FAIRCHILD
SEMICONDUCTOR®

October 2002

FDH20N40 / FDP20N40

20A, 400V, 0.216 Ohm, N-Channel SMPS Power MOSFET

Applications

**Switch Mode Power Supplies(SMPS), such as**

• PFC Boost

• Two-Switch Forward Converter

• Single Switch Forward Converter

• Flyback Converter

• Buck Converter
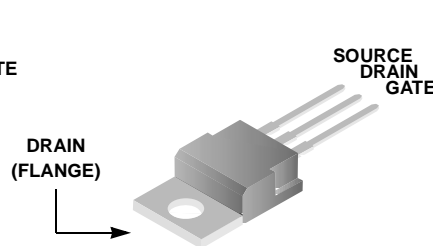
• High Speed Switching

Features

• Low Gate Charge Q_g results in Simple Drive Requirement

• Improved Gate, Avalanche and High Reapplied dv/dt Ruggedness

• Reduced $r_{DS(ON)}$

• Reduced Miller Capacitance and Low Input Capacitance

• Improved Switching Speed with Low EMI

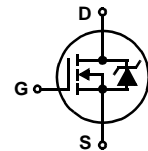• 175°C Rated Junction Temperature

Package   Symbol
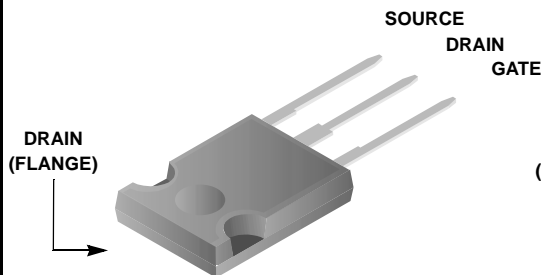
JEDEC TO-247   **JEDEC TO-220AB**

Absolute Maximum Ratings $T_C = 25°C$ unless otherwise noted

Symbol	Parameter	Ratings	Units
V_{DSS}	Drain to Source Voltage	400	V
V_{GS}	Gate to Source Voltage	±30	V
I_D	Drain Current Continuous ($T_C = 25°C$, $V_{GS} = 10V$)	20	A
	Continuous ($T_C = 100°C$, $V_{GS} = 10V$)	14	A
	Pulsed (Note 1)	80	A
P_D	Power dissipation	273	W
	Derate above 25°C	1.82	W/°C
T_J, T_{STG}	Operating and Storage Temperature	-55 to 175	°C
	Soldering Temperature for 10 seconds	300 (1.6mm from case)	°C
	Mounting Torque, 8-32 or M3 Screw	10ibf*in (1.1N*m)	

Thermal Characteristics

$R_{\theta JC}$	Thermal Resistance Junction to Case	0.55	°C/W
$R_{\theta CS}$	Thermal Resistance Case to Sink, Flat, Greased Surface	0.24	°C/W
$R_{\theta JA}$	Thermal Resistance Junction to Ambient (TO-247)	40	°C/W
$R_{\theta JA}$	Thermal Resistance Junction to Ambient (TO-220)	62	°C/W

Package Marking and Ordering Information

Device Marking	Device	Package	Reel Size	Tape Width	Quantity
FDH20N40	FDH20N40	TO-247	Tube	-	30
FDP20N40	FDP20N40	TO-220	Tube	-	50

Electrical Characteristics T_C = 25°C (unless otherwise noted)

