International IOR Rectifier

IRF7832PbF-1

HEXFET® Power MOSFET

V_{DS}	30	V
$R_{DS(on)\ max}$ (@V_{GS} = 10V)	4.0	mΩ
$Q_{g\ (typical)}$	34	nC
I_D (@T_A = 25°C)	20	A

Top View

SO-8
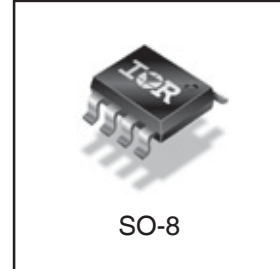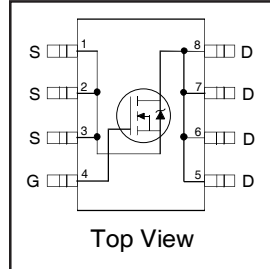
Applications

- Synchronous MOSFET for Notebook Processor Power
- Synchronous Rectifier MOSFET for Isolated DC-DC Converters in Networking Systems

Features

Features		Benefits
Industry-standard pinout SO-8 Package	$\Rightarrow$	Multi-Vendor Compatibility
Compatible with Existing Surface Mount Techniques		Easier Manufacturing
RoHS Compliant, Halogen-Free		Environmentally Friendlier
MSL1, Industrial qualification		Increased Reliability

Base Part Number	Package Type	Standard Pack		Orderable Part Number
		Form	Quantity	
IRF7832PbF-1	SO-8	Tube/Bulk	95	IRF7832PbF-1
		Tape and Reel	4000	IRF7832TRPbF-1

Absolute Maximum Ratings

	Parameter	Max.	Units
V_{DS}	Drain-to-Source Voltage	30	V
V_{GS}	Gate-to-Source Voltage	± 20	
I_D @ T_A = 25°C	Continuous Drain Current, V_{GS} @ 10V	20	
I_D @ T_A = 70°C	Continuous Drain Current, V_{GS} @ 10V	16	A
I_{DM}	Pulsed Drain Current ①	160	
P_D @T_A = 25°C	Power Dissipation	2.5	W
P_D @T_A = 70°C	Power Dissipation	1.6	
	Linear Derating Factor	0.02	W/°C
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to + 155	°C

Thermal Resistance

	Parameter	Typ.	Max.	Units
$R_{\theta JL}$	Junction-to-Drain Lead	——	20	°C/W
$R_{\theta JA}$	Junction-to-Ambient ④	——	50	

Notes ① through ④ are on page 10

Static @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions
BV_{DSS}	Drain-to-Source Breakdown Voltage	30	——	——	V	V_{GS} = 0V, I_D = 250µA
$\Delta BV_{DSS}/\Delta T_J$	Breakdown Voltage Temp. Coefficient	——	0.023	——	V/°C	Reference to 25°C, I_D = 1mA
$R_{DS(on)}$	Static Drain-to-Source On-Resistance	——	3.1	4.0	mΩ	V_{GS} = 10V, I_D = 20A ③
		——	3.7	4.8		V_{GS} = 4.5V, I_D = 16A ③
$V_{GS(th)}$	Gate Threshold Voltage	1.39	——	2.32	V	V_{DS} = V_{GS}, I_D = 250µA
$\Delta V_{GS(th)}$	Gate Threshold Voltage Coefficient	——	5.7	——	mV/°C	
I_{DSS}	Drain-to-Source Leakage Current	——	——	1.0	µA	V_{DS} = 24V, V_{GS} = 0V
		——	——	150		V_{DS} = 24V, V_{GS} = 0V, T_J = 125°C
I_{GSS}	Gate-to-Source Forward Leakage	——	——	100	nA	V_{GS} = 20V
	Gate-to-Source Reverse Leakage	——	——	-100		V_{GS} = -20V
gfs	Forward Transconductance	77	——	——	S	V_{DS} = 15V, I_D = 16A
Q_g	Total Gate Charge	——	34	51		
Q_{gs1}	Pre-Vth Gate-to-Source Charge	——	8.6	——	nC	V_{DS} = 15V
Q_{gs2}	Post-Vth Gate-to-Source Charge	——	2.9	——		V_{GS} = 4.5V
Q_{gd}	Gate-to-Drain Charge	——	12	——		I_D = 16A
Q_{godr}	Gate Charge Overdrive	——	10.5	——		See Fig. 16
Q_{sw}	Switch Charge (Q_{gs2} + Q_{gd})	——	14.9	——		
Q_{oss}	Output Charge	——	23	——	nC	V_{DS} = 16V, V_{GS} = 0V
R_g	Gate Resistance	——	1.2	2.4	Ω	
$t_{d(on)}$	Turn-On Delay Time	——	12	——		V_{DD} = 15V, V_{GS} = 4.5V
t_r	Rise Time	——	6.7	——		I_D = 16A
$t_{d(off)}$	Turn-Off Delay Time	——	21	——	ns	Clamped Inductive Load
t_f	Fall Time	——	13	——		
C_{iss}	Input Capacitance	——	4310	——		V_{GS} = 0V
C_{oss}	Output Capacitance	——	990	——	pF	V_{DS} = 15V
C_{rss}	Reverse Transfer Capacitance	——	450	——		f = 1.0MHz

