



# H02N60 Series

N-Channel Power Field Effect Transistor

## Description

This high voltage MOSFET uses an advanced termination scheme to provide enhanced voltage-blocking capability without degrading performance over time. In addition, this advanced MOSFET is designed to withstand high energy in avalanche and commutation modes. The new energy efficient design also offers a drain-to-source diode with a fast recovery time. Designed for high voltage, high speed switching applications in power supplies, converters and PWM motor controls, these devices are particularly well suited for bridge circuits where diode speed and commutating safe operating areas are critical and offer additional and safety margin against unexpected voltage transients.

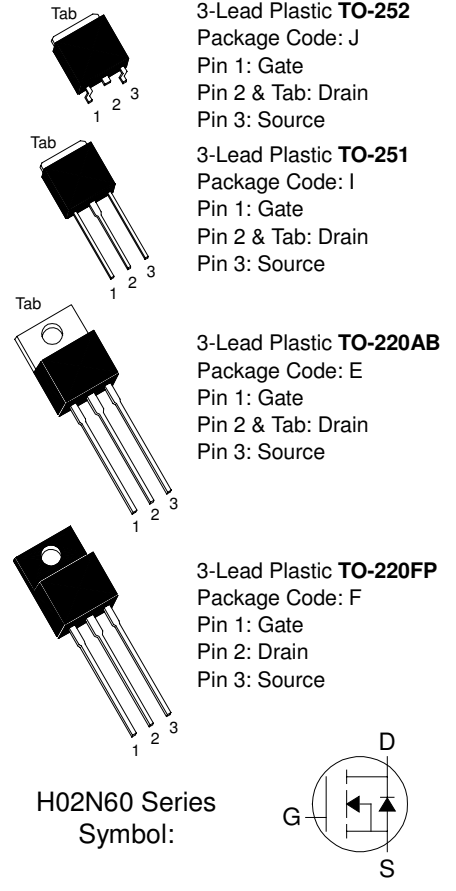
## Features

- Robust High Voltage Termination
- Avalanche Energy Specified
- Source-to-Drain Diode Recovery Time Comparable to a Discrete Fast Recovery Diode
- Diode is Characterized for Use in Bridge Circuits
- $I_{DSS}$  and  $V_{DS(on)}$  Specified at Elevated Temperature

## Absolute Maximum Ratings

Symbol	Parameter	Value	Units
$I_D$	Drain to Current (Continuous)	2	A
$I_{DM}$	Drain to Current (Pulsed)	8	A
$V_{GS}$	Gate-to-Source Voltage (Continue)	$\pm 30$	V
$P_D$	Total Power Dissipation ( $T_C=25^\circ\text{C}$ )		
	H02N60I (TO-251) / H02N60J (TO-252)	50	W
	H02N60E (TO-220AB)	50	
	H02N60F (TO-220FP)	25	
$P_D$	Derate above $25^\circ\text{C}$		
	H02N60I (TO-251) / H02N60J (TO-252)	0.4	$\text{W}/^\circ\text{C}$
	H02N60E (TO-220AB)	0.4	
	H02N60F (TO-220FP)	0.33	
$T_j, T_{stg}$	Operating and Storage Temperature Range	-55 to 150	$^\circ\text{C}$
$E_{AS}$	Single Pulse Drain-to-Source Avalanche Energy- $T_j=25^\circ\text{C}$ ( $V_{DD}=100\text{V}$ , $V_{GS}=10\text{V}$ , $I_L=2\text{A}$ , $L=10\text{mH}$ , $R_G=25\Omega$ )	35	mJ
$T_L$	Maximum Lead Temperature for Soldering Purposes, 1/8" from case for 10 seconds	260	$^\circ\text{C}$

### H02N60 Series Pin Assignment





### Thermal Characteristics

Symbol	Parameter	Value		Units
$R_{\theta JC}$	Thermal Resistance Junction to Case Max.	TO-251 / TO-252	2	°C/W
		TO-220AB	2	
		TO-220FP	3.3	
$R_{\theta JA}$	Thermal Resistance Junction to Ambient Max.	62.5		°C/W

