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# ICE7N60B N-Channel Enhancement Mode MOSFET

RoHS compliant 2011/65/EU

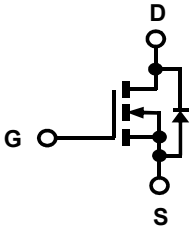
CE

HALOGEN FREE

| Product Summary | | | |
|---|---|---|---|
| $I_D$ | $T_A$=25°C | 7A | Max |
| $V_{(BR)DSS}$ | $I_D$=250uA | 600V | Min |
| $r_{DS(on)}$ | $V_{GS}$=10V | 0.57Ω | Typ |
| $Q_g$ | $V_{DS}$=480V | 23nC | Typ |

## Features

- Low $r_{DS(on)}$
- Ultra Low Gate Charge
- High d*v*/d*t* capability
- High Unclamped Inductive Switching (UIS) capability
- High peak current capability
- Increased transconductance performance
- Optimized design for high performance power systems





**T0263**

**Standard Metal Heatsink**

**1=Gate, 2=Drain, 3=Source.**

**ICEMOS AND ITS SISTER COMPANY 3D SEMI OWN THE FUNDAMENTAL PATENTS FOR SUPERJUNCTION MOSFETS. THE MAJORITY OF THESE PATENTS HAVE 17 to 20 YEARS OF REMAINING LIFE. THIS PORTFOLIO HAS GRANTED PATENTS ISSUED IN USA, CHINA, KOREA, JAPAN, TAIWAN & EUROPE.**

## *Maximum ratings* at $T_j$=25°C, unless otherwise specified

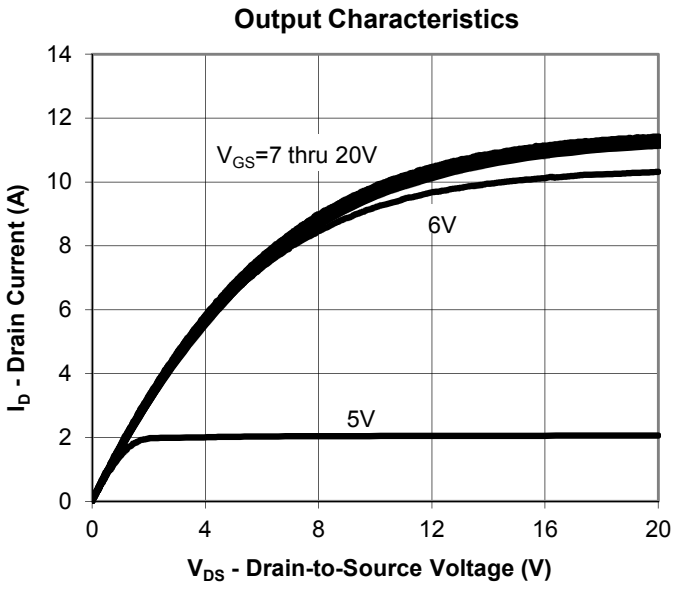
| *Parameter* | *Symbol* | *Conditions* | *Value* | *Unit* |
|---|---|---|---|---|
| Continuous drain current | $I_D$ | $T_c$=25°C<br>$T_c$=100°C | 7<br>4 | A |
| Pulsed drain current | $I_{D, pulse}$ | $T_c$=25°C | 21 | A |
| Avalanche energy, single pulse | $E_{AS}$ | $I_D$=3.5A | 170 | mJ |
| Avalanche current, repetitive | $I_{AR}$ | limited by $T_j$max | 3.5 | A |
| MOSFET d*v*/d*t* ruggedness | d*v*/d*t* | $V_{DS}$=480V, $I_D$=7A, $T_j$=125°C | 50 | V/ns |
| Gate source voltage | $V_{GS}$ | static | ±20 | V |
| | | AC (*f*>1Hz) | ±30 | |
| Power dissipation | $P_{tot}$ | $T_c$=25°C | 65 | W |
| Operating and storage temperature | $T_j$, $T_{stg}$ | | -55 to +150 | °C |