Symbol	Parameter	Test Conditions		Min	Typ	Max	Units
Statics							
B_{VDSS}	Drain to Source Breakdown Voltage	$I_D = 250\mu A$, $V_{GS} = 0V$		400	-	-	V
$\Delta B_{VDSS}/\Delta T_J$	Breakdown Voltage Temp. Coefficient	V/°C Reference to 25°C $I_D = 1mA$		-	0.43	-	
$r_{DS(ON)}$	Drain to Source On-Resistance	$V_{GS} = 10V$, $I_D = 10A$		-	0.200	0.216	Ω
$V_{GS(th)}$	Gate Threshold Voltage	$V_{DS} = V_{GS}$, $I_D = 250\mu A$		2.0	3.5	4.0	V
I_{DSS}	Zero Gate Voltage Drain Current	$V_{DS} = 400V$	$T_C = 25^oC$	-	-	25	μA
		$V_{GS} = 0V$	$T_C = 150^oC$	-	-	250	
I_{GSS}	Gate to Source Leakage Current	$V_{GS} = \pm20V$		-	-	±100	nA
Dynamics							
g_{fs}	Forward Transconductance	$V_{DS} = 50V$, $I_D = 10A$		10	-	-	S
$Q_{g(TOT)}$	Total Gate Charge at 10V	$V_{GS} = 10V$		-	35	42	nC
Q_{gs}	Gate to Source Gate Charge	$V_{DS} = 320V$		-	10	12	nC
Q_{gd}	Gate to Drain "Miller" Charge	$I_D = 20A$		-	12	14.4	nC
$t_{d(ON)}$	Turn-On Delay Time	$V_{DD} = 200V$		-	12.4	-	ns
t_r	Rise Time	$I_D = 20A$		-	32.5	-	ns
$t_{d(OFF)}$	Turn-Off Delay Time	$R_G = 10\Omega$		-	30	-	ns
t_f	Fall Time	$R_D = 15.4\Omega$		-	34	-	ns
C_{ISS}	Input Capacitance	$V_{DS} = 25V$, $V_{GS} = 0V$ f = 1MHz		-	1840	-	pF
C_{OSS}	Output Capacitance			-	245	-	pF
C_{RSS}	Reverse Transfer Capacitance			-	18	-	pF
Avalanche Characteristics							
E_{AS}	Single Pulse Avalanche Energy (Note 2)			1100	-	-	mJ
I_{AR}	Avalanche Current			-	-	20	A
Drain-Source Diode Characteristics							
I_S	Continuous Source Current (Body Diode)	MOSFET symbol showing the integral reverse p-n junction diode.		-	-	20	A
I_{SM}	Pulsed Source Current (Note 1) (Body Diode)			-	-	80	A
V_{SD}	Source to Drain Diode Voltage	$I_{SD} = 20A$		-	0.9	1.2	V
t_{rr}	Reverse Recovery Time	$I_{SD} = 20A$, $dI_{SD}/dt = 100A/\mu s$		-	351	456	ns
Q_{RR}	Reverse Recovered Charge	$I_{SD} = 20A$, $dI_{SD}/dt = 100A/\mu s$		-	4.5	5.85	μC
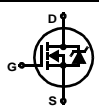
Notes:
1: Repetitive rating; pulse width limited by maximum junction temperature
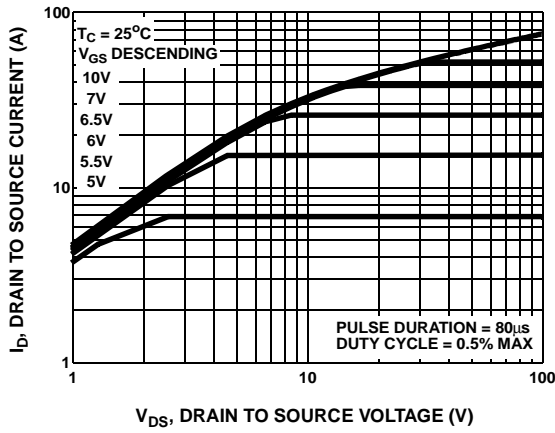**2:** Starting $T_J = 25°C$, L = 5.5mH, $I_{AS} = 20A$

