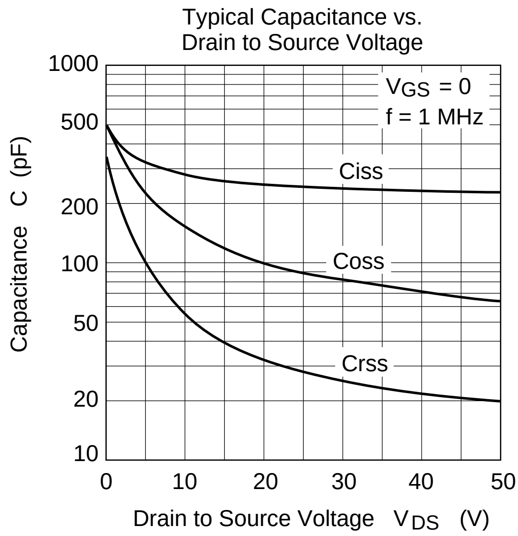

Drain to Source Saturation Voltage vs.
Gate to Source Voltage
Drain to Source Saturation Voltage
V DS(on) (V)
Pulse Test
I D = 2 A
1 A
0.5 A
0.5
0.4
0.3
0.2
0.1
0
2
4
6
8
10
Gate to Source Voltage V GS (V)

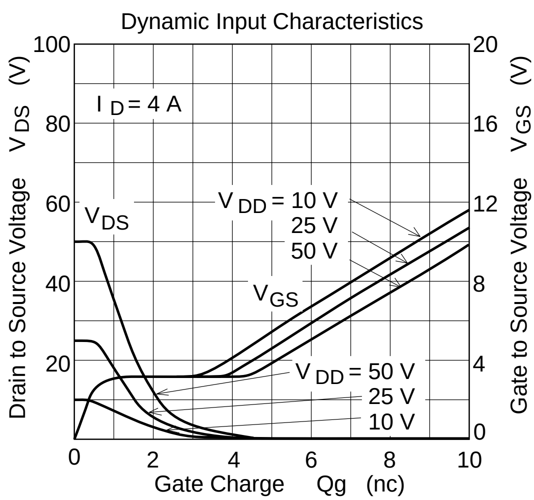

Static Drain to Source on State Resistance
vs. Drain Current
Drain to Source On State Resistance
R DS(on) (Ω)
Pulse Test
V GS = 4 V
10 V
1
0.5
0.2
0.1
0.05
0.02
0.01
0.1
0.2
0.5
1
2
5
10
Drain Current I D (A)

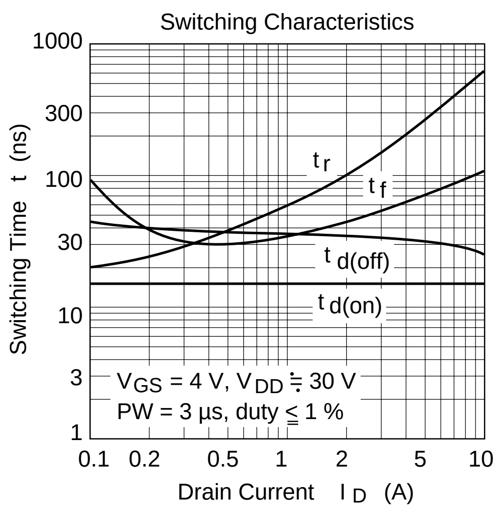

Static Drain to Source on State Resistance
vs. Temperature
Static Drain to Source on State Resistance
R DS(on) (Ω)
Pulse Test
I D = 0.5, 1, 2 A
V GS = 4 V
0.5, 1, 2 A
10 V
0.25
0.20
0.15
0.10
0.05
0
–40
0
40
80
120
160
Case Temperature Tc (°C)


Forward Transfer Admittance vs.
Drain Current
Forward Transfer Admittance |y fs| (S)
Tc = –25 °C
25 °C
75 °C
V DS = 10 V
Pulse Test
20
10
5
2
1
0.5
0.2
0.2
0.5
1
2
5
10
20
Drain Current I D (A)

