#### PD-94078A

# International IOR Rectifier

# IRF7807VD1

#### FETKY™ MOSFET / SCHOTTKY DIODE

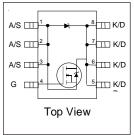
- Co-Pack N-channel HEXFET<sup>®</sup> Power MOSFET and Schottky Diode
- Ideal for Synchronous Rectifiers in DC-DC Converters Up to 5A Output
- Low Conduction Losses
- Low Switching Losses
- · Low Vf Schottky Rectifier
- 100% R<sub>G</sub> Tested

#### Description

The FETKY™ family of Co-Pack HEXFET®MOSFETs and Schottky diodes offers the designer an innovative, board space saving solution for switching regulator and power management applications. HEXFET power MOSFETs utilize advanced processing techniques to achieve extremely low on-resistance per silicon area. Combining this technology with International Rectifier's low forward drop Schottky rectifiers results in an extremely efficient device suitable for use in a wide variety of portable electronics applications.

The SO-8 has been modified through a customized leadframe for enhanced thermal characteristics. The SO-8 package is designed for vapor phase, infrared or wave soldering techniques.





11/12/03

#### **DEVICE CHARACTERISTICS** ©

	IRF7807VD1					
$R_{\rm DS(on)}$	17mΩ					
$Q_{G}$	9.5nC					
Q <sub>sw</sub>	3.4nC					
Q <sub>oss</sub>	12nC					

#### **Absolute Maximum Ratings**

Parameter	Symbol	Max	Units V		
Drain-to-Source Voltage	V <sub>DS</sub>	30			
Gate-to-Source Voltage	V <sub>GS</sub>	±20	1		
Continuous Output Current	25°C		8.3	А	
$(V_{GS} \ge 4.5V)$	70°C	l <sub>D</sub>	6.6		
Pulsed Drain Current ①	<del>!</del>	I <sub>DM</sub>	66		
Dower Dissipation 2	25°C	В	2.5	١٨/	
Power Dissipation ③	70°C	P <sub>D</sub>	1.6	W	
Schottky and Body Diode	25°C	1 (0)()	3.5		
Average Forward Current @	70°C	I <sub>F</sub> (AV)	2.2	1	
Junction & Storage Temperature Rang	е	$T_J$ , $T_{STG}$	-55 to 150	°C	

#### **Thermal Resistance**

Parameter	Symbol	Тур	Max	Units
Maximum Junction-to-Ambient ③ ⑥	$R_{\theta JA}$		50	°C/W
Maximum Junction-to-Lead ©	$R_{\theta JL}$		20	C/VV

International IOR Rectifier

### **Electrical Characteristics**

Parameter	Symbol	Min	Тур	Max	Units	Conditions
Drain-Source Breakdown Voltage	$BV_{DSS}$	30			V	$V_{GS} = 0V, I_D = 250\mu A$
Static Drain-Source On-Resistance	R <sub>DS(on)</sub>		17	25	mΩ	$V_{GS} = 4.5V, I_{D} = 7.0A$ ②
Gate Threshold Voltage	$V_{GS(th)}$	1.0		3.0	V	$V_{DS} = V_{GS}$ , $I_D = 250\mu A$
				100	μΑ	$V_{DS} = 30V, V_{GS} = 0V$
Drain-Source Leakage Current	I <sub>DSS</sub>			20	μΑ	$V_{DS} = 24V, V_{GS} = 0V$
				2.0	mA	$V_{DS} = 24V, V_{GS} = 0V, T_{J} = 100^{\circ}C$
Gate-Source Leakage Current	I <sub>GSS</sub>			±100	nA	$V_{GS} = \pm 20V$
Total Gate Charge*	$Q_G$		9.5	14		
Pre-Vth Gate-Source Charge	Q <sub>GS1</sub>		2.3			$V_{DS} = 4.5V$
Post-Vth Gate-Source Charge	Q <sub>GS2</sub>		1.0		nC	$I_D = 7.0A$
Gate-to-Drain Charge	$Q_{GD}$		2.4		IIC	$V_{DS} = 16V$
Switch Charge (Q <sub>gs2</sub> + Q <sub>gd</sub> )	$Q_{SW}$		3.4	5.2		
Output Charge*	Q <sub>oss</sub>		12	16.8		$V_{DS} = 16V, V_{GS} = 0$
Gate Resistance	$R_{G}$	0.9		2.8	Ω	
Turn-On Delay Time	t <sub>d(on)</sub>		6.3			$V_{DD} = 16V, I_D = 7.0V$
Rise Time	t <sub>r</sub>		1.2			$V_{GS} = 5V, R_G = 2\Omega$
Turn-Off Delay Time	t <sub>d(off)</sub>		11		ns	Resistive Load
Fall Time	t <sub>f</sub>		2.2			

