HAF1003(L), HAF1003(S)

Silicon P Channel MOS FET Series
Power Switching

HITACHI

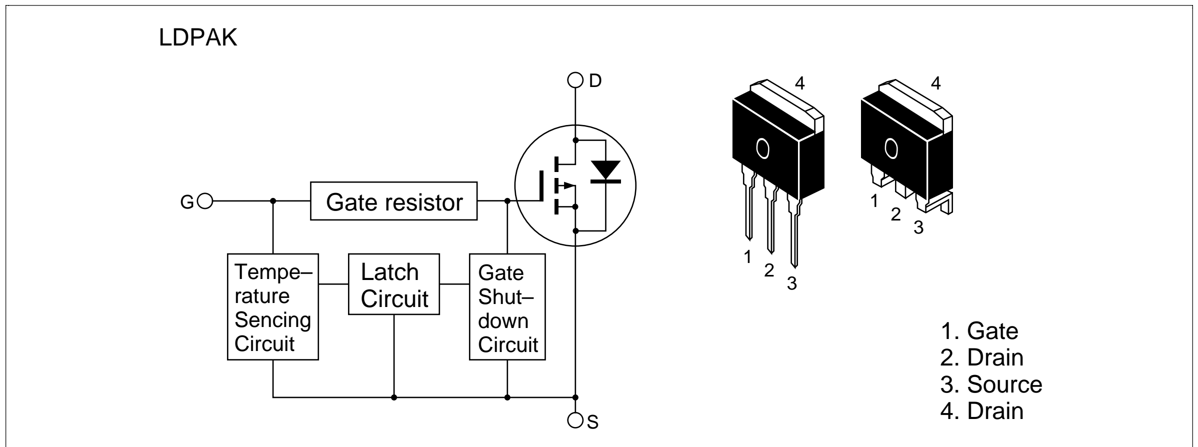
ADE-208-626B (Z)
3rd. Edition
July 2000

This FET has the over temperature shut–down capability sensing to the junction temperature. This FET has the built–in over temperature shut–down circuit in the gate area. And this circuit operation to shut–down the gate voltage in case of high junction temperature like applying over power consumption, over current etc.

Features

- Logic level operation (–4 to –6 V Gate drive)
- High endurance capability against to the short circuit
- Built–in the over temperature shut–down circuit
- Latch type shut–down operation (Need 0 voltage recovery)

Outline



Absolute Maximum Ratings (Ta = 25°C)

Item	Symbol	Ratings	Unit
Drain to source voltage	V_{DSS}	–60	V
Gate to source voltage	V_{GSS}	–16	V
Gate to source voltage	V_{GSS}	2.5	V
Drain current	I_D	–18	A
Drain peak current	$I_{D(pulse)}$ Note1	–36	A
Body-drain diode reverse drain current	I_{DR}	–18	A
Channel dissipation	Pch Note2	50	W
Channel temperature	Tch	150	°C
Storage temperature	Tstg	–55 to +150	°C