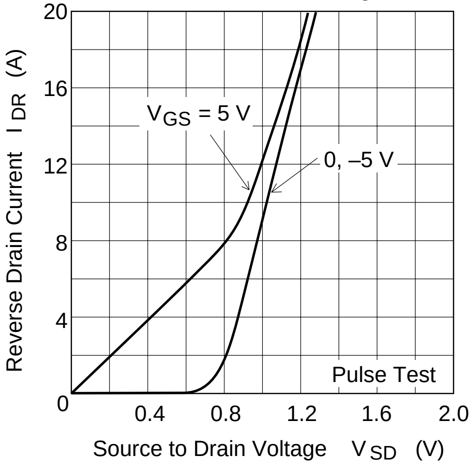

Body–Drain Diode Reverse Recovery Time
Reverse Recovery Time trr (ns)
500
200
100
50
20
10
5
0.1 0.2 0.5 1 2 5 10
Reverse Drain Current I DR (A)
di/dt = 50 A/µs
VGS = 0, Ta = 25°C


Typical Capacitance vs. Drain to Source Voltage
Capacitance C (pF)
1000
500
200
100
50
20
10
0 10 20 30 40 50
Drain to Source Voltage VDS (V)
VGS = 0
f = 1 MHz
Ciss
Coss
Crss

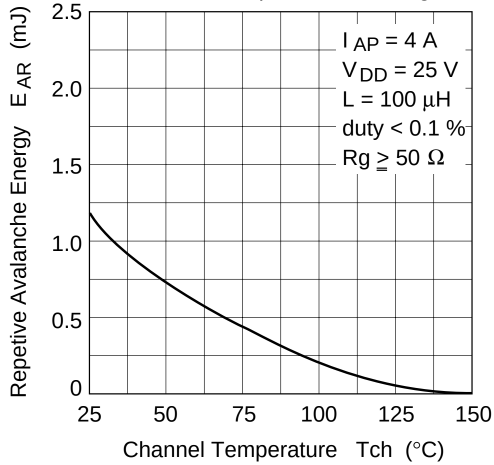

Dynamic Input Characteristics
Drain to Source Voltage VDS (V)
100
80
60
40
20
0 2 4 6 8 10
Gate Charge Qg (nc)
Gate to Source Voltage VGS (V)
20
16
12
8
4
0
I D = 4 A
VDS
VDD = 10 V
25 V
50 V
VGS
VDD = 50 V
25 V
10 V


Switching Characteristics
Switching Time t (ns)
1000
300
100
30
10
3
1
0.1 0.2 0.5 1 2 5 10
Drain Current I D (A)
tr
tf
t d(off)
t d(on)
VGS = 4 V, VDD ≒ 30 V
PW = 3 µs, duty ≦ 1 %

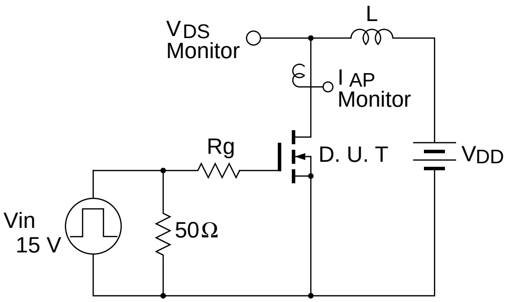
Reverse Drain Current vs.
Source to Drain Voltage



