

# ICE5N65D N-Channel Enhancement Mode MOSFET

RoHS  
compliant  
2011/65/EU

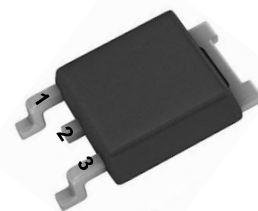
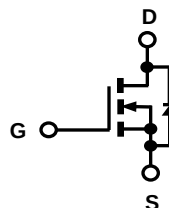
HALOGEN  
FREE

## Features

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

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.

| Product Summary |                        |              |     |
|-----------------|------------------------|--------------|-----|
| $I_D$           | $T_A=25^\circ\text{C}$ | 5A           | Max |
| $V_{(BR)DSS}$   | $I_D=250\mu\text{A}$   | 650V         | Min |
| $r_{DS(on)}$    | $V_{GS}=10\text{V}$    | $0.85\Omega$ | Typ |
| $Q_g$           | $V_{DS}=480\text{V}$   | 21nC         | Typ |



TO252

Standard Metal  
Heatsink

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

**Maximum ratings**<sup>b</sup>, at  $T_j=25^\circ\text{C}$ , unless otherwise specified

| Parameter                             | Symbol                | Conditions                                                          | Value       | Unit             |
|---------------------------------------|-----------------------|---------------------------------------------------------------------|-------------|------------------|
| Continuous drain current <sup>c</sup> | $I_D$                 | $T_c=25^\circ\text{C}$                                              | 5           | A                |
|                                       |                       | $T_c=100^\circ\text{C}$                                             | 3.2         | A                |
| Pulsed drain current                  | $I_{D, \text{pulse}}$ | $T_c=25^\circ\text{C}$                                              | 15          | A                |
| Avalanche energy, single pulse        | $E_{AS}$              | $I_D=2\text{A}$                                                     | 80          | mJ               |
| Avalanche current, repetitive         | $I_{AR}$              | limited by $T_{j\text{max}}$                                        | 2           | A                |
| MOSFET $dv/dt$ ruggedness             | $dv/dt$               | $V_{DS}=480\text{V}$ , $I_D=5\text{A}$ ,<br>$T_j=125^\circ\text{C}$ | 50          | V/ns             |
| Gate source voltage                   | $V_{GS}$              | Static                                                              | $\pm 20$    | V                |
|                                       |                       | AC ( $f>1\text{Hz}$ )                                               | $\pm 30$    |                  |
| Power dissipation                     | $P_{\text{tot}}$      | $T_c=25^\circ\text{C}$                                              | 65          | W                |
| Operating and storage temperature     | $T_j, T_{\text{stg}}$ |                                                                     | -55 to +150 | $^\circ\text{C}$ |

a When mounted on 1inch square 2oz copper clad FR-4

b Preliminary Data Sheet – Specifications subject to change

c Limited by  $T_{j\text{max}}$

| Parameter | Symbol | Conditions | Values |     |     | Unit |
|-----------|--------|------------|--------|-----|-----|------|
|           |        |            | Min    | Typ | Max |      |

### Thermal characteristics

|                                                             |            |                                     |   |   |     |      |
|-------------------------------------------------------------|------------|-------------------------------------|---|---|-----|------|
| Thermal resistance, junction-case <sup>a</sup>              | $R_{thJC}$ |                                     | - | - | 1.9 | °C/W |
| Thermal resistance, junction-ambient <sup>a</sup>           | $R_{thJA}$ | 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 <sup>b</sup>, at $T_j=25^{\circ}\text{C}$ , unless otherwise specified

#### Static characteristics

|                                  |               |                                                                 |     |      |      |               |
|----------------------------------|---------------|-----------------------------------------------------------------|-----|------|------|---------------|
| Drain-source breakdown voltage   | $V_{(BR)DSS}$ | $V_{GS}=0\text{ V}, I_D=250\mu\text{A}$                         | 650 | 700  | -    | V             |
| Gate threshold voltage           | $V_{GS(th)}$  | $V_{DS}=V_{GS}, I_D=250\mu\text{A}$                             | 2.1 | 3    | 3.9  |               |
| Zero gate voltage drain current  | $I_{DSS}$     | $V_{DS}=650\text{V}, V_{GS}=0\text{V}, T_j=25^{\circ}\text{C}$  | -   | 0.1  | 1    | $\mu\text{A}$ |
|                                  |               | $V_{DS}=650\text{V}, V_{GS}=0\text{V}, T_j=150^{\circ}\text{C}$ | -   | -    | 100  |               |
| Gate source leakage current      | $I_{GSS}$     | $V_{GS}=\pm 20\text{ V}, V_{DS}=0\text{V}$                      | -   | -    | 100  | nA            |
| Drain-source on-state resistance | $R_{DS(on)}$  | $V_{GS}=10\text{V}, I_D=2.5\text{A}, T_j=25^{\circ}\text{C}$    | -   | 0.85 | 0.95 | $\Omega$      |
|                                  |               | $V_{GS}=10\text{V}, I_D=2.5\text{A}, T_j=150^{\circ}\text{C}$   | -   | 2.2  | -    |               |
| Gate resistance                  | $R_G$         | $f=1\text{ MHz}, \text{open drain}$                             | -   | 6    | -    | $\Omega$      |