Typical Characteristics

Figure 1. Output Characteristics

T_C = 25°C
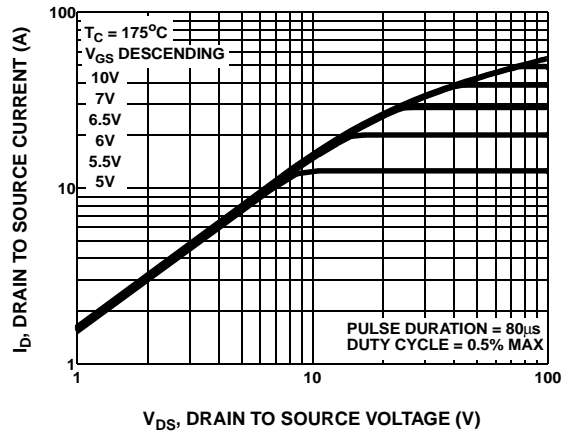V_GS DESCENDING
10V
7V
6.5V
6V
5.5V
5V

PULSE DURATION = 80μs
DUTY CYCLE = 0.5% MAX

I_D, DRAIN TO SOURCE CURRENT (A)
V_{DS}, DRAIN TO SOURCE VOLTAGE (V)

Figure 2. Output Characteristics

T_C = 175°C
V_GS DESCENDING
10V
7V
6.5V
6V
5.5V
5V

PULSE DURATION = 80μs
DUTY CYCLE = 0.5% MAX

I_D, DRAIN TO SOURCE CURRENT (A)
V_{DS}, DRAIN TO SOURCE VOLTAGE (V)
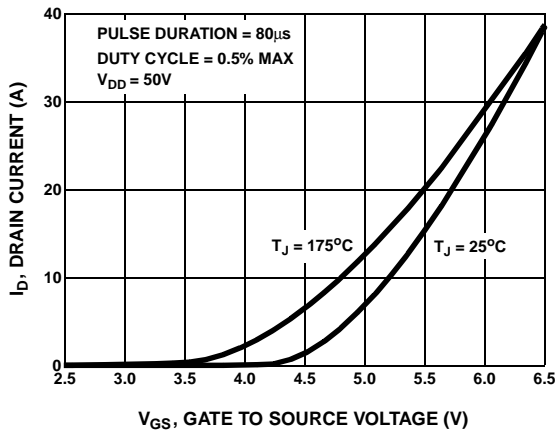
Figure 3. Transfer Characteristics

PULSE DURATION = 80μs
DUTY CYCLE = 0.5% MAX
V_DD = 50V

$T_J = 175°C$ $T_J = 25°C$

I_D, DRAIN CURRENT (A)
V_{GS}, GATE TO SOURCE VOLTAGE (V)
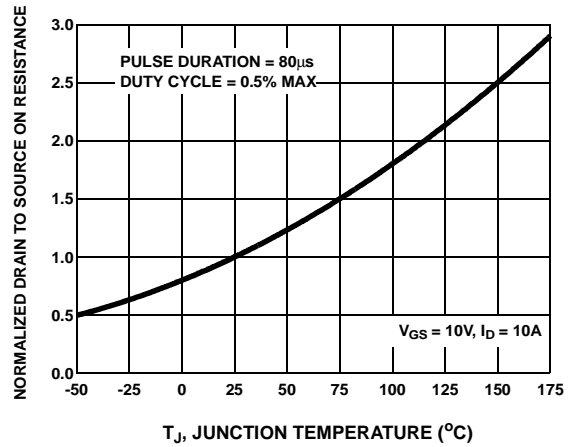
Figure 4. Normalized Drain To Source On Resistance vs Junction Temperatrue

