

April 1998

## 60V, 10A Half Bridge Power MOSFET Array

### Features

- Two 10A Power MOS N-Channel Transistors
- Output Voltage to 60V
- $r_{DS(ON)}$  . . . . . 0.135Ω Max Per Transistor at  $V_{GS} = 15V$
- $r_{DS(ON)}$  . . . . . 0.15Ω Max Per Transistor at  $V_{GS} = 10V$
- Pulsed Current . . . . . 25A Each Transistor
- Avalanche Energy . . . . . 100mJ Each Transistor
- Grounded Tab Eliminates Heat Sink Isolation

### Ordering Information

PART NUMBER	TEMP. RANGE (°C)	PACKAGE	PKG. NO.
HIP2060AS1	-40 to 125	5 Ld SIP	Z5.067C
HIP2060AS2	-40 to 125	5 Ld Gullwing SIP	Z5.067A
HIP2060AS3	-40 to 125	5 Ld SIP	Z5.067B

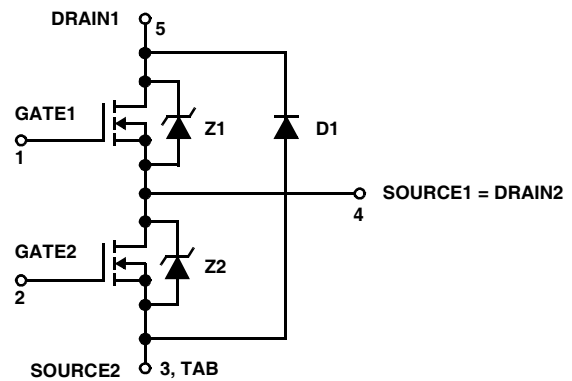
NOTE: When ordering use the entire part number.

### Description

The HIP2060 is a power half-bridge MOSFET array that consists of two matched N-Channel enhancement-mode MOS transistors. The advanced Intersil PASIC2 process technology used in this product utilizes efficient geometries that provides outstanding device performance and ruggedness.

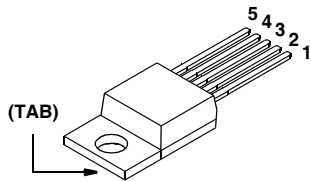
The HIP2060 is designed to integrate two power devices in one chip thus providing board layout area and heat sink savings for applications such as Motor Controls, Uninterruptable Power Supplies, Switch Mode Power Supplies, Voice Coil Motors, and Class D Power Amplifier.

### Symbol

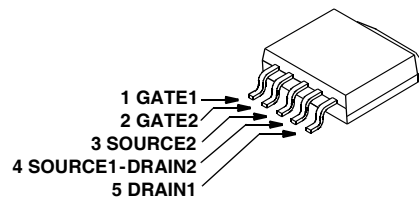


### Packages

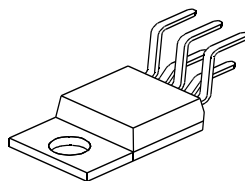
JEDEC TS-001AA (ALTERNATE VERSION)  
HIP2060 AS1



JEDEC MO-169  
HIP2060 AS2



Z5.067B (SIP)  
HIP2060 AS3



# HIP2060

## Absolute Maximum Ratings $T_C = 25^\circ\text{C}$ , Unless Otherwise Specified

	HIP2060	UNITS
Continuous Drain-Source Voltage Over Operating Junction and Case Temperature Range . . . . .	60	V
Drain-Gate Voltage . . . . .	60	V
Gate-Source Voltage . . . . .	$\pm 20$	V
Continuous Source-Drain Diode Current (Note 2) . . . . .	10	A
Pulsed Drain Current, each Output, all Outputs on (Notes 1, 2) . . . . .	25	A
Continuous Drain Current, each Output, all Outputs on (Note 2) . . . . .	10	A
Single Pulse Avalanche Energy (Note 3) Refer to UIS Curve . . . . .	100	mJ
Continuous Power Dissipation at $T_C = 25^\circ\text{C}$ (Infinite Heatsink) . . . . .	46	W
Continuous Power Dissipation, Derate above $T_C = 25^\circ\text{C}$ . . . . .	0.37	W/ $^\circ\text{C}$
Thermal Information . . . . .	60	$^\circ\text{C}/\text{W}$
Operating Case Temperature Range . . . . .	-40 to 125	$^\circ\text{C}$
Junction and Storage Temperature Range . . . . .	-40 to 150	$^\circ\text{C}$
Lead Temperature (For Soldering, 10s)(Lead Tips Only) . . . . .	300	$^\circ\text{C}$
Continuous Drain1-Source2 Voltage Over Operating Junction Temperature Range . . . . .	60	V