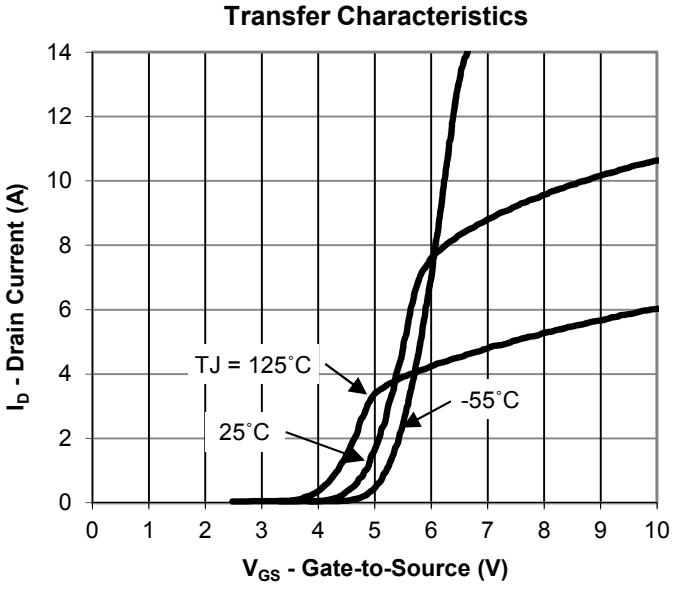
| Parameter | Symbol | Conditions | Values | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | |
| ***Thermal characteristics*** | | | | | | |
| Thermal resistance, junction-case [a] | $R_{thJC}$ | | - | - | 1.9 | °C/W |
| Thermal resistance, junction-ambient [a] | $R_{thJA}$ | leaded | - | - | 68 | |
| Soldering temperature, wave soldering only allowed at leads | $T_{sold}$ | 1.6mm (0.063in.) from case for 10 s | - | - | 260 | °C |

## ***Electrical characteristics*** at $T_j$=25°C, unless otherwise specified

| | | | | | | |
|---|---|---|---|---|---|---|
| ***Static characteristics*** | | | | | | |
| Drain-source breakdown voltage | $V_{(BR)DSS}$ | $V_{GS}$=0 V, $I_D$=250µA | 600 | - | - | V |
| Gate threshold voltage | $V_{GS(th)}$ | $V_{DS}$=$V_{GS}$, $I_D$=250µA | 2.1 | 3.3 | 3.9 | |
| Zero gate voltage drain current | $I_{DSS}$ | $V_{DS}$=600V, $V_{GS}$=0V, $T_j$=25°C | - | 0.09 | 1 | µA |
| | | $V_{DS}$=600V, $V_{GS}$=0V, $T_j$=150°C | - | 15 | - | |
| Gate source leakage current | $I_{GSS}$ | $V_{GS}$=±20 V, $V_{DS}$=0V | - | - | 100 | nA |
| Drain-source on-state resistance | $r_{DS(on)}$ | $V_{GS}$=10V, $I_D$=3.5A, $T_j$=25°C | - | 0. 57 | 0.60 | Ω |
| | | $V_{GS}$=10V, $I_D$=3.5A, $T_j$=150°C | - | 1.6 | - | |
| Gate resistance | $R_G$ | $f$=1 MHZ, open drain | - | 5.3 | - | Ω |
| ***Dynamic characteristics*** | | | | | | |
| Input capacitance | $C_{iss}$ | $V_{GS}$=0 V, $V_{DS}$=25 V, $f$=1 MHz | - | 623 | - | pF |
| Output capacitance | $C_{oss}$ | | - | 325 | - | |
| Reverse transfer capacitance | $C_{rss}$ | | - | 3 | - | |
| Transconductance | $g_{fs}$ | $V_{DS}$>2*$I_D$*$R_{DS}$, $I_D$=3.5A | - | 7 | - | S |
| Turn-on delay time | $t_{d(on)}$ | $V_{DS}$=380V, $V_{GS}$=10V, $I_D$=7A, $R_G$=4Ω (External) | - | 23 | - | ns |
| Rise time | $t_r$ | | - | 7.4 | - | |
| Turn-off delay time | $t_{d(off)}$ | | - | 50 | - | |
| Fall time | $t_f$ | | - | 8 | - | |