Avalanche Characteristics

	Parameter	Typ.	Max.	Units
E_{AS}	Single Pulse Avalanche Energy ②	——	260	mJ
I_{AR}	Avalanche Current ①	——	16	A

Diode Characteristics

|	Parameter	Min.	Typ.	Max.	Units	Conditions
I_S	Continuous Source Current (Body Diode)	——	——	3.1	A	MOSFET symbol showing the integral reverse p-n junction diode.
I_{SM}	Pulsed Source Current (Body Diode) ①	——	——	160		
V_{SD}	Diode Forward Voltage	——	——	1.0	V	T_J = 25°C, I_S = 16A, V_{GS} = 0V ③
t_{rr}	Reverse Recovery Time	——	41	62	ns	T_J = 25°C, I_F = 16A, V_{DD} = 10V
Q_{rr}	Reverse Recovery Charge	——	39	59	nC	di/dt = 100A/µs ③
t_{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by LS+LD)				
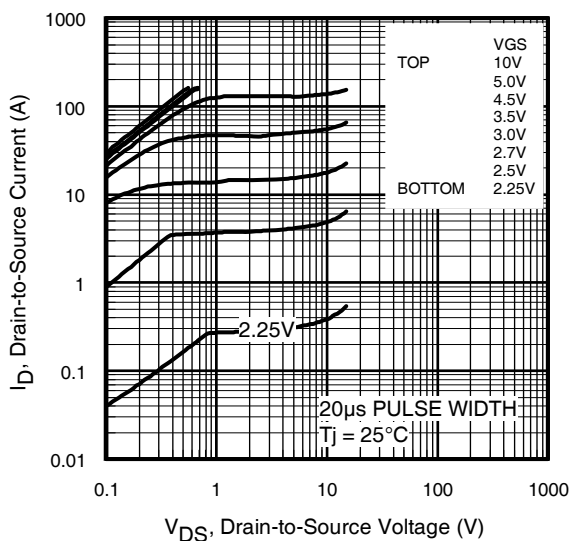
Fig 1. Typical Output Characteristics
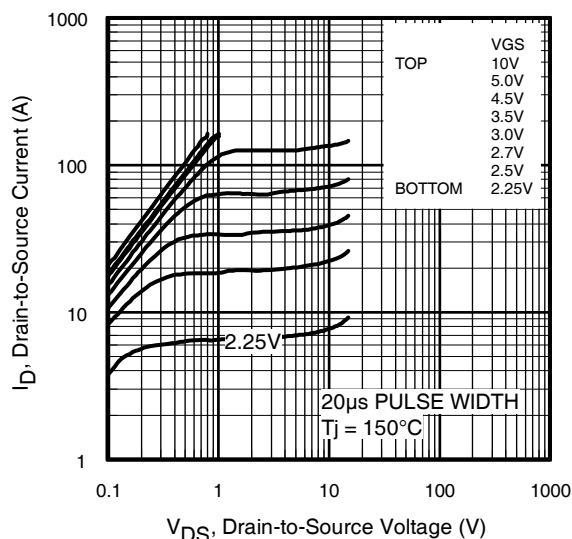
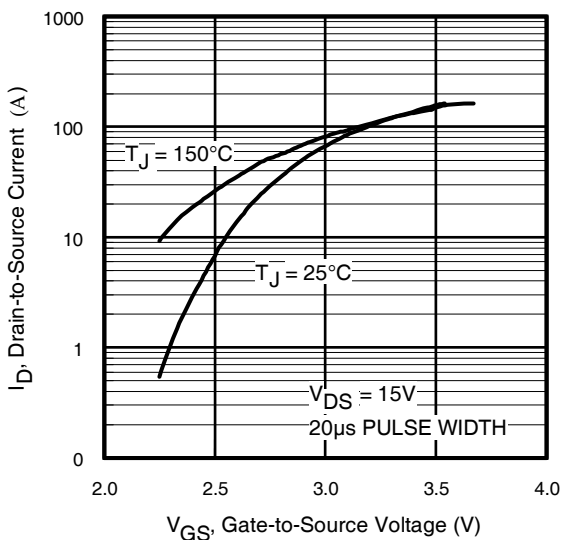Fig 2. Typical Output Characteristics