PULSE DURATION = 80μs
DUTY CYCLE = 0.5% MAX

V_GS = 10V, I_D = 10A

NORMALIZED DRAIN TO SOURCE ON RESISTANCE
T_J, JUNCTION TEMPERATURE (°C)
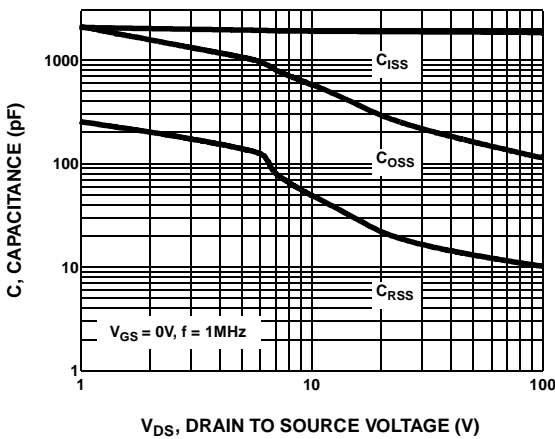
Figure 5. Capacitance vs Drain To Source Voltage

C_ISS
C_OSS
C_RSS
V_GS = 0V, f = 1MHz

C, CAPACITANCE (pF)
V_{DS}, DRAIN TO SOURCE VOLTAGE (V)
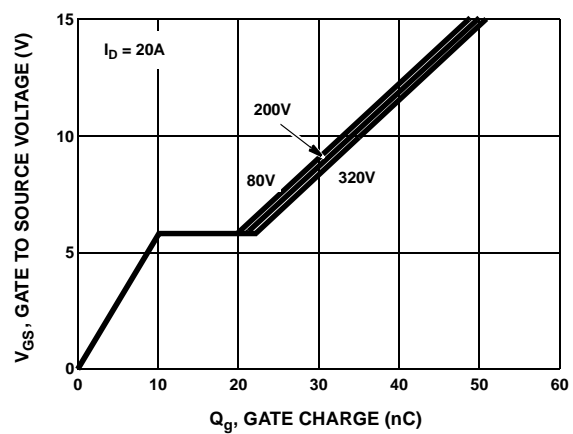
Figure 6. Gate Charge Waveforms For Constant Gate Current

I_D = 20A
200V
80V
320V

V_{GS}, GATE TO SOURCE VOLTAGE (V)
Q_g, GATE CHARGE (nC)

Typical Characteristics

I_SD, SOURCE TO DRAIN CURRENT (A)

T_J = 175°C   T_J = 25°C

V_SD, SOURCE TO DRAIN VOLTAGE (V)
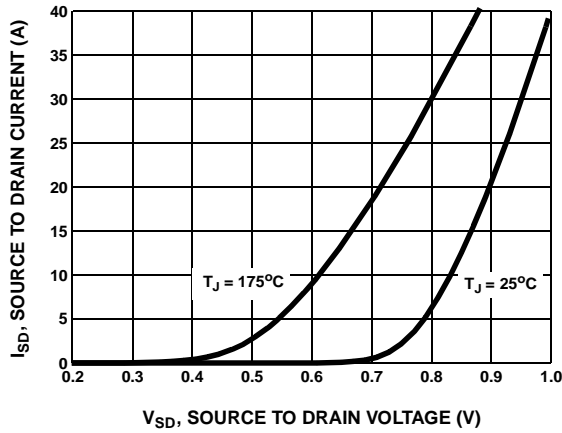
Figure 7. Source to Drain Diode Forward Voltage

I_D, DRAIN CURRENT (A)

OPERATION IN THIS AREA LIMITED BY RDS(ON)

100μs

1ms

10ms

DC

TC = 25°C

V_DS, DRAIN TO SOURCE VOLTAGE (V)
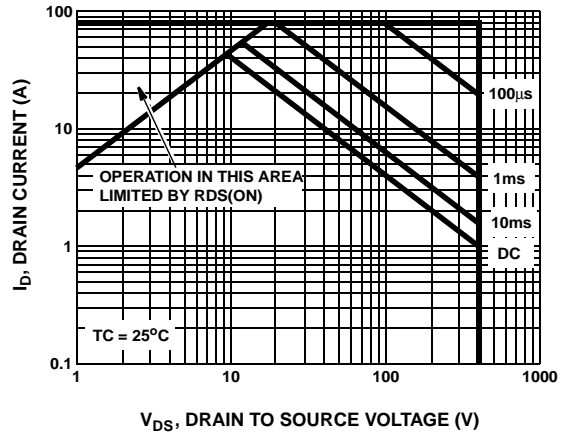
Figure 8. Maximum Safe Operating Area