| Parameter | Symbol | Conditions | Values | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | |
| ***Gate charge characteristics*** | | | | | | |
| Gate to source charge | $Q_{gs}$ | $V_{DS}$=480 V, $I_D$=7A, $V_{GS}$=0 to 10 V | - | 4.2 | - | nC |
| Gate to drain charge | $Q_{gd}$ | | - | 9.0 | - | |
| Gate charge total | $Q_g$ | | - | 23 | - | |
| Gate plateau voltage | $V_{plateau}$ | | - | 5.8 | - | V |
| ***Reverse Diode*** | | | | | | |
| Continuous forward current | $I_S$ | $V_{GS}$=0V | - | - | 7 | A |
| Diode forward voltage | $V_{SD}$ | $V_{GS}$=0V, $I_S$=$I_F$ | - | 0.9 | 1.2 | V |
| Reverse recovery time | $t_{rr}$ | $V_{RR}$=100V, $I_S$=$I_F$, $d_{iF}/d_t$=100 A/µS | - | 231 | - | ns |
| Reverse recovery charge | $Q_{rr}$ | | - | 2.6 | - | µC |
| Peak reverse recovery current | $I_{rm}$ | | - | 22 | - | A |



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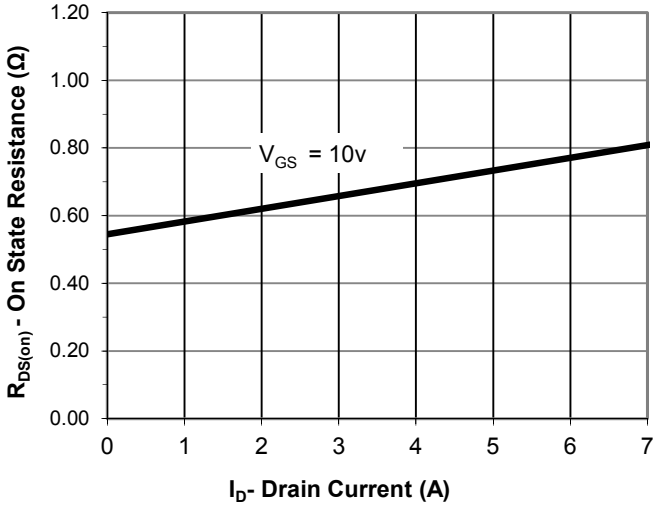
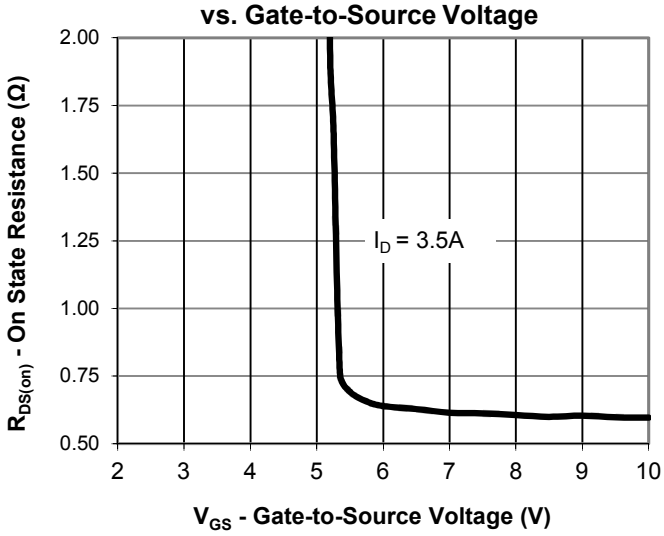
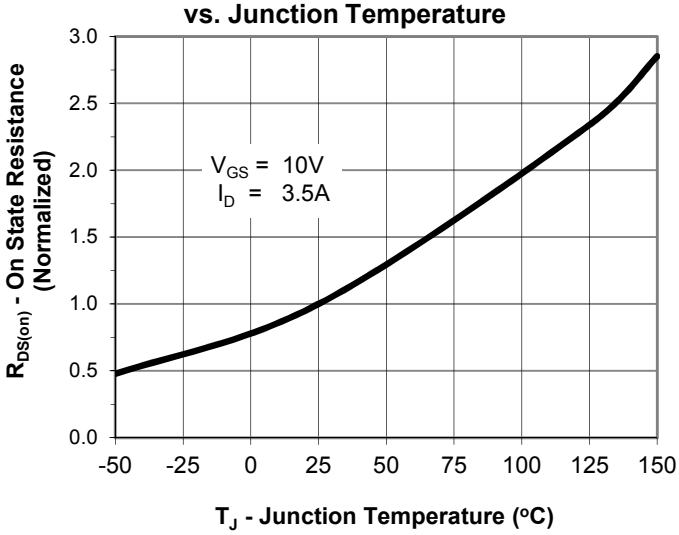
**Drain-Source On-State Resistance vs. Drain Current**