Note: 1. PW ≤ 10ms, duty cycle ≤ 1 %
2. Value at Tc = 25°C

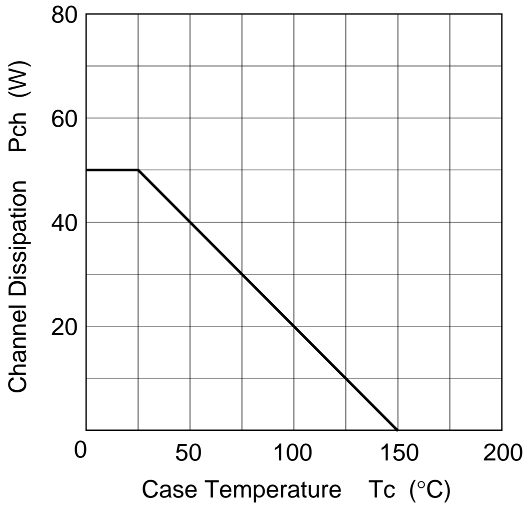
Typical Operation Characteristics

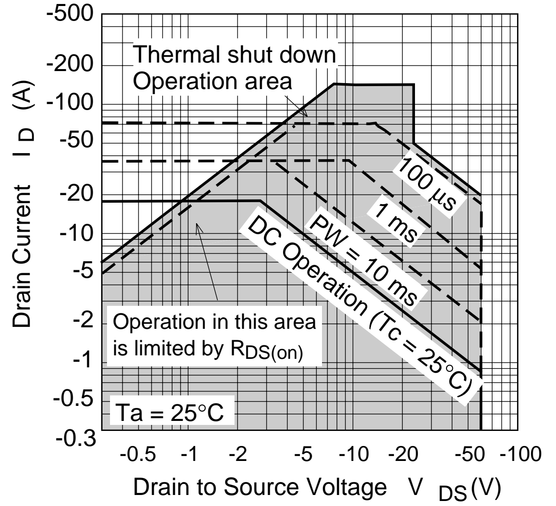
Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Input voltage	V_{IH}	–3.5	—	—	V	
	V_{IL}	—	—	–1.2	V	
Input current	I_{IH1}	—	—	–100	µA	Vi = –8V, V_{DS} = 0
(Gate non shut down)	I_{IH2}	—	—	–50	µA	Vi = –3.5V, V_{DS} = 0
	I_{IL}	—	—	–1	µA	Vi = –1.2V, V_{DS} = 0
Input current	$I_{IH(sd)1}$	—	–0.8	—	mA	Vi = –8V, V_{DS} = 0
(Gate shut down)	$I_{IH(sd)2}$	—	–0.35	—	mA	Vi = –3.5V, V_{DS} = 0
Shut down temperature	T_{sd}	—	175	—	°C	Channel temperature
Gate operation voltage	Vop	–3.5	—	–12	V	

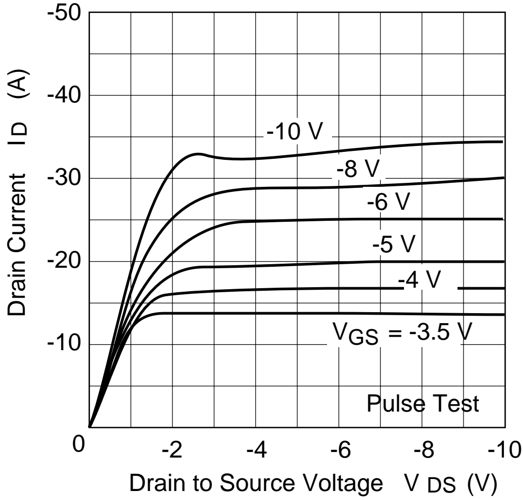
Electrical Characteristics (Ta = 25°C)