I_D, DRAIN CURRENT (A)

T_C, CASE TEMPERATURE (°C)
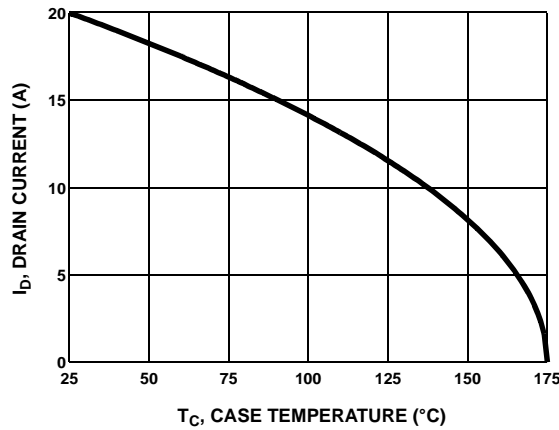
Figure 9. Maximum Drain Current vs Case Temperature

Z_θJC, NORMALIZED THERMAL IMPEDANCE

0.50

0.20

0.10

0.05

0.02

0.01

SINGLE PULSE

P_D   t_1   t_2

DUTY FACTOR, D = t_1 / t_2
PEAK T_J = (P_D X Z_θJC X R_θJC) + T_C

t_1, RECTANGULAR PULSE DURATION (s)
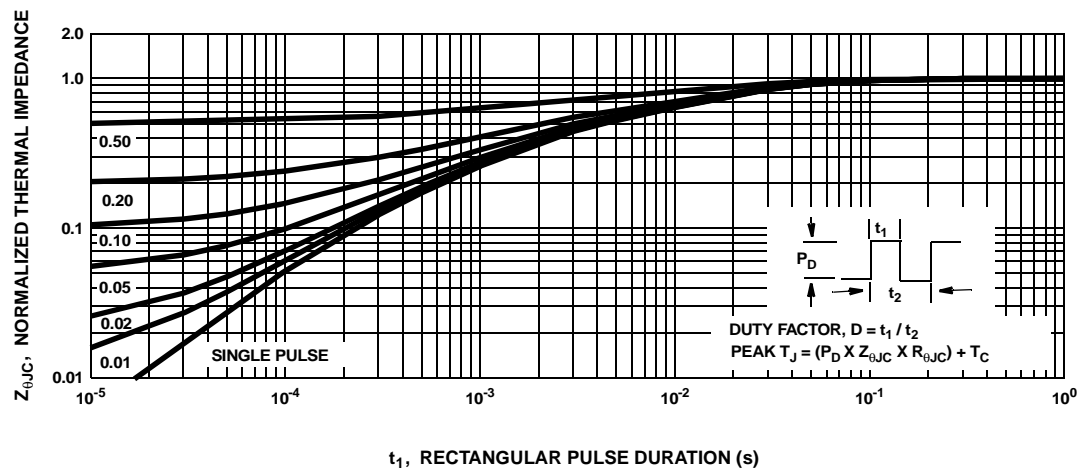
Figure 10. Normalized Maximum Transient Thermal Impedance

Test Circuits and Waveforms
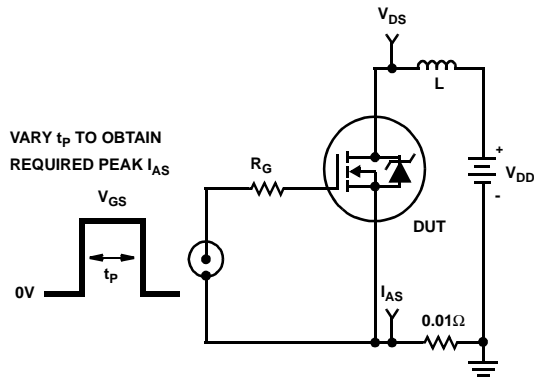
VARY t$_P$ TO OBTAIN
REQUIRED PEAK I$_{AS}$