### Electrical Characteristics (T<sub>J</sub>=25°C, unless otherwise specified)

Symbol	Characteristic	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-Source Breakdown Voltage ( $V_{GS}=0V, I_D=250\mu A$ )	600	-	-	V
$I_{DSS}$	Drain-Source Leakage Current ( $V_{DS}=600V, V_{GS}=0V$ )	-	-	1	$\mu A$
	Drain-Source Leakage Current ( $V_{DS}=480V, V_{GS}=0V, T_J=125^\circ C$ )	-	-	50	$\mu A$
$I_{GSSF}$	Gate-Source Leakage Current-Forward ( $V_{gsf}=30V, V_{DS}=0V$ )	-	-	100	nA
$I_{GSSR}$	Gate-Source Leakage Current-Reverse ( $V_{gsr}=-30V, V_{DS}=0V$ )	-	-	-100	nA
$V_{GS(th)}$	Gate Threshold Voltage ( $V_{DS}=V_{GS}, I_D=250\mu A$ )	2	-	4	V
$R_{DS(on)}$	Static Drain-Source On-Resistance ( $V_{GS}=10V, I_D=1A$ )*	-	-	4.4	$\Omega$
$g_{FS}$	Forward Transconductance ( $V_{DS}\geq 50V, I_D=1A$ )*	1	-	-	mhos
$C_{iss}$	Input Capacitance	-	435	-	pF
$C_{oss}$	Output Capacitance	$V_{GS}=0V, V_{DS}=25V, f=1MHz$		-	
$C_{rss}$	Reverse Transfer Capacitance	-	9.2	-	
$t_{d(on)}$	Turn-on Delay Time	-	12	-	ns
$t_r$	Rise Time	$(V_{DD}=300V, I_D=2A, R_G=18\Omega, V_{GS}=10V)^*$		-	
$t_{d(off)}$	Turn-off Delay Time	-	30	-	
$t_f$	Fall Time	-	24	-	
$Q_g$	Total Gate Charge	-	13	22	nC
$Q_{gs}$	Gate-Source Charge	$(V_{DS}=300V, I_D=6A, V_{GS}=10V)^*$		-	
$Q_{gd}$	Gate-Drain Charge	-	6	-	
$L_D$	Internal Drain Inductance (Measured from the drain lead 0.25" from package to center of die)	-	4.5	-	nH
$L_S$	Internal Drain Inductance (Measured from the drain lead 0.25" from package to source bond pad)	-	7.5	-	nH