#### Dynamic characteristics

|                              |              |                                                                                        |   |     |   |    |
|------------------------------|--------------|----------------------------------------------------------------------------------------|---|-----|---|----|
| Input capacitance            | $C_{iss}$    | $V_{GS}=0\text{ V}, V_{DS}=25\text{ V}, f=1\text{ MHz}$                                | - | 635 | - | pF |
| Output capacitance           | $C_{oss}$    |                                                                                        | - | 365 | - |    |
| Reverse transfer capacitance | $C_{rss}$    |                                                                                        | - | 6   | - |    |
| Transconductance             | $g_{fs}$     | $V_{DS}>2*I_D*R_{DS}, I_D=2.5\text{A}$                                                 | - | 7   | - | S  |
| Turn-on delay time           | $t_{d(on)}$  | $V_{DS}=380\text{V}, V_{GS}=10\text{V}, I_D=5\text{A}, R_G=4\Omega \text{ (External)}$ | - | 6   | - | ns |
| Rise time                    | $T_r$        |                                                                                        | - | 3.5 | - |    |
| Turn-off delay time          | $t_{d(off)}$ |                                                                                        | - | 54  | - |    |
| Fall time                    | $t_f$        |                                                                                        | - | 7   | - |    |

| Parameter | Symbol | Conditions | Values |     |     | Unit |
|-----------|--------|------------|--------|-----|-----|------|
|           |        |            | Min    | Typ | Max |      |

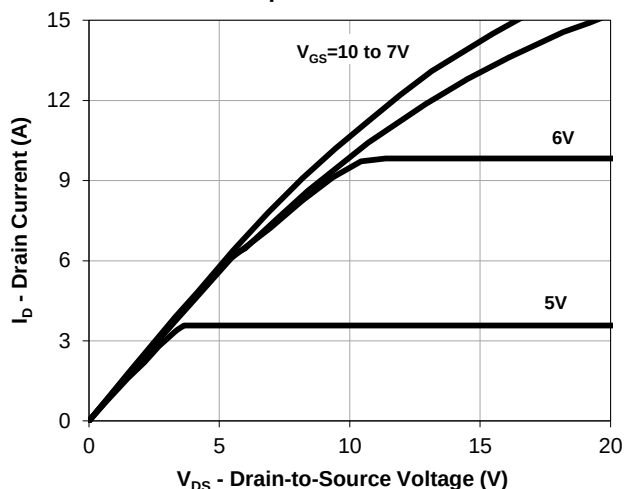
### Gate charge characteristics

|                       |               |                                                                            |   |     |   |    |
|-----------------------|---------------|----------------------------------------------------------------------------|---|-----|---|----|
| Gate to source charge | $Q_{gs}$      | $V_{DS}=480\text{ V}, I_D=5\text{ A},$<br>$V_{GS}=0\text{ to }10\text{ V}$ | - | 4.6 | - | nC |
| Gate to drain charge  | $Q_{gd}$      |                                                                            | - | 6.4 | - |    |
| Gate charge total     | $Q_g$         |                                                                            | - | 21  | - |    |
| Gate plateau voltage  | $V_{plateau}$ |                                                                            | - | 5.5 | - | V  |

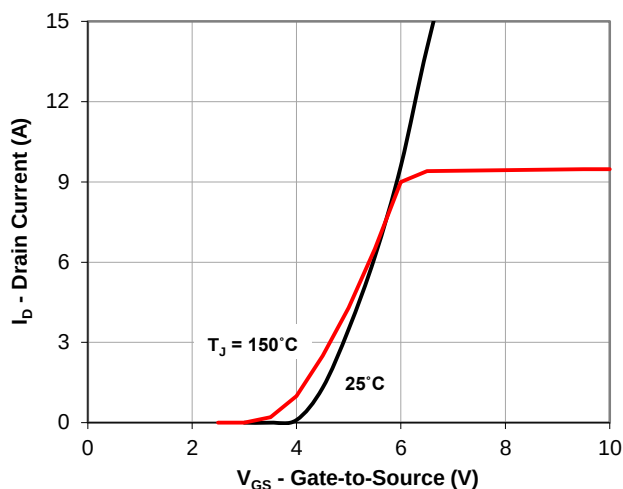
### Reverse Diode

|                               |          |                                                                          |   |     |     |               |
|-------------------------------|----------|--------------------------------------------------------------------------|---|-----|-----|---------------|
| Diode forward voltage         | $V_{SD}$ | $V_{GS}=0\text{ V}, I_S=I_F$                                             | - | 0.9 | 1.2 | V             |
| Reverse recovery time         | $t_{rr}$ | $V_{RR}=480\text{ V}, I_S=I_F,$<br>$d_{iF}/d_t=100\text{ A}/\mu\text{S}$ | - | 277 | -   | ns            |
| Reverse recovery charge       | $Q_{rr}$ |                                                                          | - | 2.6 | -   | $\mu\text{C}$ |
| Peak reverse recovery current | $I_{rm}$ |                                                                          | - | 20  | -   | A             |