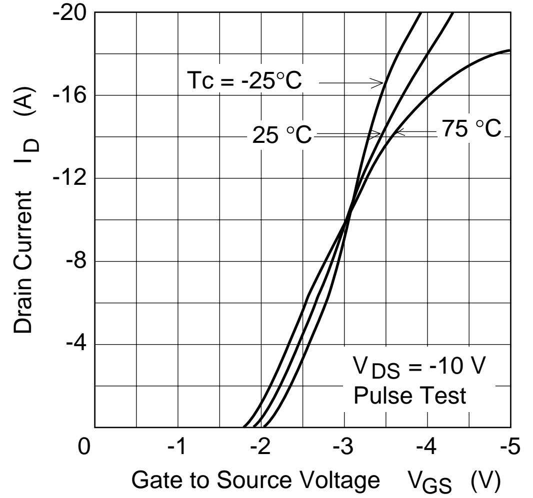
Item	Symbol	Min	Typ	Max	Unit	Test Conditions
Drain current	I_{D1}	–6	—	—	A	V_{GS} = –3.5V, V_{DS} = –2V
Drain current	I_{D2}	—	—	–10	mA	V_{GS} = –1.2V, V_{DS} = –2V
Drain to source breakdown voltage	$V_{(BR)DSS}$	–60	—	—	V	I_D = –10mA, V_{GS} = 0
Gate to source breakdown voltage	$V_{(BR)GSS}$	–16	—	—	V	I_G = –300µA, V_{DS} = 0
Gate to source breakdown voltage	$V_{(BR)GSS}$	2.5	—	—	V	I_G = 100µA, V_{DS} = 0
Gate to source leak current	I_{GSS1}	—	—	–100	µA	V_{GS} = –8V, V_{DS} = 0
	I_{GSS2}	—	—	–50	µA	V_{GS} = –3.5V, V_{DS} = 0
	I_{GSS3}	—	—	–1	µA	V_{GS} = –1.2V, V_{DS} = 0
	I_{GSS4}	—	—	100	µA	V_{GS} = 2.4V, V_{DS} = 0
Input current (shut down)	$I_{GS(op)1}$	—	–0.8	—	mA	V_{GS} = –8V, V_{DS} = 0
	$I_{GS(op)2}$	—	–0.35	—	mA	V_{GS} = –3.5V, V_{DS} = 0
Zero gate voltege drain current	I_{DSS}	—	—	–10	µA	V_{DS} = –60 V, V_{GS} = 0
Gate to source cutoff voltage	$V_{GS(off)}$	–1.1	—	–2.25	V	I_D = –1mA, V_{DS} = –10V
Static drain to source on state resistance	$R_{DS(on)}$	—	80	110	mΩ	I_D = –9A, V_{GS} = –4V Note3
Static drain to source on state resistance	$R_{DS(on)}$	—	52	60	mΩ	I_D = –9A, V_{GS} = –10V Note3
Forward transfer admittance	$\|y_{fs}\|$	5.3	11	—	S	I_D = –9A, V_{DS} = –10V Note3
Output capacitance	Coss	—	700	—	pF	V_{DS} = –10V , V_{GS} = 0 f = 1 MHz
Turn-on delay time	$t_{d(on)}$	—	8.7	—	µs	I_D = –9A, V_{GS} = –5V R_L =3.3Ω
Rise time	t_r	—	44.5	—	µs	
Turn-off delay time	$t_{d(off)}$	—	4	—	µs	
Fall time	t_f	—	4.6	—	µs	
Body–drain diode forward voltage	V_{DF}	—	–0.9	—	V	I_F = –18A, V_{GS} = 0
Body–drain diode reverse recovery time	t_{rr}	—	140	—	ns	I_F = –18A, V_{GS} = 0 diF/ dt =50A/µs
Over load shut down operation time Note4	t_{os1}	—	3	—	ms	V_{GS} = –5V, V_{DD} = –16V
	t_{os2}	—	1.5	—	ms	V_{GS} = –5V, V_{DD} = –24V

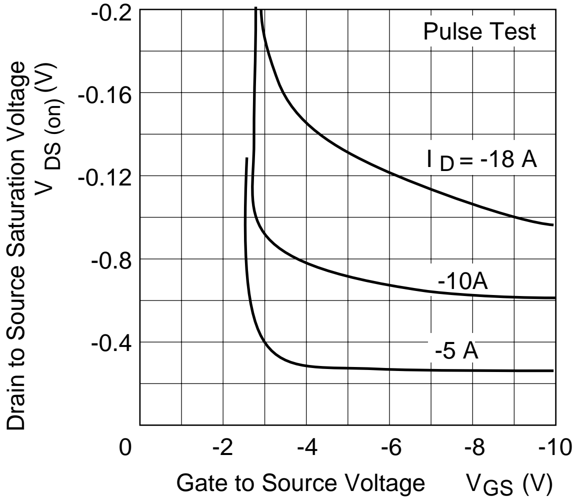
Note: 3. Pulse test
4. Including the junction temperature rise of the over loaded condition.