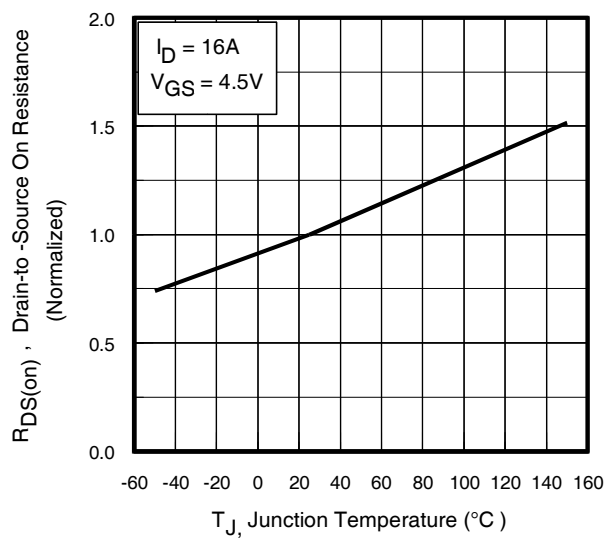Fig 3. Typical Transfer Characteristics

Fig 4. Normalized On-Resistance
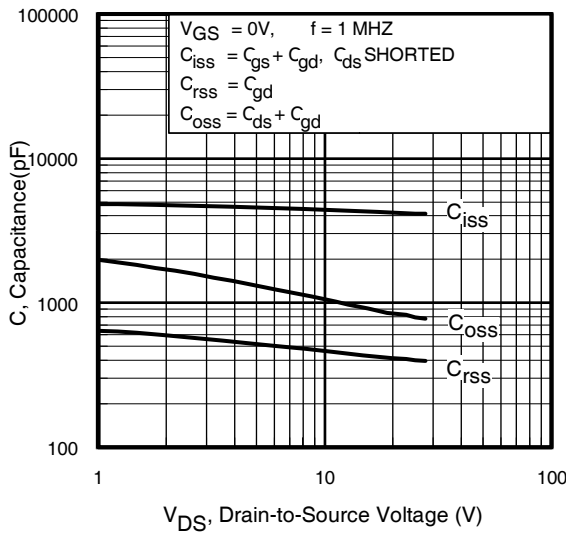Vs. Temperature

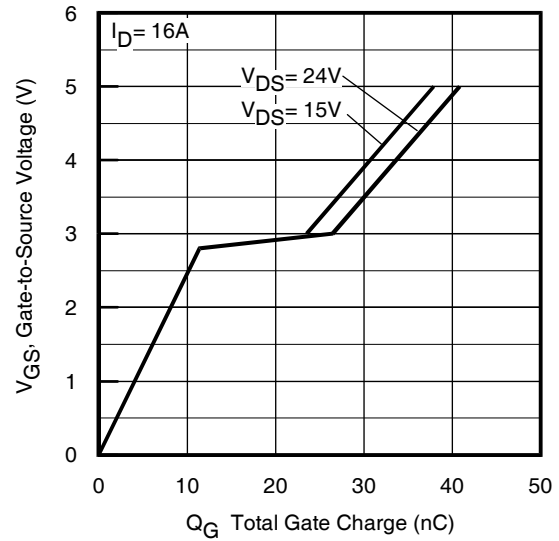**Fig 5.** Typical Capacitance Vs.
Drain-to-Source Voltage