\*: Pulse Test: Pulse Width  $\leq 300\mu s$ , Duty Cycle  $\leq 2\%$

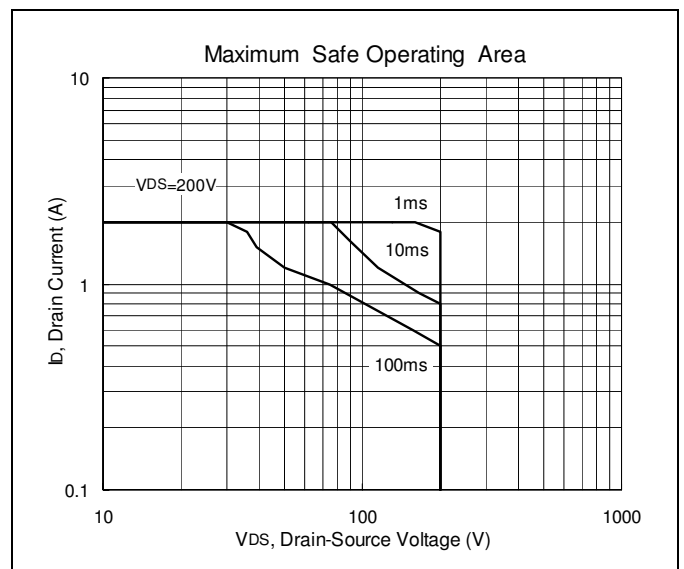
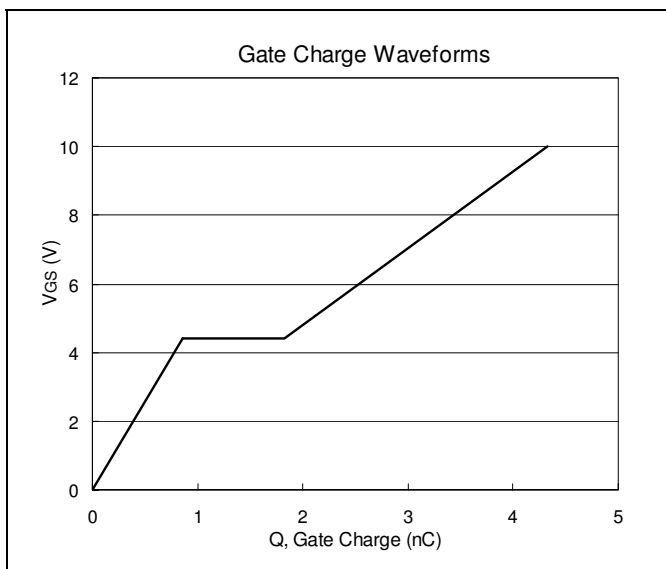
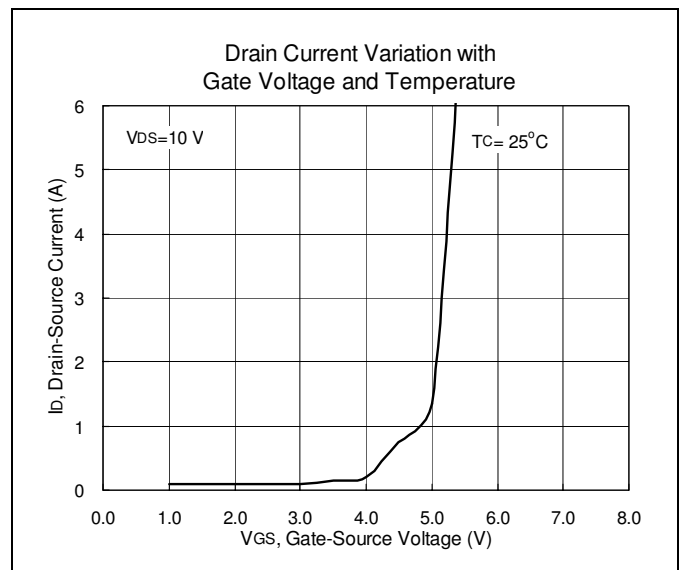
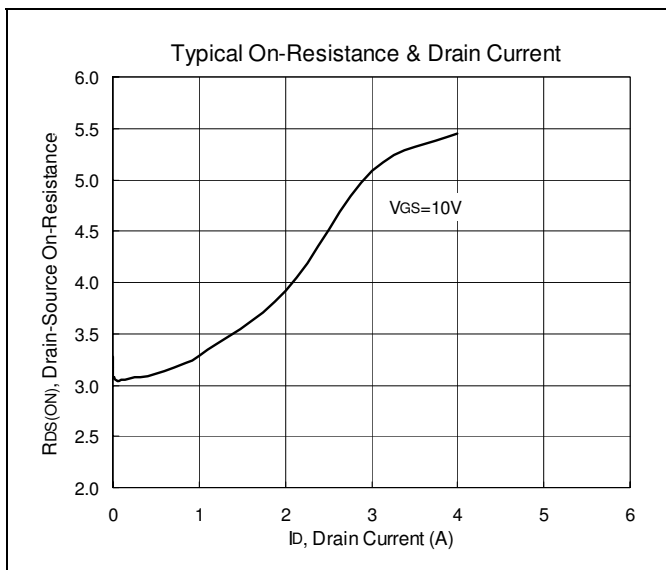
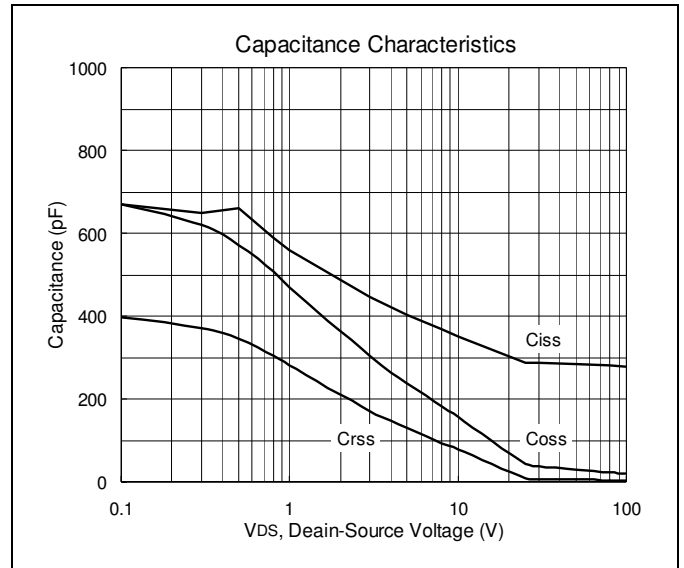
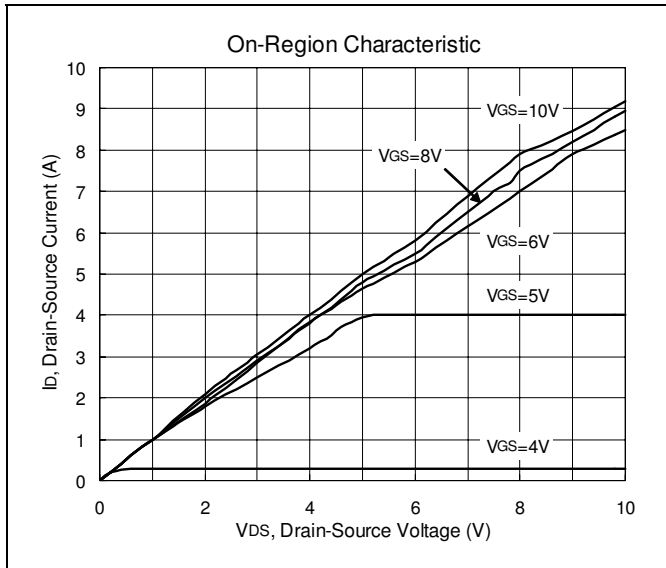
### Source-Drain Diode