### NOTES:

1. Pulse width limited by maximum junction temperature.
2. Drain current limited by package construction.
3.  $V_{DD} = 25\text{V}$ , Start  $T_J = 25^\circ\text{C}$ ,  $L = 1.5\text{mH}$ ,  $R_{GS} = 50\Omega$ ,  $R = 0$ . See Figures 2, 12, and 13.

## Electrical Specifications $T_C = 25^\circ\text{C}$ , Unless Otherwise Specified

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNITS	
Drain-Source Breakdown Voltage	BV <sub>DSS</sub>	I <sub>D</sub> = 100 $\mu$ A, V <sub>GS</sub> = 0V	T <sub>C</sub> = -40 $^\circ\text{C}$ to 125 $^\circ\text{C}$	60	-	-	V
			T <sub>C</sub> = 25 $^\circ\text{C}$	-	70	-	V
Gate Threshold Voltage	V <sub>GS(TH)</sub>	V <sub>GS</sub> = V <sub>DS</sub> , I <sub>D</sub> = 250 $\mu$ A	1.5	2.3	2.7	V	
Drain1-Source2 Breakdown Voltage (Across D1)	BV <sub>D1S2</sub>	I <sub>D1S2</sub> = 1 $\mu$ A, V <sub>G1S1</sub> , V <sub>G2S2</sub> = 0V	-	105	-	V	
Zero Gate Voltage Drain Current	I <sub>DSS</sub>	V <sub>DS</sub> = 60V V <sub>GS</sub> = 0V	-	-	1	$\mu$ A	
Drain1-Source2 Current (Through D1)	I <sub>D1S2</sub>	V <sub>D1S2</sub> = 60V V <sub>G1S1</sub> = 0V, V <sub>G2S2</sub> = 0V	T <sub>C</sub> = 25 $^\circ\text{C}$	-	0.3	1	$\mu$ A
			T <sub>C</sub> = 125 $^\circ\text{C}$	-	1	-	$\mu$ A
Drain-Source On-State Voltage (Note 4)	V <sub>DS(ON)</sub>	I <sub>D</sub> = 10A, V <sub>GS</sub> = 15V	-	0.9	1.25	V	
		I <sub>D</sub> = 10A, V <sub>GS</sub> = 10V	-	1.1	1.5	V	
Forward Gate Current, Drain Short Circuited to Source	I <sub>GSSF</sub>	V <sub>DS</sub> = 0V, V <sub>GS</sub> = 20V	-	-	100	nA	
Reverse Gate Current, Drain Short Circuited to Source	I <sub>GSSR</sub>	V <sub>DS</sub> = 0V, V <sub>GS</sub> = -20V	-	-	-100	nA	
Drain-Source On Resistance (Note 4)	r <sub>DS(ON)</sub>	V <sub>GS</sub> = 15V, I <sub>D</sub> = 10A	T <sub>C</sub> = 25 $^\circ\text{C}$	-	0.09	0.135	$\Omega$
		V <sub>GS</sub> = 15V, I <sub>D</sub> = 10A	T <sub>C</sub> = 125 $^\circ\text{C}$	-	0.15	0.21	$\Omega$
		V <sub>GS</sub> = 10V, I <sub>D</sub> = 10A	T <sub>C</sub> = 25 $^\circ\text{C}$	-	0.11	0.15	$\Omega$
		V <sub>GS</sub> = 10V, I <sub>D</sub> = 10A	T <sub>C</sub> = 125 $^\circ\text{C}$	-	0.19	0.25	$\Omega$
Forward Transconductance (Note 4)	g <sub>fs</sub>	V <sub>DS</sub> = 15V, I <sub>D</sub> = 5A	-	4.5	-	S	