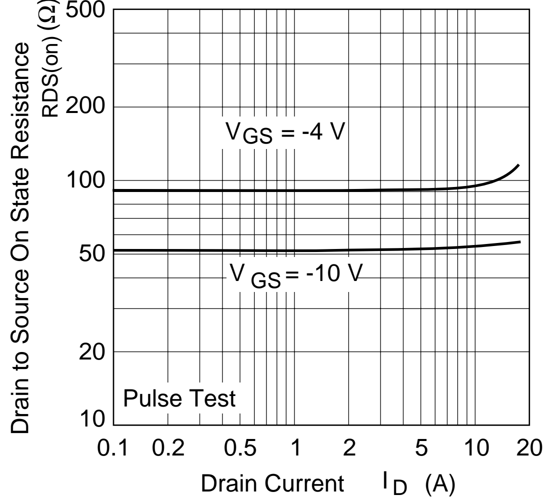

Power vs.Temperature Derating
Channel Dissipation Pch (W)
80
60
40
20
0
50
100
150
200
Case Temperature Tc (°C)

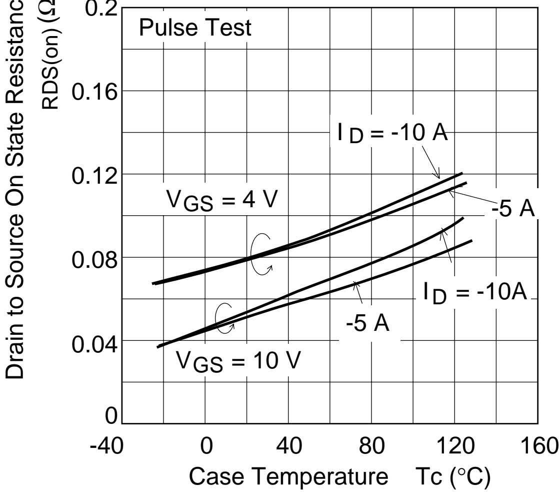

Maximum Safe Operation Area
Drain Current I D (A)
-500
-200
-100
-50
-20
-10
-5
-2
-1
-0.5
-0.3
Thermal shut down
Operation area
100 μs
1 ms
PW = 10 ms
DC Operation (Tc = 25°C)
Operation in this area
is limited by RDS(on)
Ta = 25°C
-0.5 -1 -2 -5 -10 -20 -50 -100
Drain to Source Voltage V DS (V)

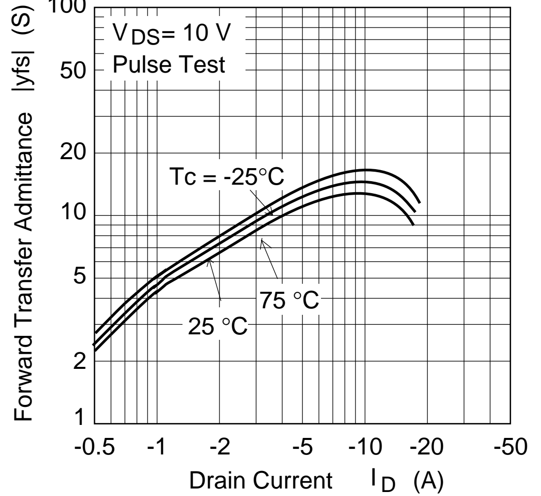

Typical Output Characteristics
Drain Current I D (A)
-50
-40
-30
-20
-10
0
-10 V
-8 V
-6 V
-5 V
-4 V
VGS = -3.5 V
Pulse Test
-2 -4 -6 -8 -10
Drain to Source Voltage V DS (V)