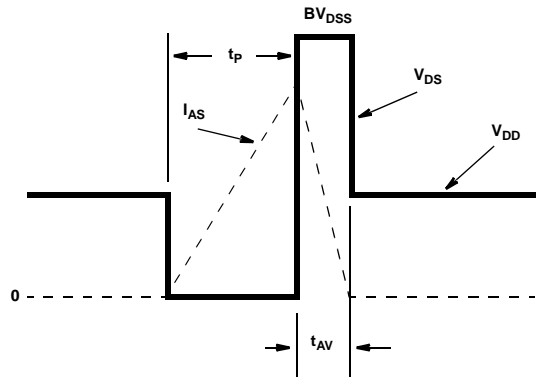**Figure 11. Unclamped Energy Test Circuit**
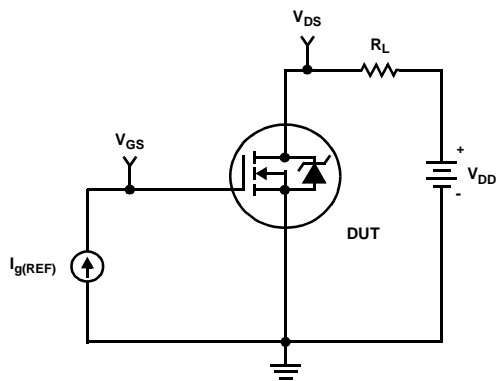
Figure 12. Unclamped Energy Waveforms

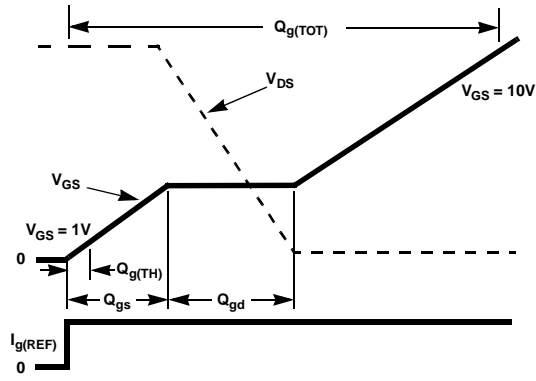**Figure 13. Gate Charge Test Circuit**
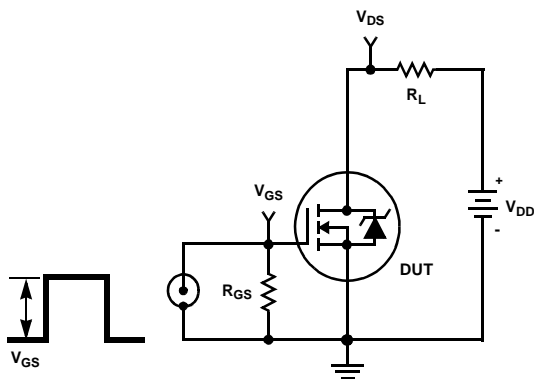
Figure 14. Gate Charge Waveforms

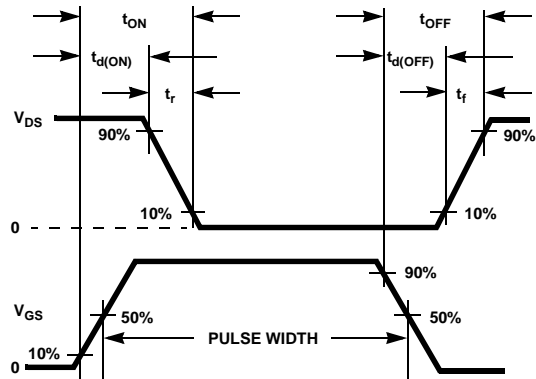**Figure 15. Switching Time Test Circuit**

Figure 16. Switching Time Waveform

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