# HIP2060

## Electrical Specifications $T_C = 25^\circ\text{C}$ , Unless Otherwise Specified (Continued)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Turn-On Delay Time (Note 5)	$t_{d(ON)}$	$V_{DD} = 30\text{V}$ , $R_L = 3\Omega$ $I_D = 10\text{A}$ , $V_{GS} = 10\text{V}$ , $R_G = 50\Omega$ See Figure 14	-	4	-	ns
Rise Time (Note 5)	$t_r$		-	5	-	ns
Turn-Off Delay Time (Note 5)	$t_{d(OFF)}$		-	12	-	ns
Fall Time (Note 5)	$t_f$		-	6	-	ns
Total Gate Charge (Note 5)	$Q_{g(TOT)}$	$V_{DS} = 50\text{V}$ , $V_{GS} = 10\text{V}$ , $I_D = 10\text{A}$ See Figures 16 and 17	-	10.5	12.0	nC
Gate-Source Charge (Note 5)	$Q_{gs}$		-	1.4	2.0	nC
Gate-Drain Charge (Note 5)	$Q_{gd}$		-	4.9	5.5	nC
Short-Circuit Input Capacitance, Common Source	$C_{ISS}$	$V_{DS} = 25\text{V}$ , $V_{GS} = 0\text{V}$ , $f = 1\text{MHz}$	-	230	-	pF
Short-Circuit Output Capacitance, Common Source for Upper FET	$C_{OSS(U)}$		-	150	-	pF
Short Circuit Output Capacitance Common Source for Lower FET	$C_{OSS(L)}$		-	225	-	pF
Short-Circuit Reverse Transfer Capacitance, Common Source	$C_{RSS}$		-	40	-	pF
Thermal Resistance Junction to Case	$R_{\theta JC}$		-	-	2.7	$^\circ\text{C/W}$
Thermal Resistance Junction to Ambient	$R_{\theta JA}$		-	-	60	$^\circ\text{C/W}$

## Source-Drain Diode Specifications

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNITS
<b>SOURCE-TO-DRAIN DIODE SPECIFICATIONS</b> (Across Z1 and Z2)						
Forward Voltage (Note 4)	$V_{SD}$	$I_{SD} = 10\text{A}$ , $V_{GS} = 0\text{V}$	-	1.05	1.25	V
Reverse Recovery Time (Across Z1)	$t_{rr(S1-D1)}$	$I_{SD} = 10\text{A}$ , $dI_{SD}/dt = 100\text{A}/\mu\text{s}$	-	50	-	ns
Reverse Recovery Time (Across Z2)	$t_{rr(S2-D2)}$	$I_{SD} = 10\text{A}$ , $dI_{SD}/dt = 100\text{A}/\mu\text{s}$	-	75	-	ns
<b>SOURCE2-TO-DRAIN1 DIODE SPECIFICATIONS D</b> (Across D1)						
Forward Voltage (Note 4)	$V_{SD}$	$I_{SD} = 10\text{A}$ , $V_{GS} = 0\text{V}$	-	8.5	9.5	V
Reverse Recovery Time	$t_{rr}$	$I_{SD} = 10\text{A}$ , $dI_{SD}/dt = 100\text{A}/\mu\text{s}$	-	200	-	ns
<b>DEVICE MATCHING</b>						
Drain-Source On Resistance Match	$r_{DS(ON)M}$	$V_{GS} = 10\text{V}$ , $I_D = 10\text{A}$ , $T_C = 25^\circ\text{C}$	-	90	-	%