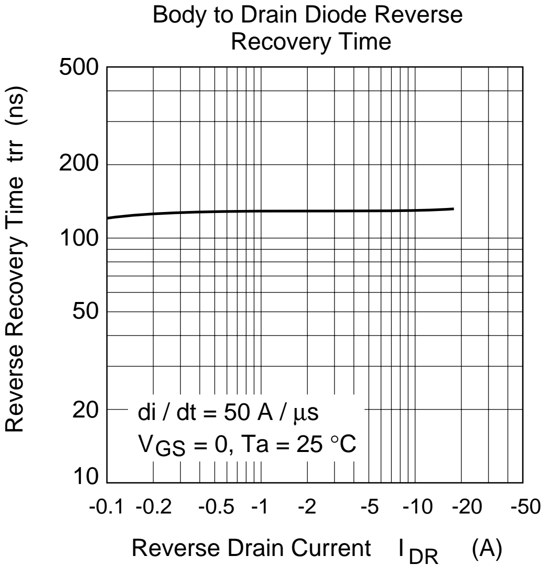

Typical Transfer Characteristics
Drain Current I D (A)
-20
-16
-12
-8
-4
Tc = -25°C
25 °C
75 °C
V DS = -10 V
Pulse Test
0 -1 -2 -3 -4 -5
Gate to Source Voltage VGS (V)

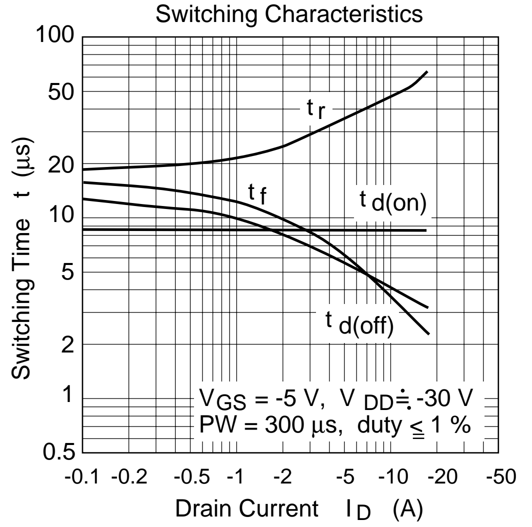

Drain to Source Saturation Voltage vs.
Gate to Source Voltage
Pulse Test
I D = -18 A
-10A
-5 A
-0.2
-0.16
-0.12
-0.8
-0.4
0
-2
-4
-6
-8
-10
Drain to Source Saturation Voltage
V DS (on) (V)
Gate to Source Voltage V GS (V)

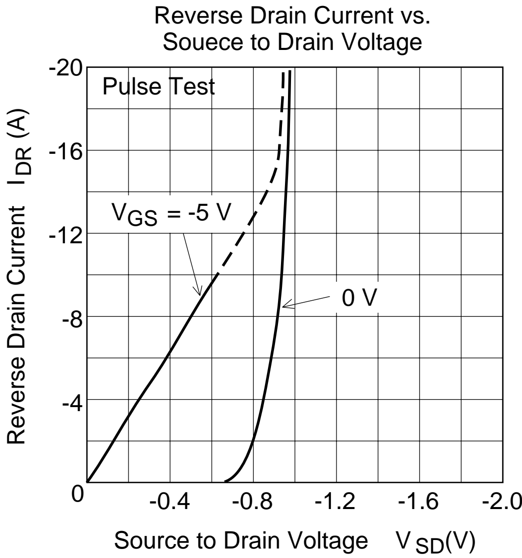

Static Drain to Source State Resistance
vs. Drain Current
V GS = -4 V
V GS = -10 V
Pulse Test
500
200
100
50
20
10
0.1
0.2
0.5
1
2
5
10
20
Drain to Source On State Resistance
RDS(on) (Ω)
Drain Current I D (A)