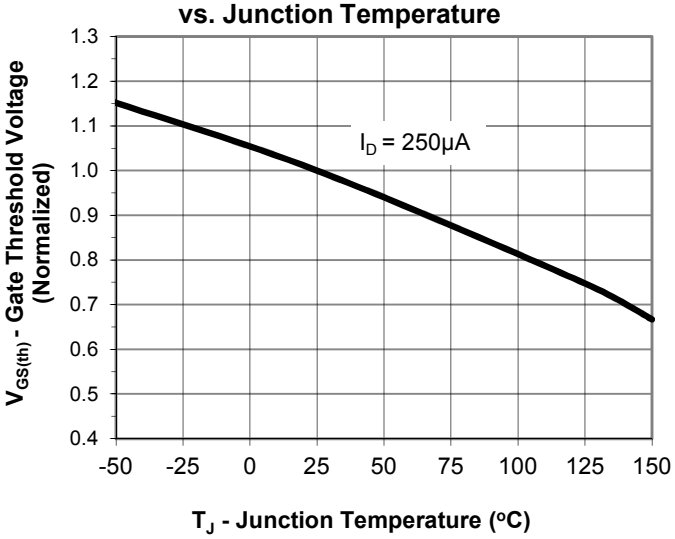

**Drain-Source On-State Resistance vs. Gate-to-Source Voltage**



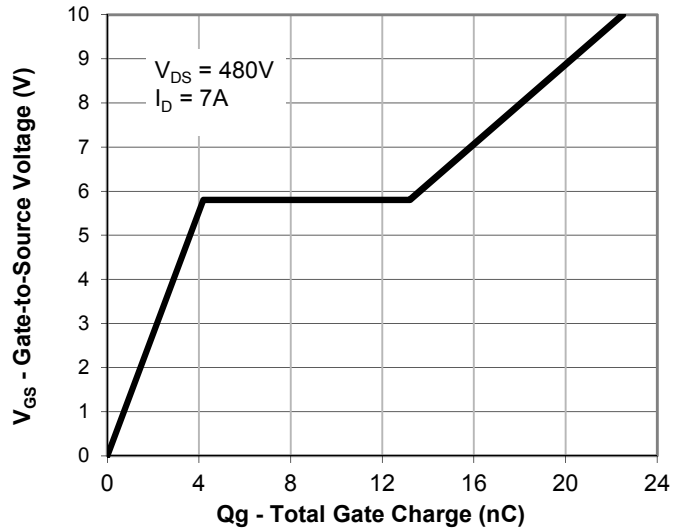

**Drian-Source On State Resistance vs. Junction Temperature**



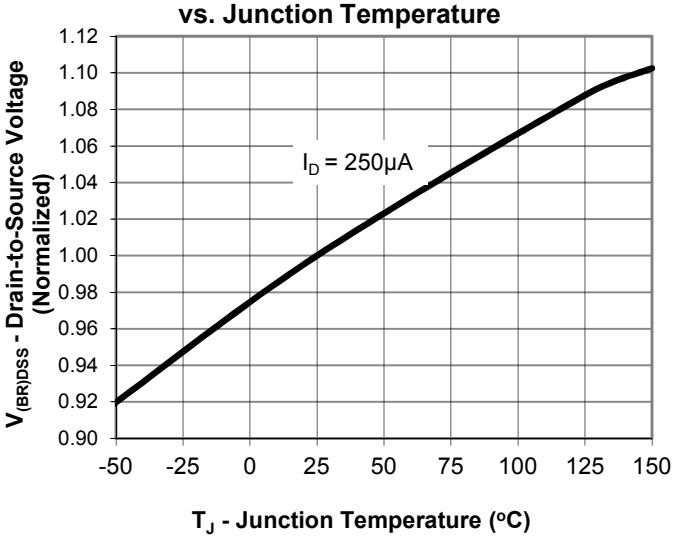