### **Diode Characteristics**

Parameter	Symbol	Min	Тур	Max	Units	Conditions
Diode Forward Voltage	$V_{SD}$			0.5	V	$T_J = 25$ °C, $I_S = 1.0$ A , $V_{GS} = 0$ V2
				0.39	٧	$T = 125$ °C, $I_S = 1.0A$ , $V_{GS} = OV$ ②
Reverse Recovery Time @	t <sub>rr</sub>		51		ne	$di/dt = 700A/\mu s$ $V_{DD} = 16V, V_{GS} = 0V, I_D = 15A$
Reverse Recovery Charge @	Q <sub>rr</sub>		51		nC	$T_J = 25^{\circ}C$ , $I_S = 7.0A$ , $V_{DS} = 16V$ di/dt = 100A/ $\mu$ s

International

TOR Rectifier

### IRF7807VD1

# Power MOSFET Selection for 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  $R_{\rm ds(on)}$  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;

$$\begin{split} P_{loss} &= \left(I_{rms}^{2} \times R_{ds(on)}\right) \\ &+ \left(I \times \frac{Q_{gd}}{i_{g}} \times V_{in} \times f\right) + \left(I \times \frac{Q_{gs2}}{i_{g}} \times V_{in} \times f\right) \\ &+ \left(Q_{g} \times V_{g} \times f\right) \\ &+ \left(\frac{Q_{oss}}{2} \times V_{in} \times f\right) \end{split}$$

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. 1

 $Q_{gs2}$  indicates the charge that must be supplied by the gate driver between the time that the threshold voltage has been reached (t1) and the time the drain current rises to  $I_{dmax}$  (t2) at which time the drain voltage begins to change. Minimizing  $Q_{gs2}$  is a critical factor in reducing switching losses in Q1.

 $Q_{\mbox{\tiny oss}}$  is the charge that must be supplied to the output capacitance of the MOSFET during every switching cycle. Figure 2 shows how  $Q_{\mbox{\tiny oss}}$  is formed by the parallel combination of the voltage dependant (nonlinear) capacitance's  $C_{\mbox{\tiny ds}}$  and  $C_{\mbox{\tiny dg}}$  when multiplied by the power supply input buss voltage.

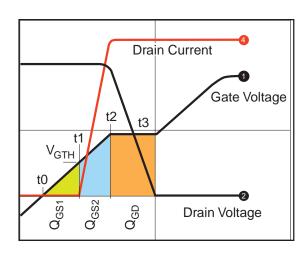


Figure 1: Typical MOSFET switching waveform

#### **Synchronous FET**

The power loss equation for Q2 is approximated by:

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

\*dissipated primarily in Q1.

For the synchronous MOSFET Q2,  $R_{\rm ds(on)}$  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  $Q_{\rm oss}$  and reverse recovery charge  $Q_{\rm r}$  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  $V_{\rm in}$ . 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  $Q_{\rm gd}/Q_{\rm gs1}$  must be minimized to reduce the potential for Cdv/dt turn on.

Spice model for IRF7807V can be downloaded in machine readable format at www.irf.com.