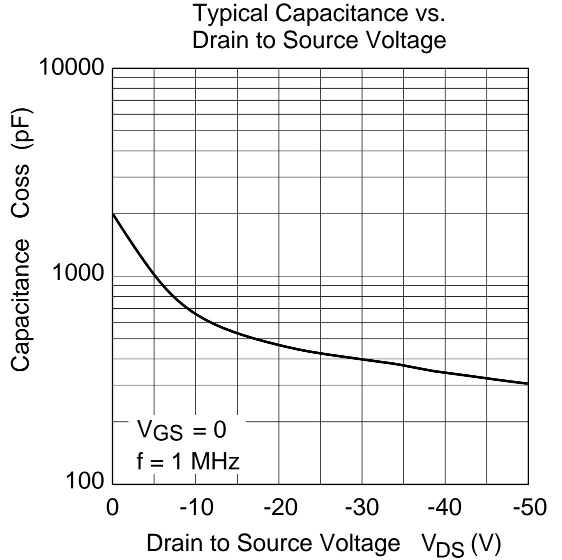

Static Drain to Source on state Resistance
vs. Temperature
Pulse Test
I D = -10 A
-5 A
V GS = 4 V
I D = -10A
-5 A
V GS = 10 V
0.2
0.16
0.12
0.08
0.04
0
-40
0
40
80
120
160
Drain to Source On State Resistance
RDS(on) (Ω)
Case Temperature Tc (°C)

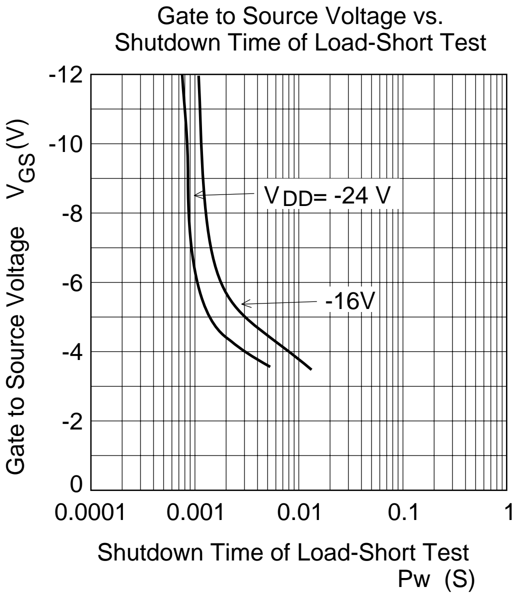

Forward Transfer Admittance vs.
Drain Current
V DS = 10 V
Pulse Test
Tc = -25°C
75 °C
25 °C
100
50
20
10
5
2
1
-0.5
-1
-2
-5
-10
-20
-50
Forward Transfer Admittance |yfs| (S)
Drain Current I D (A)

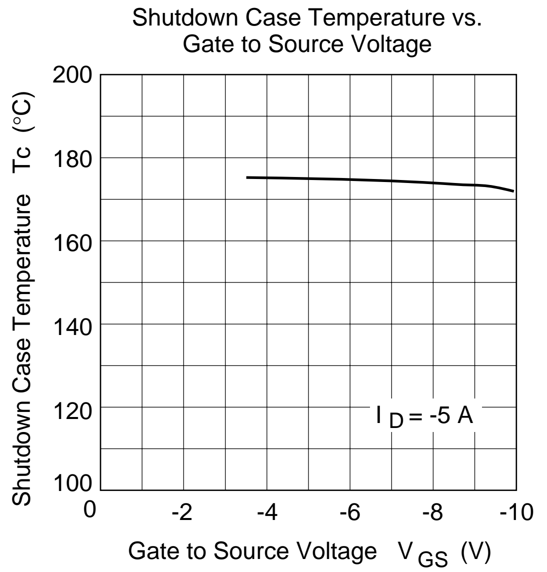

Body to Drain Diode Reverse
Recovery Time
Reverse Recovery Time trr (ns)
500
200
100
50
20
10
di / dt = 50 A / µs
VGS = 0, Ta = 25 °C
-0.1 -0.2 -0.5 -1 -2 -5 -10 -20 -50
Reverse Drain Current IDR (A)