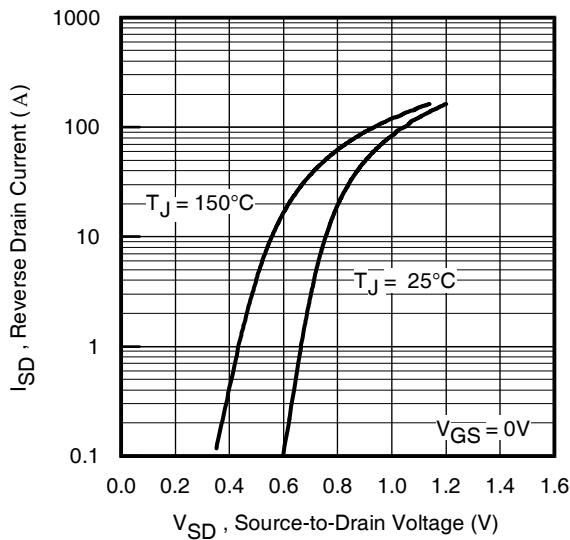

Fig 6. Typical Gate Charge Vs.
Gate-to-Source Voltage
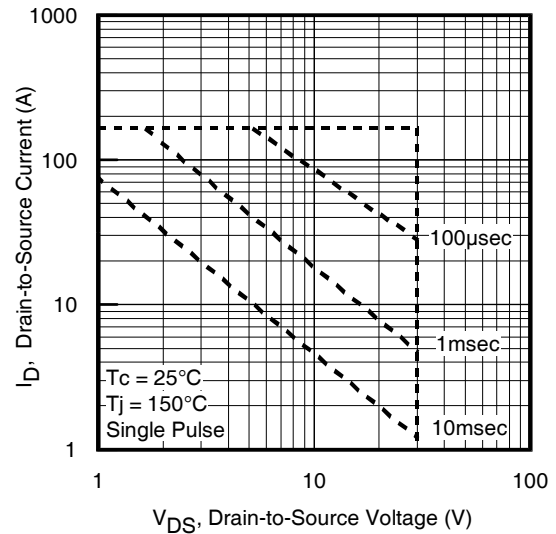

Fig 7. Typical Source-Drain Diode
Forward Voltage
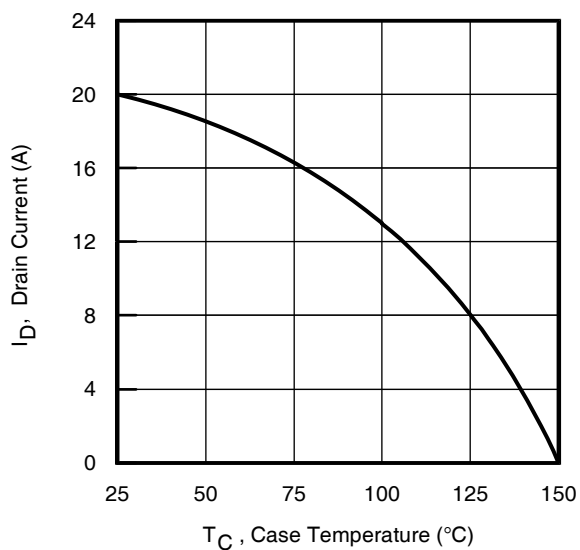

Fig 8. Maximum Safe Operating Area
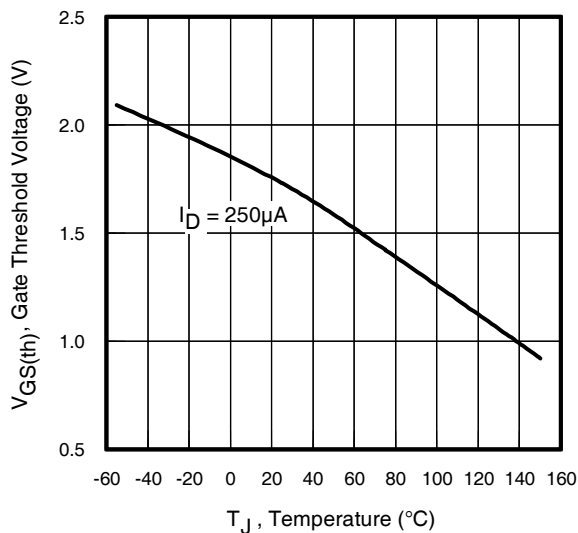
Fig 9. Maximum Drain Current Vs. Case Temperature
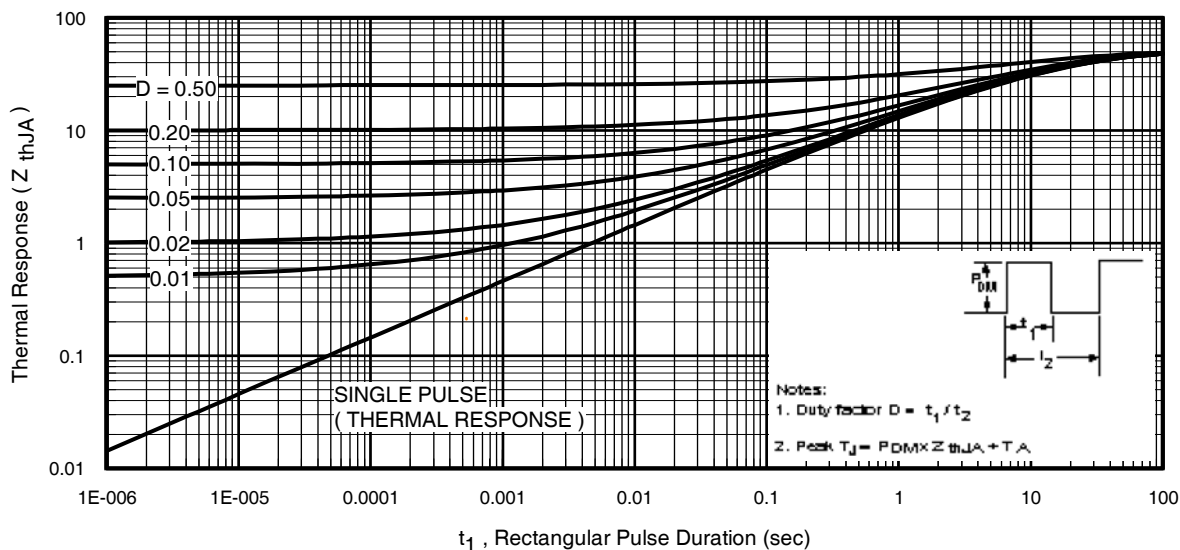