Maximun Avalanche Energy vs.
Channel Temperature Derating

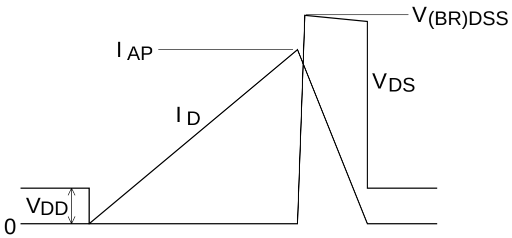


Avalanche Test Circuit

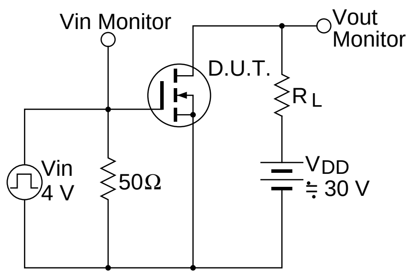


Avalanche Waveform

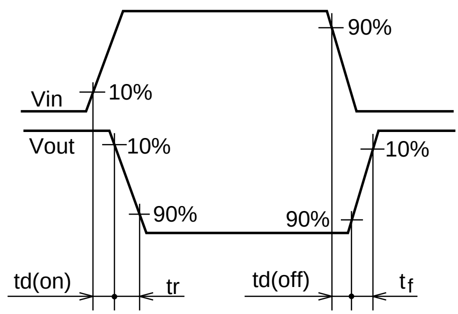
$$E_{AR} = \frac{1}{2} \bullet L \bullet I_{AP}^{2} \bullet \frac{V_{DSS}}{V_{DSS} - V_{DD}}$$