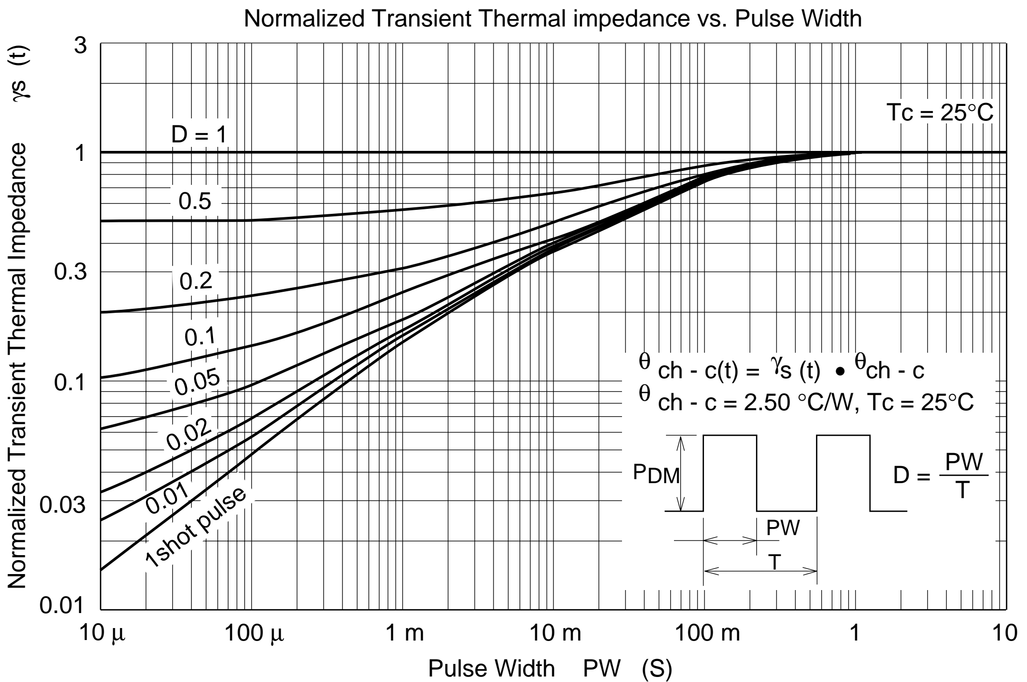

Switching Characteristics
Switching Time t (µs)
100
50
20
10
5
2
1
0.5
tr
tf
td(on)
td(off)
VGS = -5 V, VDD ≒ -30 V
PW = 300 µs, duty ≦ 1 %
-0.1 -0.2 -0.5 -1 -2 -5 -10 -20 -50
Drain Current ID (A)


Reverse Drain Current vs.
Souece to Drain Voltage
Reverse Drain Current IDR (A)
-20
-16
-12
-8
-4
0
Pulse Test
VGS = -5 V
0 V
-0.4 -0.8 -1.2 -1.6 -2.0
Source to Drain Voltage VSD(V)

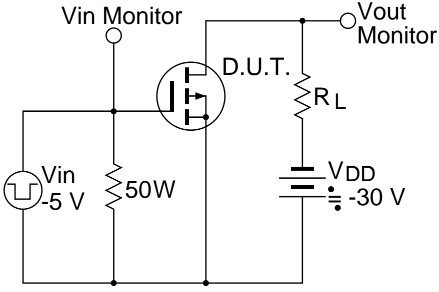

Typical Capacitance vs.
Drain to Source Voltage
Capacitance Coss (pF)
10000
1000
100
VGS = 0
f = 1 MHz
0 -10 -20 -30 -40 -50
Drain to Source Voltage VDS (V)