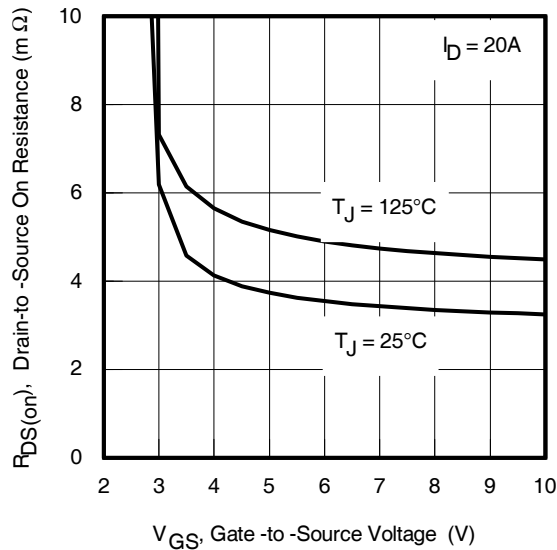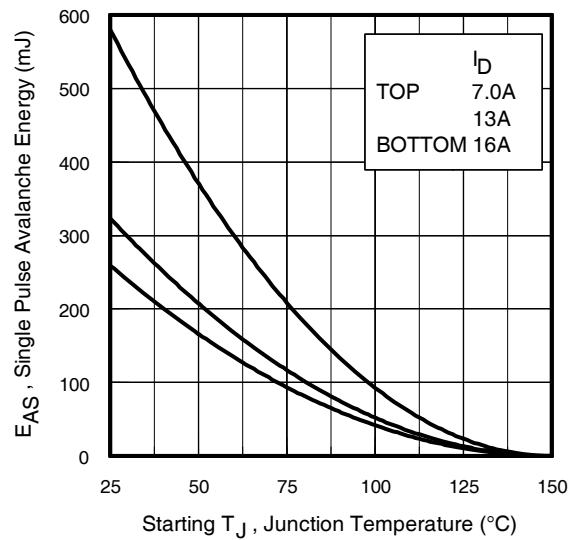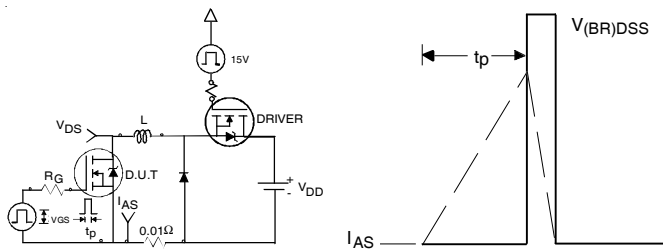**Fig 10.** Threshold Voltage Vs. Temperature

Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Ambient

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$R_{DS(on)}$, Drain-to -Source On Resistance (m Ω)

I_D = 20A

T_J = 125°C

T_J = 25°C

V_{GS}, Gate -to -Source Voltage (V)

Fig 12. On-Resistance vs. Gate Voltage

E_{AS} , Single Pulse Avalanche Energy (mJ)

	I_D
TOP	7.0A
	13A
BOTTOM	16A

Starting T_J , Junction Temperature (°C)