Symbol	Characteristic		Min.	Typ.	Max.	Units
$V_{SD}$	Forward On Voltage(1)	$I_S=2A, V_{GS}=0V, T_J=25^\circ C$	-	-	1.6	V
$t_{on}$	Forward Turn-On Time	$I_S=2A, V_{GS}=0V, d_{IS}/d_t=100A/\mu s$	-	**	-	ns
$t_{rr}$	Reverse Recovery Time		-	340	-	ns

\*\* : Negligible, Dominated by circuit inductance



### Characteristics Curve





### TO-252 Dimension

3-Lead TO-252 Plastic  
Surface Mount Package  
HSMC Package Code: J

**Marking:**

Pb Free Mark  
 Pb-Free: "●" (Note)  
 Normal: None

Date Code      Control Code

Note: Green label is used for pb-free packing

Pin Style: 1.Gate 2.Drain 3.Source

**Material:**

- Lead solder plating: Sn60/Pb40 (Normal), Sn/3.0Ag/0.5Cu or Pure-Tin (Pb-free)
- Mold Compound: Epoxy resin family, flammability solid burning class: UL94V-0

DIM	Min.	Max.
A	6.35	6.80
C	4.80	5.50
F	1.30	1.70
G	5.40	6.25
H	2.20	3.00
L	0.40	0.90
M	2.20	2.40
N	0.90	1.50
a1	0.40	0.65
a2	-	*2.30
a5	0.65	1.05

\*: Typical, Unit: mm

3-Lead TO-252 Plastic  
Surface Mount Package  
HSMC Package Code: J

**Marking:**

Pb Free Mark  
 Pb-Free: "●" (Note)  
 Normal: None

Date Code      Control Code

Note: Green label is used for pb-free packing

Pin Style: 1.Gate 2.Drain 3.Source

**Material:**

- Lead solder plating: Sn60/Pb40 (Normal), Sn/3.0Ag/0.5Cu or Pure-Tin (Pb-free)
- Mold Compound: Epoxy resin family, flammability solid burning class: UL94V-0

DIM	Min.	Max.
A	6.40	6.80
B	-	6.00
C	5.04	5.64
D	-	*4.34
E	0.40	0.80
F	0.50	0.90
G	5.90	6.30
H	2.50	2.90
I	9.20	9.80
J	0.60	1.00
K	-	0.96
L	0.66	0.86
M	2.20	2.40
N	0.70	1.10
O	0.82	1.22
a1	0.40	0.60
a2	2.10	2.50
y1	-	5°
y2	-	3°