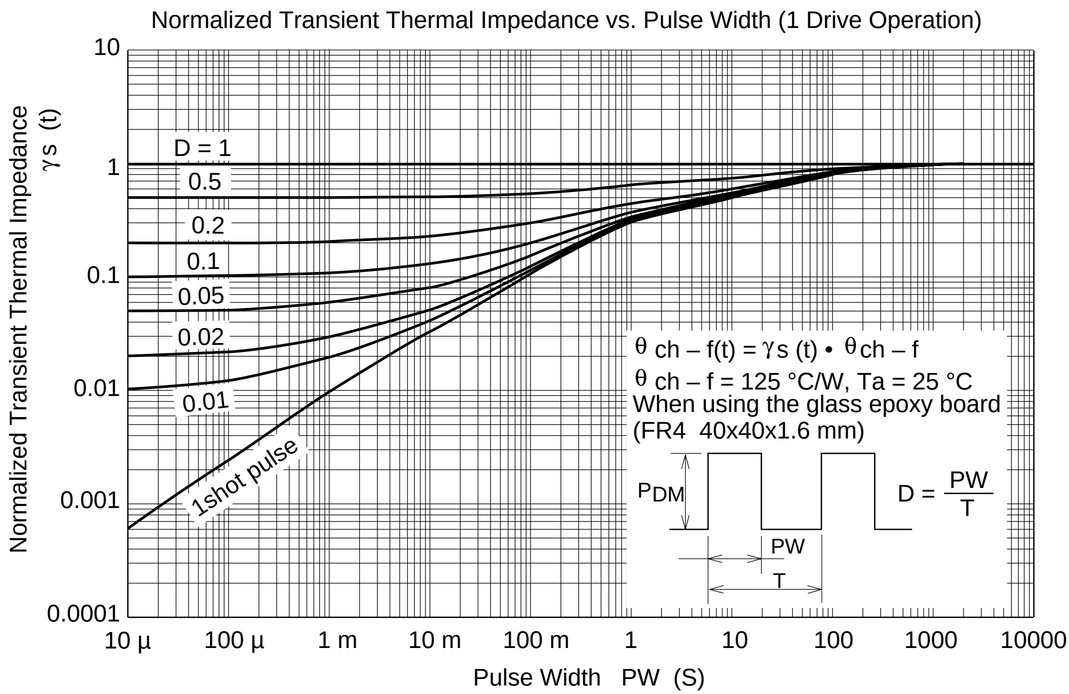


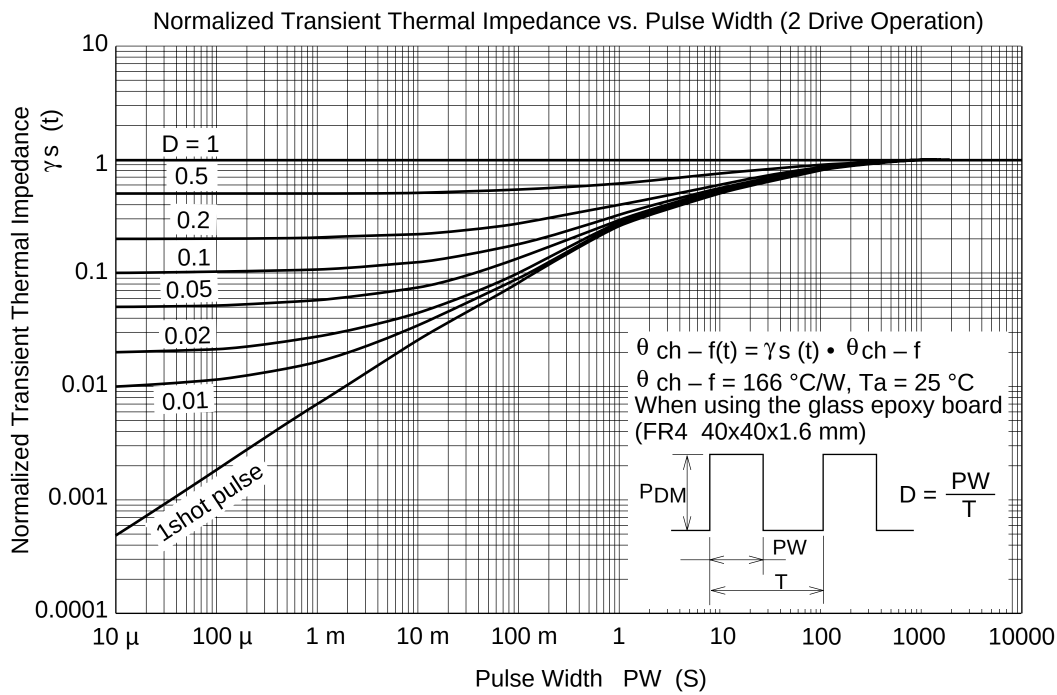
Switching Time Test Circuit



Switching Time Waveform



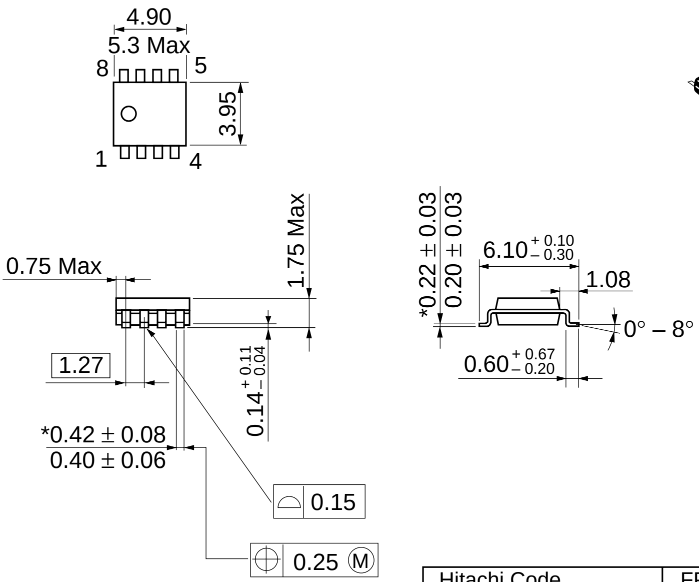

Normalized Transient Thermal Impedance vs. Pulse Width (1 Drive Operation)
Normalized Transient Thermal Impedance γs (t)
10
1
0.1
0.01
0.001
0.0001
D = 1
0.5
0.2
0.1
0.05
0.02
0.01
1shot pulse
θ ch – f(t) = γs (t) • θch – f
θ ch – f = 125 °C/W, Ta = 25 °C
When using the glass epoxy board
(FR4 40x40x1.6 mm)
PDM
D = PW/T
PW
T
10 µ
100 µ
1 m
10 m
100 m
1
10
100
1000
10000
Pulse Width PW (S)

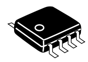

Normalized Transient Thermal Impedance vs. Pulse Width (2 Drive Operation)
Normalized Transient Thermal Impedance γs (t)
10
1
0.1
0.01
0.001
0.0001
D = 1
0.5
0.2
0.1
0.05
0.02
0.01
1shot pulse
θ ch – f(t) = γs (t) • θch – f
θ ch – f = 166 °C/W, Ta = 25 °C
When using the glass epoxy board
(FR4 40x40x1.6 mm)
PDM
D = PW/T
PW
T
10 µ
100 µ
1 m
10 m
100 m
1
10
100
1000
10000
Pulse Width PW (S)

Package Dimensions

As of January, 2001

Unit: mm





Hitachi Code	FP-8DA
JEDEC	Conforms
EIAJ	—
Mass (reference value)	0.085 g

*Dimension including the plating thickness

Base material dimension

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