Fig 13. Maximum Avalanche Energy vs. Drain Current

Fig 14. Unclamped Inductive Test Circuit and Waveform
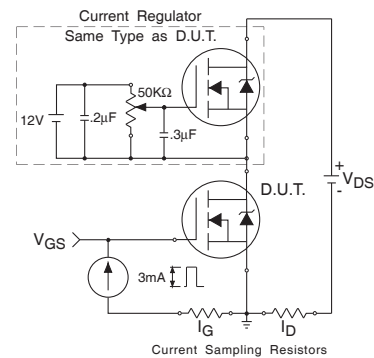
Fig 15. Gate Charge Test Circuit
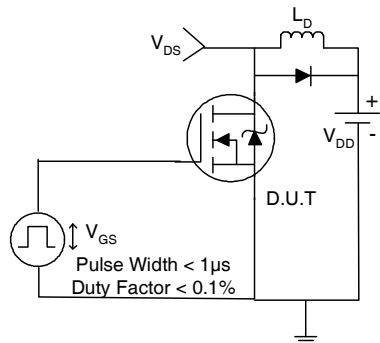
Fig 16. Switching Time Test Circuit
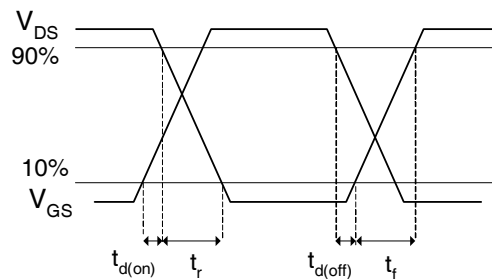
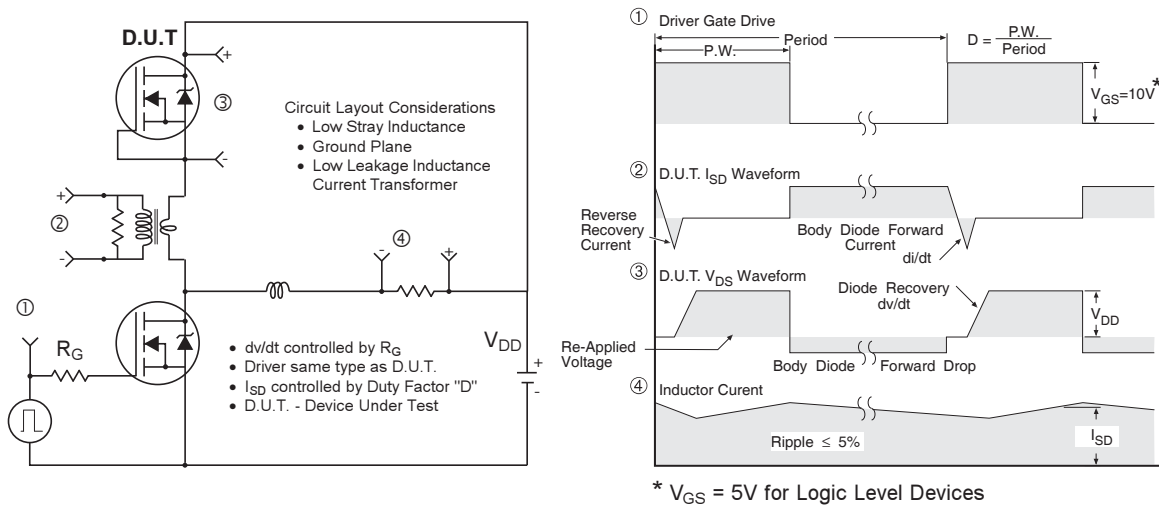**Fig 17.** Switching Time Waveforms

Fig 18. Peak Diode Recovery dv/dt Test Circuit for N-Channel
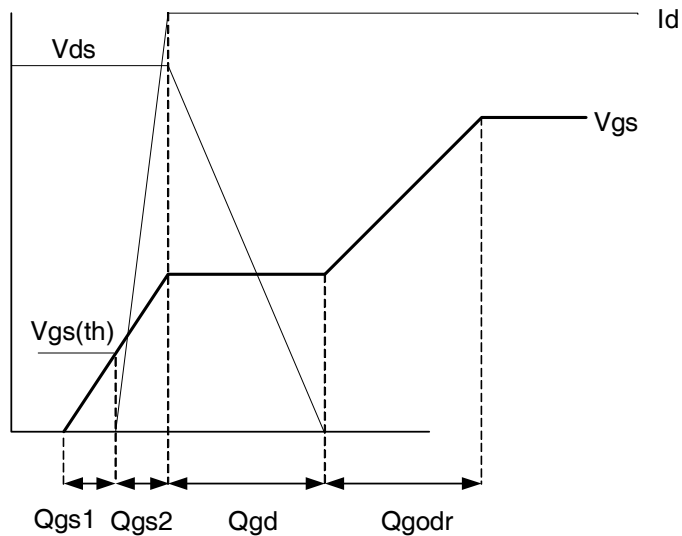HEXFET® Power MOSFETs

Fig 19. Gate Charge Waveform

Power MOSFET Selection for Non-Isolated DC/DC Converters

Control FET

Special attention has been given to the power losses in the switching elements of the circuit - Q1 and Q2. Power losses in the high side switch Q1, also called the Control FET, are impacted by the $R_{ds(on)}$ of the MOSFET, but these conduction losses are only about one half of the total losses.