\*: Typical, Unit: mm



### TO-251 Dimension

**Marking:**

Pb Free Mark  
 Pb-Free: "●" (Note)  
 Normal: None

Date Code      Control Code

Note: Green label is used for pb-free packing

Pin Style: 1.Gate 2.Drain 3.Source

**Material:**

- Lead solder plating: Sn60/Pb40 (Normal), Sn/3.0Ag/0.5Cu or Pure-Tin (Pb-free)
- Mold Compound: Epoxy resin family, flammability solid burning class: UL94V-0

DIM	Min.	Max.
A	6.35	6.80
C	4.80	5.50
F	1.30	1.70
G	5.40	6.25
H1	6.75	8.00
K	0.50	0.90
K1	0.40	0.90
L	0.90	1.50
M	2.20	2.40
a1	0.40	0.65
a2	-	*2.30

\*: Typical, Unit: mm

**3-Lead TO-251  
Plastic Package  
HSMC Package Code: I**

**Marking:**

Pb Free Mark  
 Pb-Free: "●" (Note)  
 Normal: None

Date Code      Control Code

Note: Green label is used for pb-free packing

Pin Style: 1.Gate 2.Drain 3.Source

**Material:**

- Lead solder plating: Sn60/Pb40 (Normal), Sn/3.0Ag/0.5Cu or Pure-Tin (Pb-free)
- Mold Compound: Epoxy resin family, flammability solid burning class: UL94V-0

DIM	Min.	Max.
A	6.40	6.80
B	-	6.00
C	5.04	5.64
D	-	*4.34
E	0.40	0.80
F	0.50	0.90
G	5.90	6.30
H	-	*1.80
H1	-	*9.30
I	-	*16.10
J	-	*0.80
K	-	0.96
K1	-	*0.76
M	2.20	2.40
a1	0.40	0.60
a2	2.10	2.50
y1	-	5°
y2	-	3°

\*: Typical, Unit: mm

**3-Lead TO-251  
Plastic Package  
HSMC Package Code: I**



### TO-220AB Dimension

3-Lead TO-220AB  
Plastic Package  
HSMC Package Code: E

**Marking:**

Pb Free Mark  
Pb-Free: "●" (Note)  
Normal: None

Date Code      Control Code

Note: Green label is used for pb-free packing

Pin Style: 1.Gate 2 & Tab.Drain 3.Source

**Material:**

- Lead solder plating: Sn60/Pb40 (Normal), Sn/3.0Ag/0.5Cu or Pure-Tin (Pb-free)
- Mold Compound: Epoxy resin family, flammability solid burning class: UL94V-0

DIM	Min.	Max.
A	5.58	7.49
B	8.38	8.90
C	4.40	4.70
D	1.15	1.39
E	0.35	0.60
F	2.03	2.92
G	9.66	10.28
H	-	*16.25
I	-	*3.83
J	3.00	4.00
K	0.75	0.95
L	2.54	3.42
M	1.14	1.40
N	-	*2.54
O	12.70	14.27
P	14.48	15.87

\*: Typical, Unit: mm

### TO-220FP Dimension

3-Lead TO-220FP  
Plastic Package  
HSMC Package Code: F

**Marking:**

Pb Free Mark  
Pb-Free: "●" (Note)  
Normal: None

Date Code      Control Code

Note: Green label is used for pb-free packing

Pin Style: 1.Gate 2.Drain 3.Source

**Material:**

- Lead solder plating: Sn60/Pb40 (Normal), Sn/3.0Ag/0.5Cu or Pure-Tin (Pb-free)
- Mold Compound: Epoxy resin family, flammability solid burning class: UL94V-0

DIM	Min.	Max.
A	6.48	7.40
C	4.40	4.90
D	2.34	3.00
E	0.45	0.80
F	9.80	10.36
G	3.10	3.60
I	2.70	3.43
J	0.60	1.00
K	2.34	2.74
L	12.48	13.60
M	15.67	16.20
N	0.90	1.47
O	2.00	2.96
$\alpha 1/2/4/5$	-	*5°
$\alpha 3$	-	*27°