### NOTES:

4. Pulse test: Pulse Width  $\leq 300\mu\text{s}$ , Duty Cycle  $\leq 2\%$ .
5. Independent of operating temperature.

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Typical Performance Curves

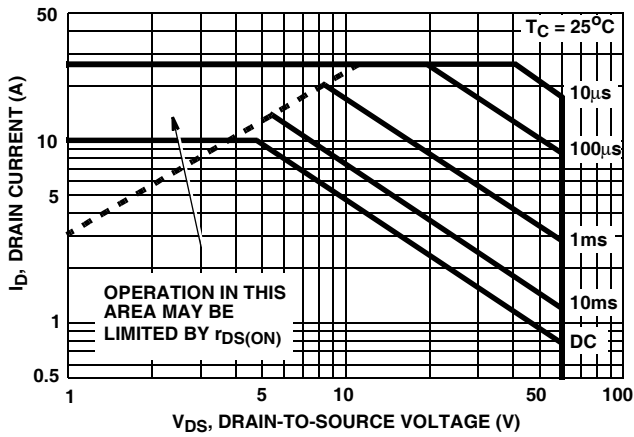


FIGURE 1. SAFE-OPERATING AREA CURVE

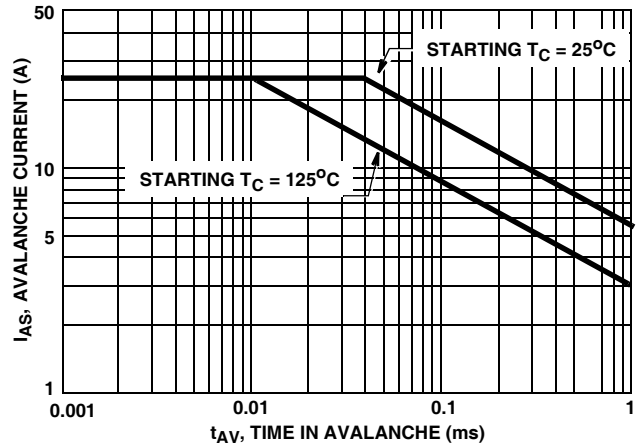


FIGURE 2. UNCLAMPED INDUCTIVE-SWITCHING

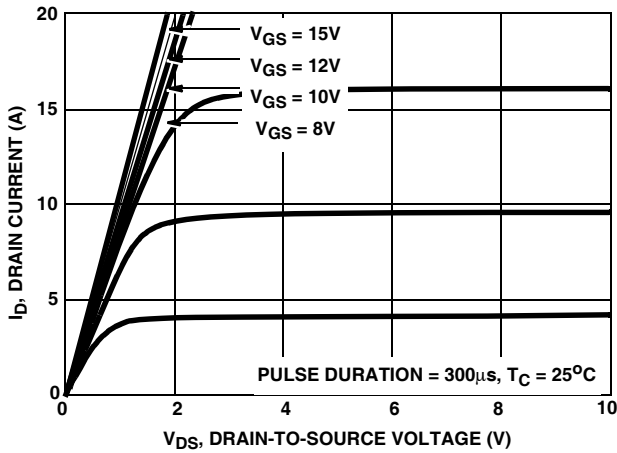


FIGURE 3. SATURATION CHARACTERISTICS

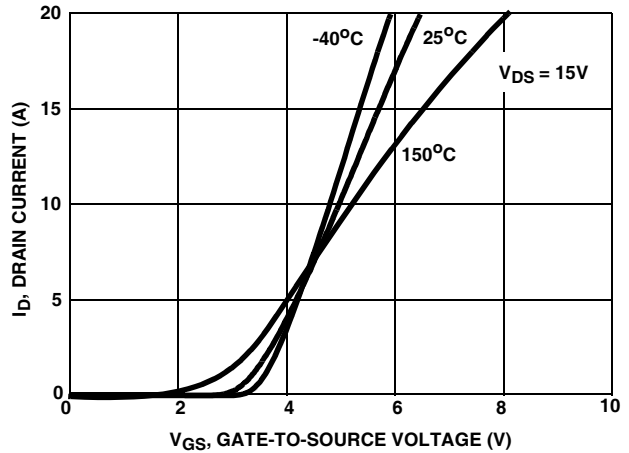


FIGURE 4. TRANSFER CHARACTERISTICS

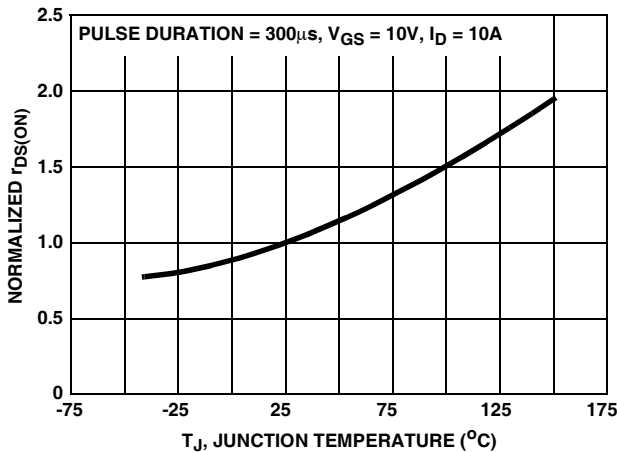


FIGURE 5. NORMALIZED  $r_{DS(ON)}$  vs JUNCTION TEMPERATURE

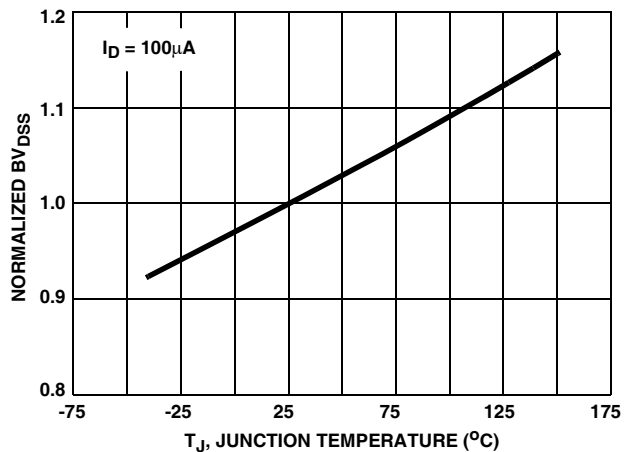


FIGURE 6. NORMALIZED  $BV_{DSS}$  vs JUNCTION TEMPERATURE

Typical Performance Curves (Continued)