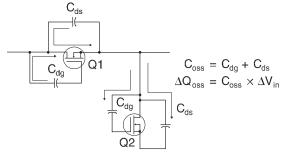
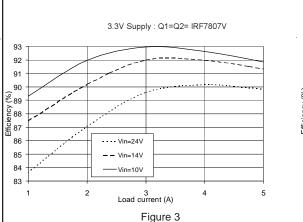
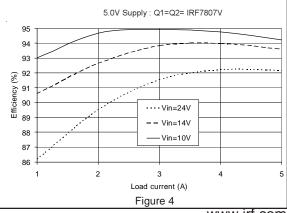


Figure 2: Q<sub>oss</sub> Characteristic

#### **Typical Mobile PC Application**

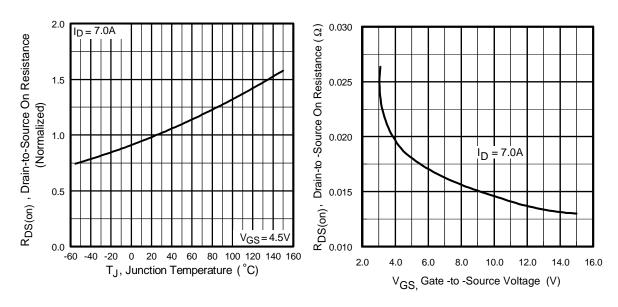
The performance of these new devices has been tested in circuit and correlates well with performance predictions generated by the system models. An advantage of this new technology platform is that the MOSFETs it produces are suitable for both control FET and synchronous FET applications. This has been demonstrated with the 3.3V and 5V converters. (Fig 3 and Fig 4). In these applications the same MOSFET IRF7807V was used for both the control FET (Q1) and the synchronous FET (Q2). This provides a highly effective cost/performance solution.





www.irf.com

4



**Fig 5.** Normalized On-Resistance Vs. Temperature

Fig 7. On-Resistance Vs. Gate Voltage

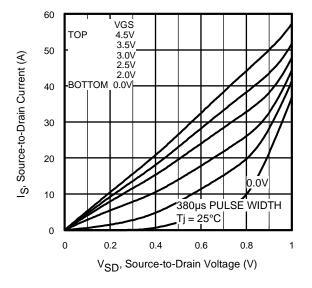


Fig 7. Typical Reverse Output Characteristics

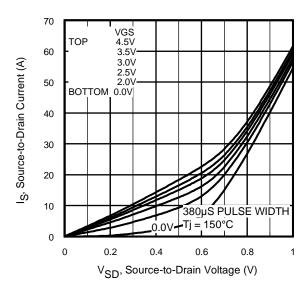


Fig 8. Typical Reverse Output Characteristics

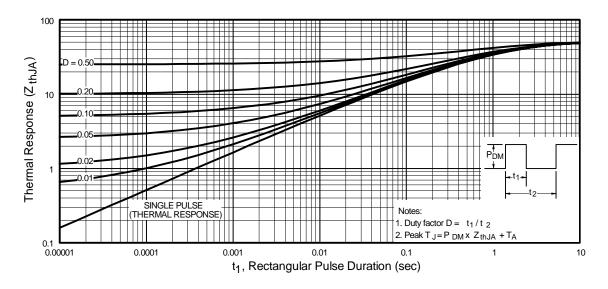
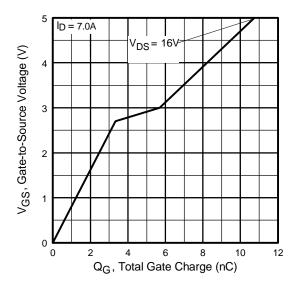
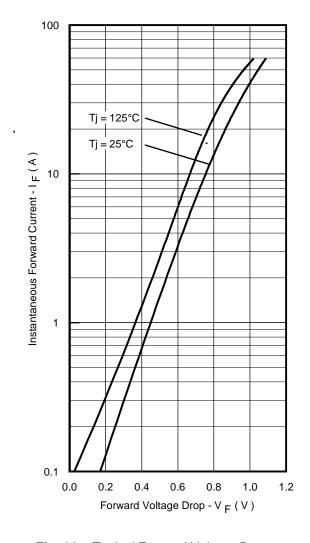