**Gate Threshold Voltage vs. Junction Temperature**




**Gate Charge**




**Drain-toSource Breakdown Voltage vs. Junction Temperature**



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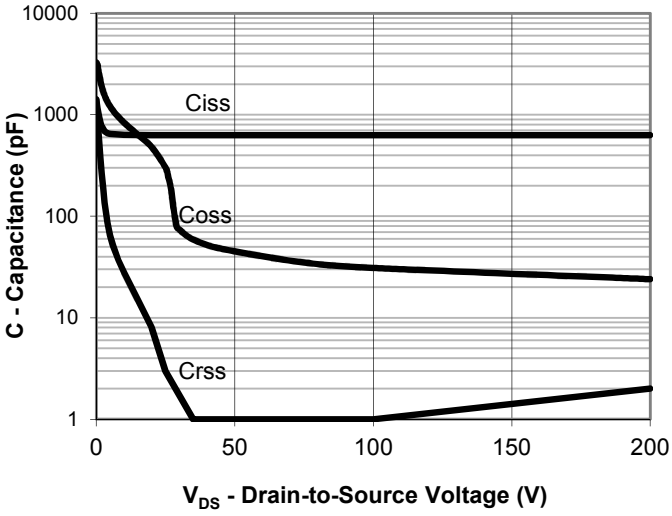
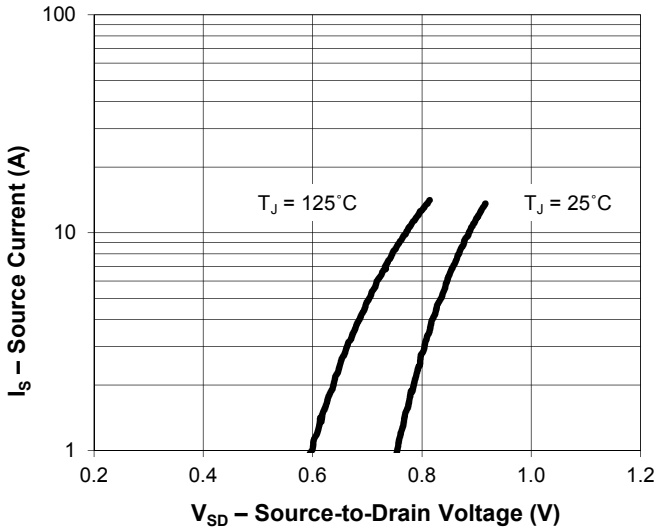
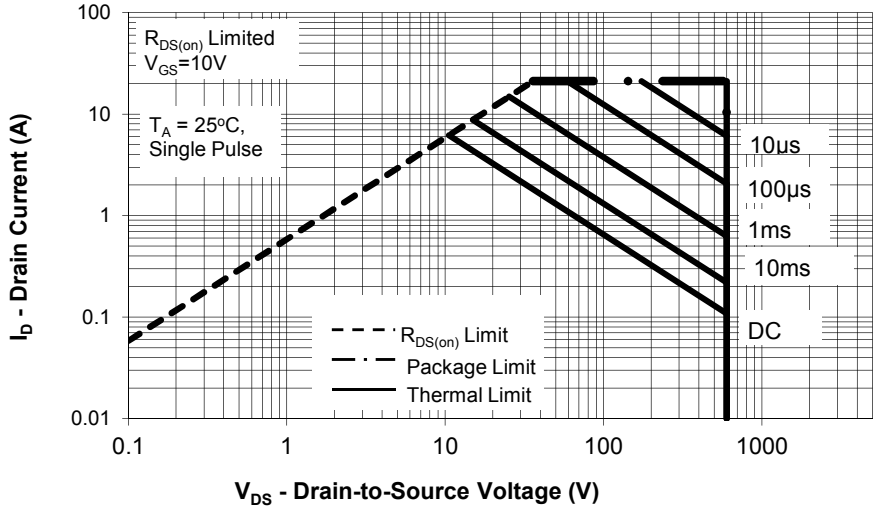
### Capacitance