Power losses in the control switch Q1 are given by;

$$P_{loss} = P_{conduction} + P_{switching} + P_{drive} + P_{output}$$

This can be expanded and approximated by;

$$P_{loss} = \left(I_{rms}^{\;2} \times R_{ds(on)}\right)$$
$$+ \left(I \times \frac{Q_{gd}}{i_g} \times V_{in} \times f\right) + \left(I \times \frac{Q_{gs2}}{i_g} \times V_{in} \times f\right)$$
$$+ \left(Q_g \times V_g \times f\right)$$
$$+ \left(\frac{Q_{oss}}{2} \times V_{in} \times f\right)$$

This simplified loss equation includes the terms Q_{gs2} and Q_{oss} which are new to Power MOSFET data sheets.

Q_{gs2} is a sub element of traditional gate-source charge that is included in all MOSFET data sheets. The importance of splitting this gate-source charge into two sub elements, Q_{gs1} and Q_{gs2}, can be seen from Fig 16.

Q_{gs2} indicates the charge that must be supplied by the gate driver between the time that the threshold voltage has been reached and the time the drain current rises to I_{dmax} at which time the drain voltage begins to change. Minimizing Q_{gs2} is a critical factor in reducing switching losses in Q1.

Q_{oss} is the charge that must be supplied to the output capacitance of the MOSFET during every switching cycle. Figure A shows how Q_{oss} is formed by the parallel combination of the voltage dependant (non-linear) capacitance's C_{ds} and C_{dg} when multiplied by the power supply input buss voltage.

Synchronous FET

The power loss equation for Q2 is approximated by;

$$P_{loss} = P_{conduction} + P_{drive} + P_{output}^*$$
$$P_{loss} = \left(I_{rms}^{\;2} \times R_{ds(on)}\right)$$
$$+ \left(Q_g \times V_g \times f\right)$$
$$+ \left(\frac{Q_{oss}}{2} \times V_{in} \times f\right) + \left(Q_{rr} \times V_{in} \times f\right)$$

*dissipated primarily in Q1.

For the synchronous MOSFET Q2, $R_{ds(on)}$ is an important characteristic; however, once again the importance of gate charge must not be overlooked since it impacts three critical areas. Under light load the MOSFET must still be turned on and off by the control IC so the gate drive losses become much more significant. Secondly, the output charge Q_{oss} and reverse recovery charge Q_{rr} both generate losses that are transfered to Q1 and increase the dissipation in that device. Thirdly, gate charge will impact the MOSFETs' susceptibility to Cdv/dt turn on.

The drain of Q2 is connected to the switching node of the converter and therefore sees transitions between ground and V_{in}. As Q1 turns on and off there is a rate of change of drain voltage dV/dt which is capacitively coupled to the gate of Q2 and can induce a voltage spike on the gate that is sufficient to turn the MOSFET on, resulting in shoot-through current . The ratio of Q_{gd}/Q_{gs1} must be minimized to reduce the potential for Cdv/dt turn on.
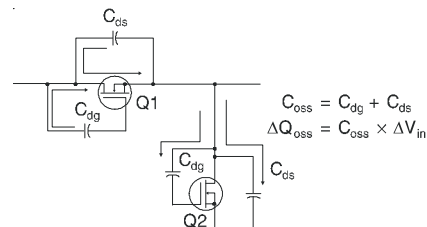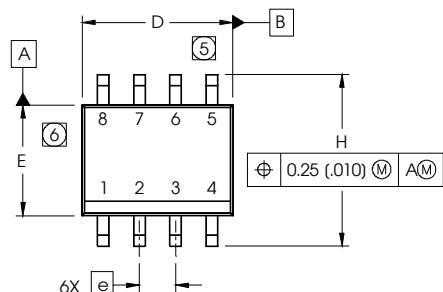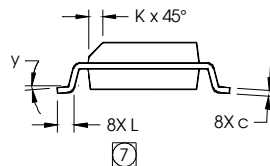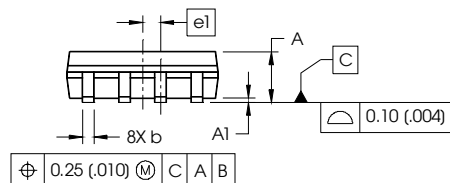

