



# H02N60S 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 ( $T_C=25^\circ\text{C}$ )   |            |                           |
|                | H02N60SI (TO-251) / H02N60SJ (TO-252)  | 50         | W                         |
|                | H02N60SE (TO-220AB)  | 50         |                           |
|                | H02N60SF (TO-220FP)  | 25         |                           |
| $P_D$          | Derate above $25^\circ\text{C}$  |            |                           |
|                | H02N60SI (TO-251) / H02N60SJ (TO-252)  | 0.4        | $\text{W}/^\circ\text{C}$ |
|                | H02N60SE (TO-220AB)  | 0.4        |                           |
|                | H02N60SF (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- $T_j=25^\circ\text{C}$<br>( $V_{DD}=100\text{V}$ , $V_{GS}=10\text{V}$ , $I_L=2\text{A}$ , $L=10\text{mH}$ , $R_G=25\Omega$ ) | 35         | mJ                        |
| $T_L$          | Maximum Lead Temperature for Soldering Purposes, 1/8" from case for 10 seconds   | 260        | $^\circ\text{C}$          |

**H02N60S Series Pin Assignment**

**3-Lead Plastic TO-252**  
 Package Code: J  
 Pin 1: Gate  
 Pin 2 & Tab: Drain  
 Pin 3: Source

**3-Lead Plastic TO-251**  
 Package Code: I  
 Pin 1: Gate  
 Pin 2 & Tab: Drain  
 Pin 3: Source

**3-Lead Plastic TO-220AB**  
 Package Code: E  
 Pin 1: Gate  
 Pin 2 & Tab: Drain  
 Pin 3: Source

**3-Lead Plastic TO-220FP**  
 Package Code: F  
 Pin 1: Gate  
 Pin 2: Drain  
 Pin 3: Source

**H02N60S Series Symbol:**



### 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 ( $V_{GS}=10V, I_D=1A$ )*                                    | -    | -    | 5    | $\Omega$ |
| $g_{FS}$      | Forward Transconductance ( $V_{DS}\geq 50V, I_D=1A$ )*   | 1    | -    | -    | mhos     |
| $C_{iss}$     | Input Capacitance  | -    | 435  | -    | pF       |
| $C_{oss}$     | Output Capacitance   | -    | 56   | -    |          |
| $C_{rss}$     | Reverse Transfer Capacitance   | -    | 9.2  | -    |          |
| $t_{d(on)}$   | Turn-on Delay Time   | -    | 12   | -    | ns       |
| $t_r$         | Rise Time  | -    | 21   | -    |          |
| $t_{d(off)}$  | Turn-off Delay Time  | -    | 30   | -    |          |
| $t_f$         | Fall Time  | -    | 24   | -    |          |
| $Q_g$         | Total Gate Charge  | -    | 13   | 22   | nC       |
| $Q_{gs}$      | Gate-Source Charge   | -    | 2    | -    |          |
| $Q_{gd}$      | 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



### 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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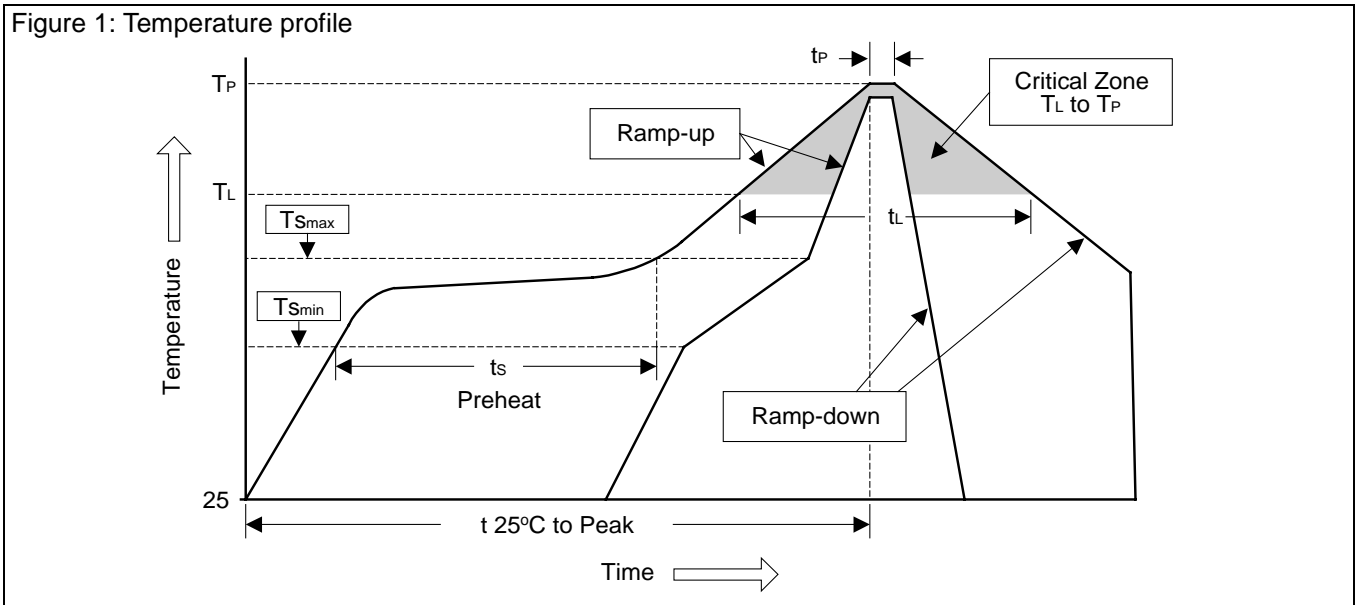
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### Soldering Methods for HSMC's Products

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



| 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   |