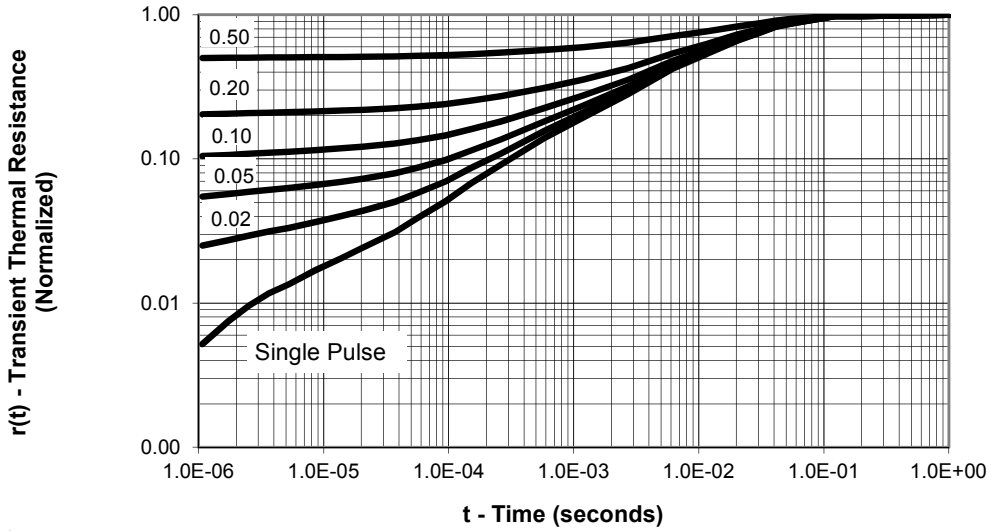

### Source-Drain Diode Forward Voltage

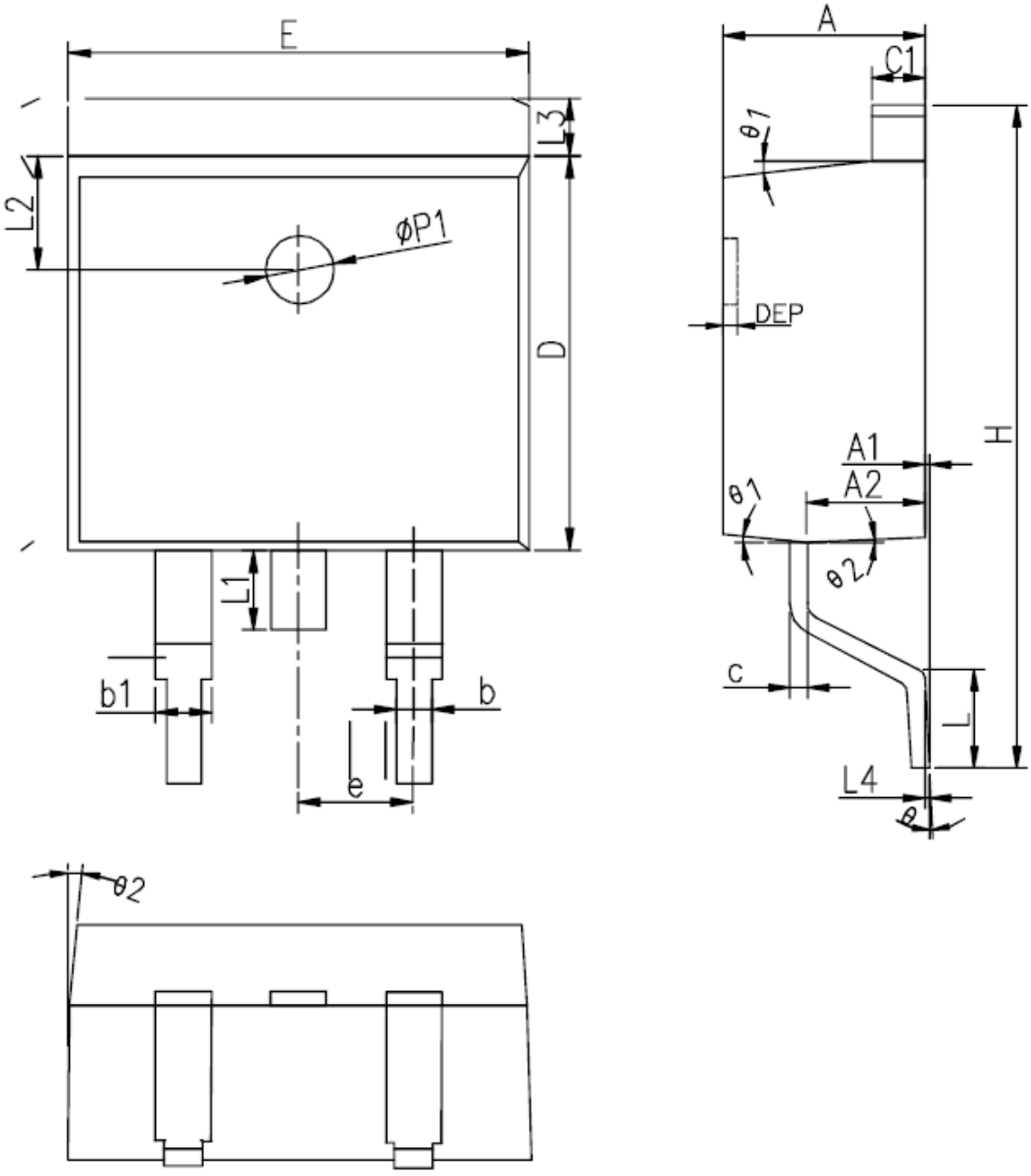



### Maximum Rated Forward Biased Safe Operating Area




### Transient Thermal Response, Junction-to-Ambient




E
L3
L2
ØP1
D
L1
b1
b
e
θ2
A
C1
θ1
DEP
H
A1
A2
θ1
θ2
c
L
L4
θ

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# COMMON DIMENSIONS

| SYMBOL | MM | | | INCH | | |
|---|---|---|---|---|---|---|
| | MIN | NOM | MAX | MIN | NOM | MAX |
| A | 4.40 | 4.57 | 4.70 | 0.173 | 0.180 | 0.185 |
| A1 | 0 | 0.10 | 0.25 | 0 | 0.004 | 0.010 |
| A2 | 2.59 | 2.69 | 2.79 | 0.102 | 0.106 | 0.110 |
| b | 0.77 | – | 0.90 | 0.030 | – | 0.035 |
| b1 | 1.23 | – | 1.36 | 0.048 | – | 0.054 |
| c | 0.34 | – | 0.47 | 0.013 | – | 0.019 |
| C1 | 1.22 | – | 1.32 | 0.048 | – | 0.052 |
| D | 8.60 | 8.70 | 8.80 | 0.338 | 0.343 | 0.346 |
| E | 10.06 | 10.16 | 10.26 | 0.396 | 0.4 | 0.404 |
| e | 2.54BSC | | | 0.1BSC | | |
| H | 14.70 | 15.10 | 15.50 | 0.579 | 0.594 | 0.610 |
| L | 2.00 | 2.30 | 2.60 | 0.079 | 0.090 | 0.102 |
| L3 | 1.17 | 1.27 | 1.40 | 0.046 | 0.050 | 0.055 |
| L1 | – | – | 1.70 | – | – | 0.067 |
| L4 | 0.25BSC | | | 0.01BSC | | |
| L2 | 2.50REF | | | 0.098REF | | |
| θ | 0° | – | 8° | 0° | – | 8° |