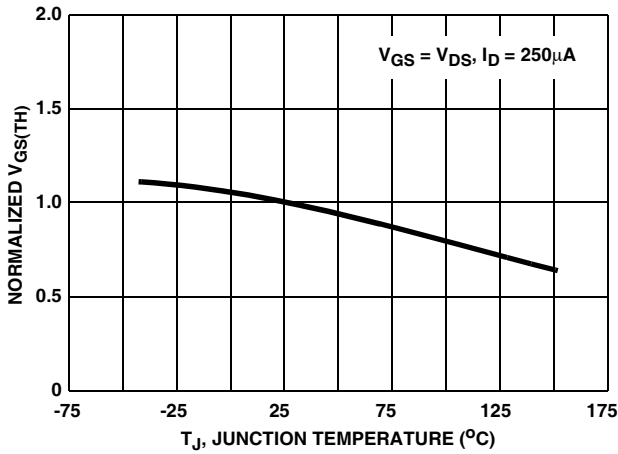


FIGURE 7. NORMALIZED  $V_{GS(TH)}$  vs JUNCTION TEMPERATURE

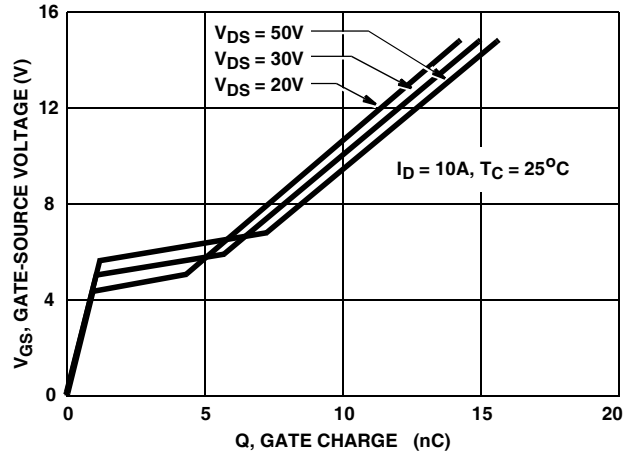


FIGURE 8. GATE-SOURCE VOLTAGE vs GATE CHARGE

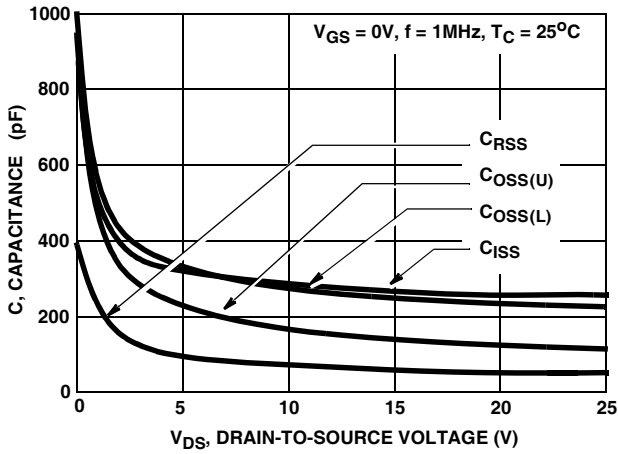


FIGURE 9. CAPACITANCE vs VOLTAGE

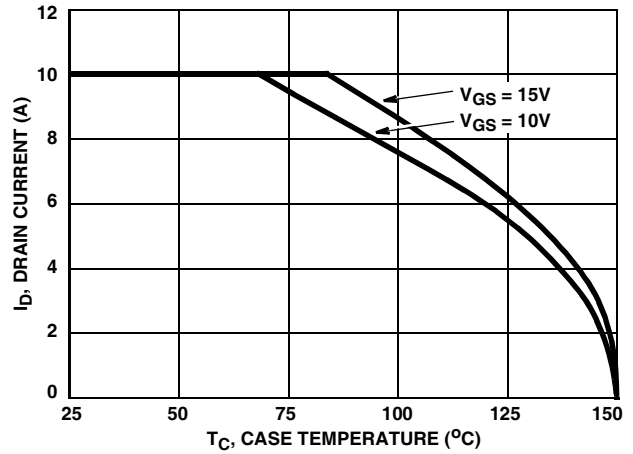


FIGURE 10. MAXIMUM CONTINUOUS DRAIN CURRENT vs CASE TEMPERATURE

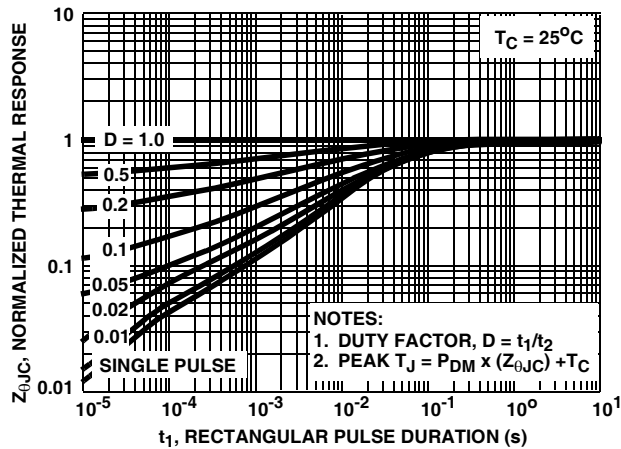


FIGURE 11. NORMALIZED MAXIMUM TRANSIENT THERMAL IMPEDANCE

Test Circuits and Waveforms

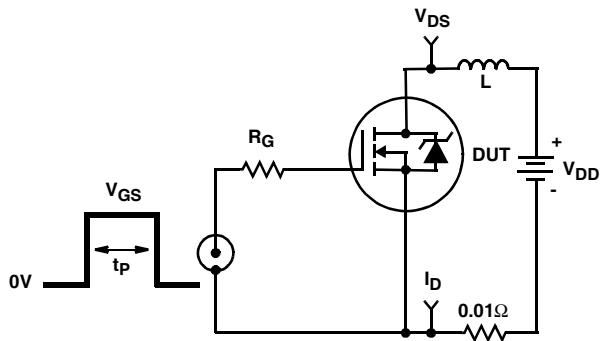