Figure 9. Maximum Effective Transient Thermal Impedance, Junction-to-Ambient



**Fig 10.** Typical Gate Charge Vs. Gate-to-Source Voltage

### **MOSFET**, Body Diode & Schottky Diode Characteristics



100 10 Tj = 150°C 100°C 10

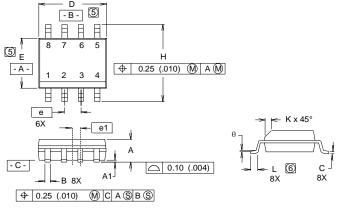
Fig. 12 - Typical Values of Reverse Current Vs. Reverse Voltage

**Fig. 11** - Typical Forward Voltage Drop Characteristics

International

TOR Rectifier

### **SO-8 Package Details**

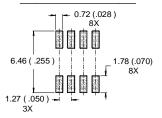


#### NOTES:

- 1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1982.
- 2. CONTROLLING DIMENSION: INCH.
- 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 0.25 (.006).
- 6 DIMENSIONS IS THE LENGTH OF LEAD FOR SOLDERING TO A SUBSTRATE..

INC	HES	MILLIMETERS			
MIN	MAX	MIN	MAX		
.0532	.0688	1.35	1.75		
.0040	.0098	0.10	0.25		
.014	.018	0.36	0.46		
.0075	.0098	0.19	0.25		
.189	.196	4.80	4.98		
.150	.157	3.81	3.99		
.050 I	BASIC	1.27 BASIC			
.025 I	BASIC	0.635 BASIC			
.2284	.2440	5.80	6.20		
.011	.019	0.28	0.48		
0.16	.050	0.41	1.27		
0°	8°	0°	8°		
	MIN .0532 .0040 .014 .0075 .189 .150 .025 I .2284 .011 0.16	.0532 .0688 .0040 .0098 .014 .018 .0075 .0098 .189 .196 .150 .157 .050 BASIC .025 BASIC .2284 .2440 .011 .019 0.16 .050	MIN         MAX         MIN           .0532         .0688         1.35           .0040         .0098         0.10           .014         .018         0.36           .0075         .0098         0.19           .189         .196         4.80           .150         .157         3.81           .050         BASIC         1.271           .025         BASIC         0.635           .2284         .2440         5.80           .011         .019         0.28           0.16         .050         0.41		

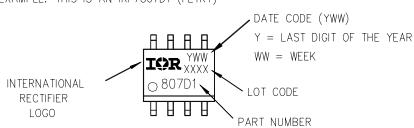
RECOMMENDED FOOTPRINT



### **SO-8 Part Marking**

SO-8 (MS-012AA)

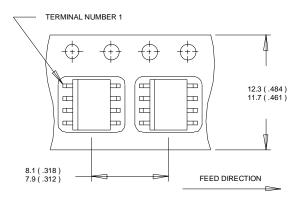
EXAMPLE: THIS IS AN IRF7807D1 (FETKY)



International IOR Rectifier

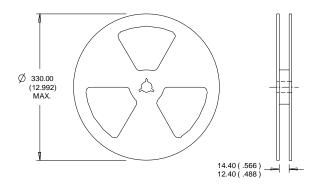
# IRF7807VD1

### **SO-8 Tape and Reel**



#### NOTES:

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



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

This product has been designed and qualified for the commercial market. Qualification Standards can be found on IR's Web site.



IR WORLD HEADQUARTERS: 233 Kansas St., El Segundo, California 90245, USA Tel: (310) 252-7105

TAC Fax: (310) 252-7903

Visit us at www.irf.com for sales contact information. 10/03