| θ1 | 5° | 7° | 9° | 5° | 7° | 9° |
| θ2 | 1° | 3° | 5° | 1° | 3° | 5° |
| DEP | 0.05 | 0.10 | 0.20 | 0.002 | 0.004 | 0.008 |
| φp1 | 1.40 | 1.50 | 1.60 | 0.055 | 0.059 | 0.063 |

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# ICEMOS SUPERJUNCTION PATENT PORTFOLIO

## ICEMOS GRANTED PATENTS

US7,429,772
US7,439,178
US7,446,018
US7,579,607
US7,723,172
US7,795,045
US7,846,821
US7,944,018
US8,012,806
US8,030,133

## 3D SEMI PATENTS LICENSED TO ICEMOS

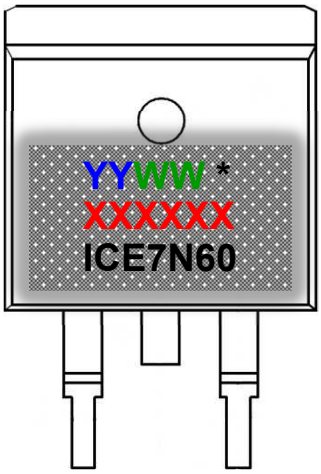
US7,041,560B2
US7,023,069B2
US7,364,994
US7,227,197B2
US7,304,944B2
US7,052,982B2
US7,339,252
US7,410,891
US7,439,583
US7,227,197B2
US6,635,906
US6,936,867
US7,015,104
US9,109,110
US7,271,067
US7,354,818
US7,052,982,
US7,199,006B2

**Note: additional patents in China, Korea, Japan, Taiwan, Europe have also been granted to IceMOS and 3D Semi for Superjunction MOSFETs with 70 additional Patent applications in process in the USA and the above listed countries.**

# Marking Information

**YY** = Last two digits of the year

**WW** = Work week calendar on Icemos subcon assembly & test house




* = Initial for Icemos subcon assembly and test house

**XXXXXX** = Lot ID

**ICE7N60** = ICE is Icemos logo and 7N60 is a designated device part number