FIGURE 12. UNCLAMPED ENERGY TEST CIRCUIT

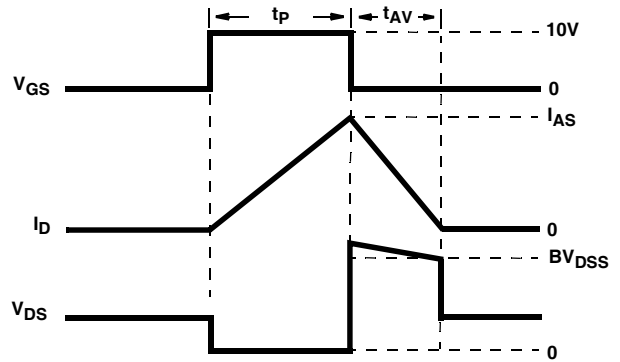


FIGURE 13. UNCLAMPED ENERGY WAVEFORMS

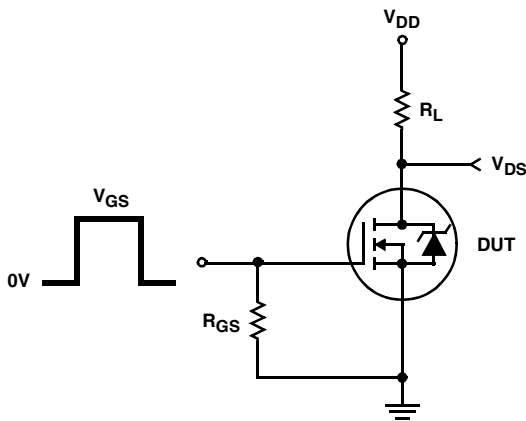


FIGURE 14. RESISTIVE SWITCHING TEST CIRCUIT

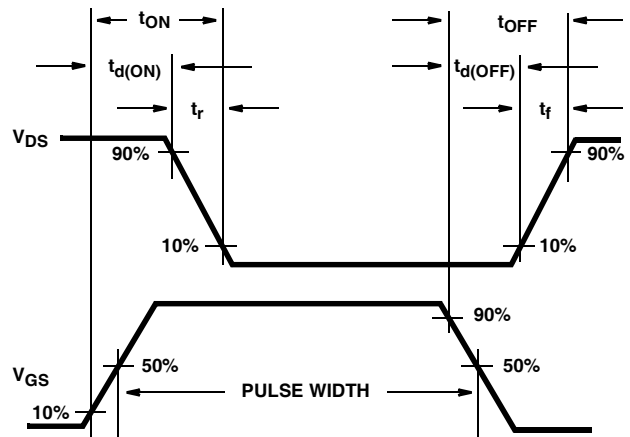


FIGURE 15. RESISTIVE SWITCHING WAVEFORMS

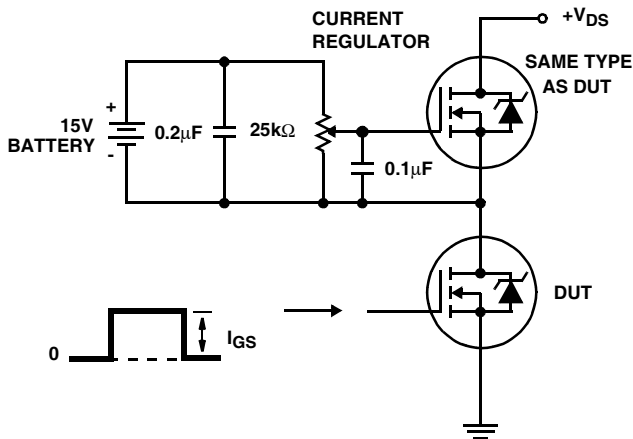


FIGURE 16. GATE CHARGE TEST CIRCUIT

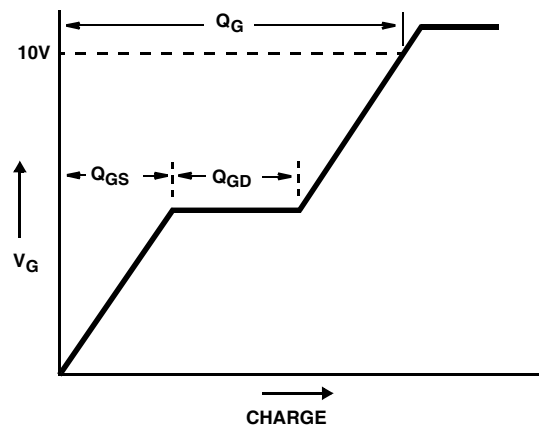


FIGURE 17. BASIC GATE CHARGE WAVEFORM

# HIP2060

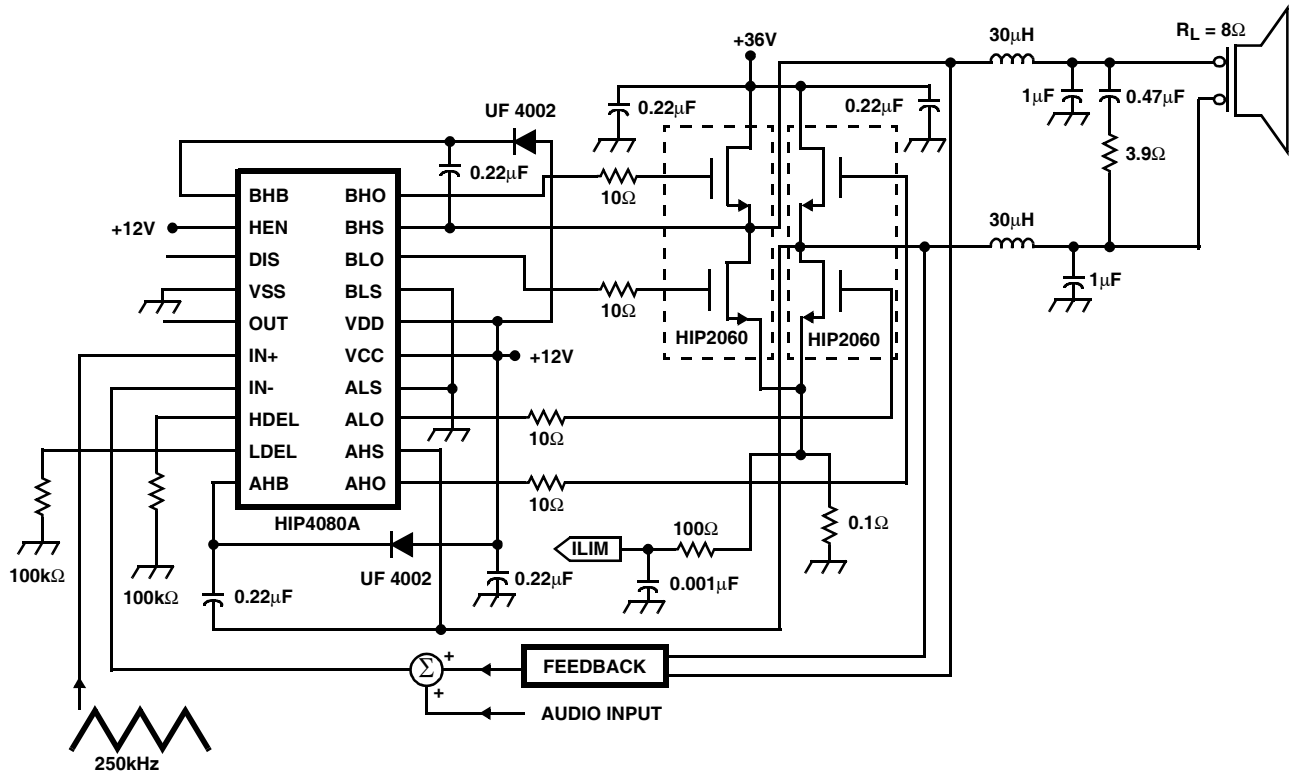