Gate to Source Voltage vs.
Shutdown Time of Load-Short Test
Gate to Source Voltage VGS (V)
-12
-10
-8
-6
-4
-2
0
VDD= -24 V
-16V
0.0001
0.001
0.01
0.1
1
Shutdown Time of Load-Short Test
Pw (S)

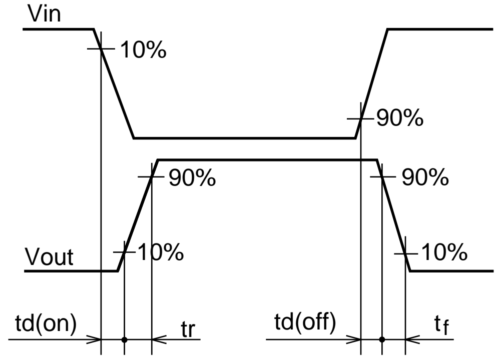

Shutdown Case Temperature vs.
Gate to Source Voltage
Shutdown Case Temperature Tc (°C)
200
180
160
140
120
100
ID = -5 A
0
-2
-4
-6
-8
-10
Gate to Source Voltage VGS (V)


Normalized Transient Thermal impedance vs. Pulse Width
Normalized Transient Thermal Impedance γs (t)
3
1
0.3
0.1
0.03
0.01
Tc = 25°C
D = 1
0.5
0.2
0.1
0.05
0.02
0.01
1shot pulse
θch - c(t) = γs (t) • θch - c
θch - c = 2.50 °C/W, Tc = 25°C
PDM
D = PW/T
PW
T
10 µ
100 µ
1 m
10 m
100 m
1
10
Pulse Width PW (S)

Switching Time Test Circuit

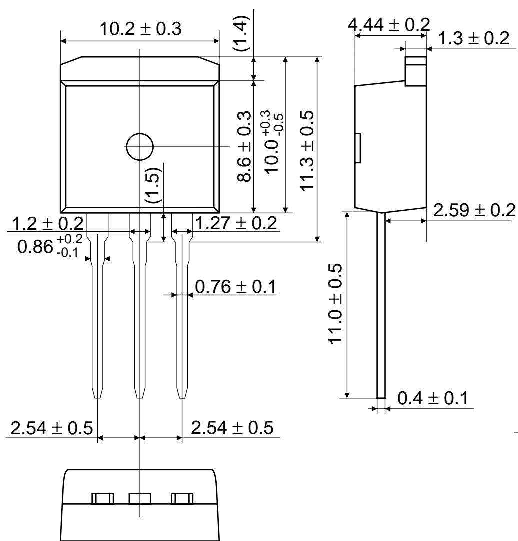


Waveform



Package Dimensions

Unit: mm



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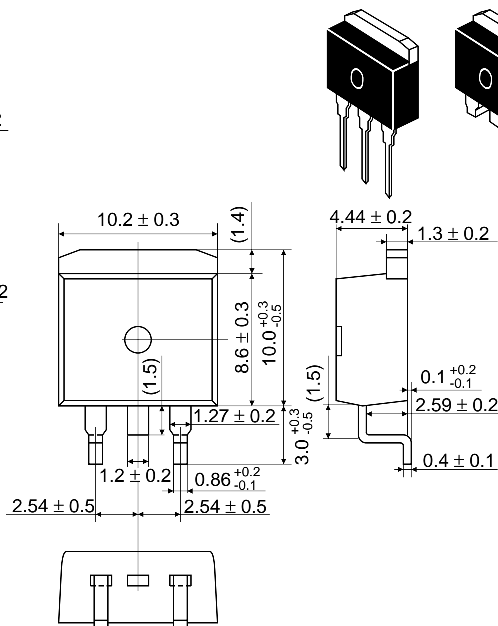

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