\*: Typical, Unit: mm

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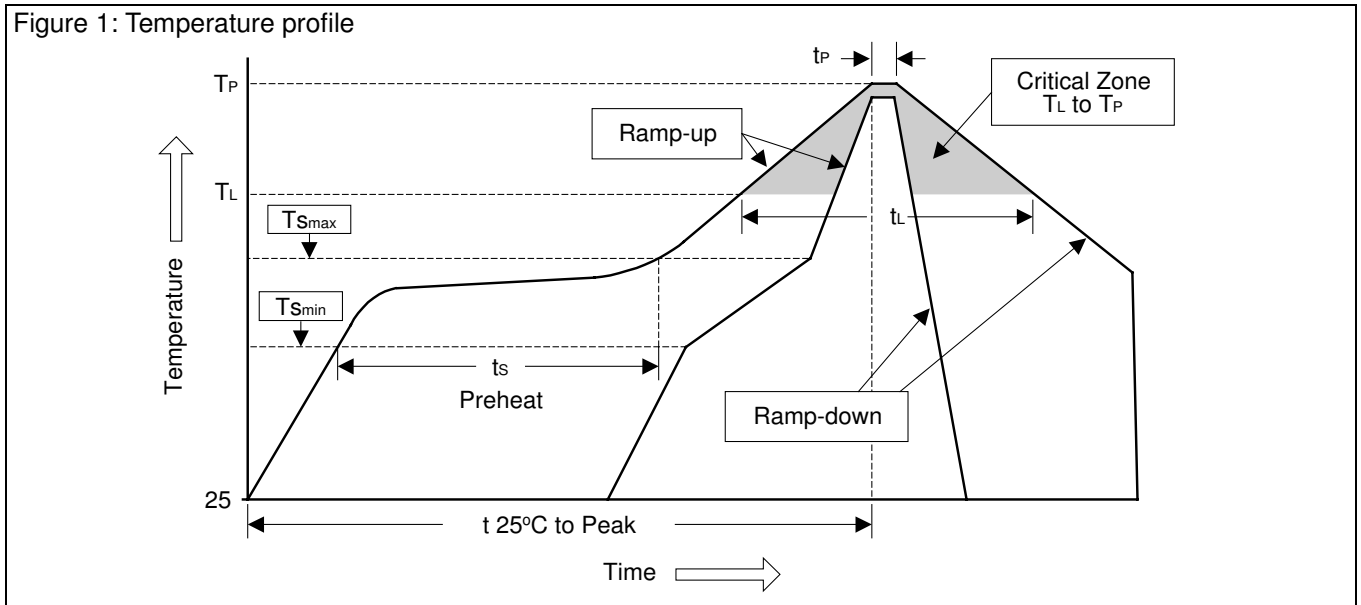
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### Soldering Methods for HSMC's Products

1. Storage environment: Temperature=10°C~35°C Humidity=65%±15%
2. Reflow soldering of surface-mount devices

Figure 1: Temperature profile



Profile Feature	Sn-Pb Eutectic Assembly	Pb-Free Assembly
Average ramp-up rate ( $T_L$ to $T_P$ )	<3°C/sec	<3°C/sec
Preheat		
- Temperature Min ( $T_{Smin}$ )	100°C	150°C
- Temperature Max ( $T_{Smax}$ )	150°C	200°C
- Time (min to max) ( $t_s$ )	60~120 sec	60~180 sec
$T_{Smax}$ to $T_L$		
- Ramp-up Rate	<3°C/sec	<3°C/sec
Time maintained above:		
- Temperature ( $T_L$ )	183°C	217°C
- Time ( $t_L$ )	60~150 sec	60~150 sec
Peak Temperature ( $T_P$ )	240°C +0/-5°C	260°C +0/-5°C
Time within 5°C of actual Peak Temperature ( $t_P$ )	10~30 sec	20~40 sec
Ramp-down Rate	<6°C/sec	<6°C/sec
Time 25°C to Peak Temperature	<6 minutes	<8 minutes

### 3. Flow (wave) soldering (solder dipping)

Products	Peak temperature	Dipping time
Pb devices.	245°C ±5°C	5sec ±1sec
Pb-Free devices.	260°C +0/-5°C	5sec ±1sec