FIGURE 18. 70W SWITCHING AUDIO AMPLIFIER APPLICATION CIRCUIT

## Device Model Netlist for HIP2060 Half Bridge Power MOSFET Array

```
.SUBCKT HIP2060 1 2 3 4 5
X1 6 1 7 3 HIP2060_1
LS1 5 6 7.5n
X2 7 2 8 3 HIP2060_1
LS2 7 4 7.5n
LS3 8 3 7.5n
.ENDS

.SUBCKT HIP2060_1 3 2 11 9
MOS1 4 2 1 1 NMOS1
JFET 10 1 4 J1
D1 5 6 D1
DBODY 1 10 D2
DBREAK 10 7 D3
DSUB 9 3 D4
VBREAK 7 1 DC 90
C21 2 1 850P
C23 2 10 50P
C24 2 4 1350P
RDRAIN 3 10 1.5e-03
RSOURCE 1 11 17.5e-03
FDSCHRG 4 2 VMEAS 1.0
E41 5 11 4 1 1.0
VPINCH 6 8 DC 10.0
VMEAS 8 11 DC 0.0
.MODEL NMOS1 NMOS LEVEL=3 (VTO=2.75 TOX=5e-08 KP=3.150e-03 PHI=0.65 GAMMA=2.55
+ VMAX=6.42e+07 NSUB=4.33e+16 THETA=0.60973 ETA=0.0015 KAPPA=1.275 L=1u W=5950u)
.MODEL J1 NJF (VTO=-15.0 BETA=10.736 LAMBDA=1.15e-02 P1.MODEL D1 D (IS=1.0e-15 N=0.03 RS=1.0)
.MODEL D2 D (IS=3.0e-13 RS=2.5e-03 TT=20N CJO=350e-12)
.MODEL D3 D (IS=1.0e-13 N=1.0 RS=2.0)
.MODEL D4 D (IS=1.0e-13 RS=2.0e-03 CJO=197e-12)
.ENDS
```

NOTE: For further discussion of the PSPICE PowerFET Macromodel consult "Spicing-up SPICE II Software for Power MOSFET Modeling", Intersil Application Note AN8610.