$C_{oss} = C_{dg} + C_{ds}$
$\Delta Q_{oss} = C_{oss} \times \Delta V_{in}$

Figure A: Q_{oss} Characteristic

SO-8 Package Details

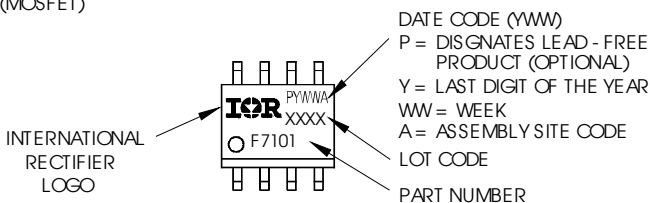| DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.0532	.0688	1.35	1.75
A1	.0040	.0098	0.10	0.25
b	.013	.020	0.33	0.51
c	.0075	.0098	0.19	0.25
D	.189	.1968	4.80	5.00
E	.1497	.1574	3.80	4.00
e	.050 BASIC		1.27 BASIC	
e1	.025 BASIC		0.635 BASIC	
H	.2284	.2440	5.80	6.20
K	.0099	.0196	0.25	0.50
L	.016	.050	0.40	1.27
y	0°	8°	0°	8°

NOTES:
1. DIMENSIONING & TOLERANCING PER ASME Y14.5M-1994.
2. CONTROLLING DIMENSION: MILLIMETER
3. DIMENSIONS ARE SHOWN IN MILLIMETERS (INCHES).
4. OUTLINE CONFORMS TO JEDEC OUTLINE MS-012AA.
5. DIMENSION DOES NOT INCLUDE MOLD PROTRUSIONS. MOLD PROTRUSIONS NOT TO EXCEED 0.15 (.006).
6. DIMENSION DOES NOT INCLUDE MOLD PROTRUSIONS. MOLD PROTRUSIONS NOT TO EXCEED 0.25 (.010).
7. DIMENSION IS THE LENGTH OF LEAD FOR SOLDERING TO A SUBSTRATE.

FOOTPRINT
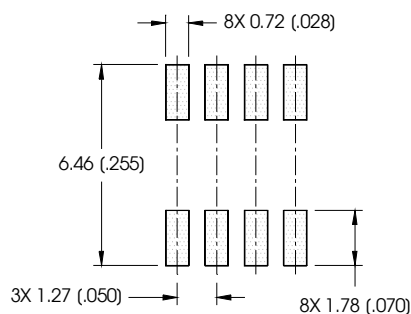
SO-8 Part Marking

EXAMPLE: THIS IS AN IRF7101 (MOSFET)

INTERNATIONAL RECTIFIER LOGO

DATE CODE (YWW)
P = DISGNATES LEAD - FREE PRODUCT (OPTIONAL)
Y = LAST DIGIT OF THE YEAR
WW = WEEK
A = ASSEMBLY SITE CODE
LOT CODE
PART NUMBER

Note: For the most current drawing please refer to IR website at http://www.irf.com/package/

SO-8 Tape and Reel

TERMINAL NUMBER 1

12.3 (.484)
11.7 (.461)

8.1 (.318)
7.9 (.312)

FEED DIRECTION

NOTES:
1. CONTROLLING DIMENSION : MILLIMETER.
2. ALL DIMENSIONS ARE SHOWN IN MILLIMETERS(INCHES).
3. OUTLINE CONFORMS TO EIA-481 & EIA-541.

Ø 330.00
(12.992)
MAX.

14.40 (.566)
12.40 (.488)

NOTES :
1. CONTROLLING DIMENSION : MILLIMETER.
2. OUTLINE CONFORMS TO EIA-481 & EIA-541.

Note: For the most current drawing please refer to IR website at http://www.irf.com/package/

Qualification information[†]

Qualification level	Industrial (per JEDEC JESD47F[††] guidelines)	
Moisture Sensitivity Level	SO-8	MSL1 (per JEDEC J-STD-020D[††])
RoHS compliant	Yes	

† Qualification standards can be found at International Rectifier's web site: http://www.irf.com/product-info/reliability
†† Applicable version of JEDEC standard at the time of product release

Notes:

① Repetitive rating; pulse width limited by max. junction temperature.

② Starting T_J = 25°C, L = 2.0mH, R_G = 25Ω, I_{AS} = 16A.

③ Pulse width ≤ 400µs; duty cycle ≤ 2%.

④ When mounted on 1 inch square copper board.

International IR Rectifier

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To contact International Rectifier, please visit http://www.irf.com/whoto-call/