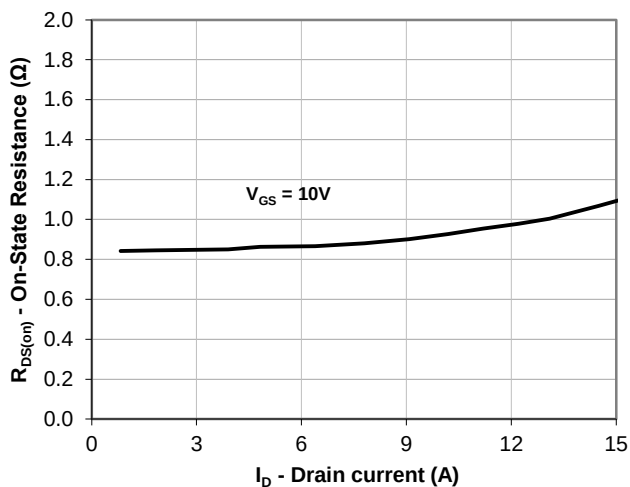
### Output Characteristics



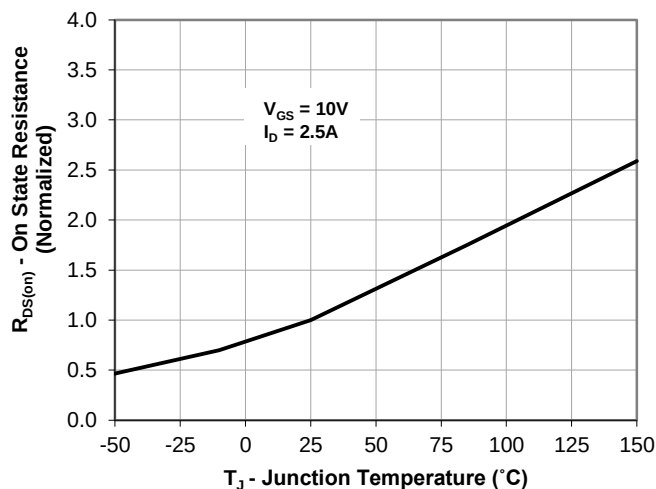
### Transfer Characteristics



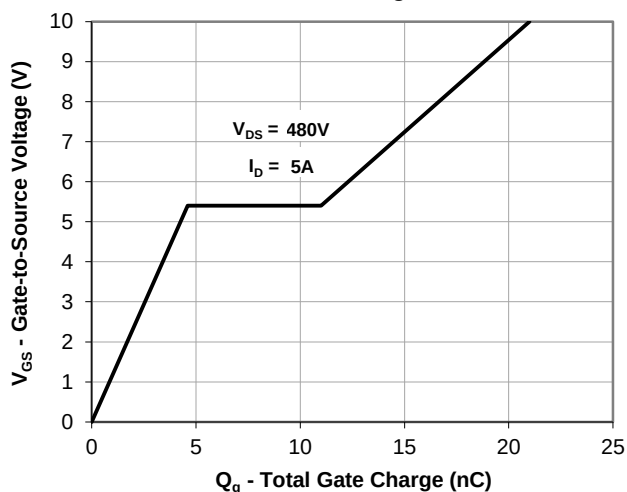
### On Resistance vs Drain Current



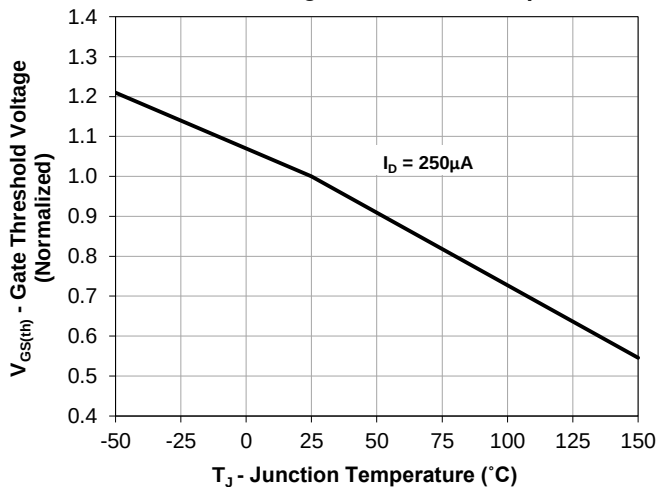
### On Resistance vs Junction Temperature

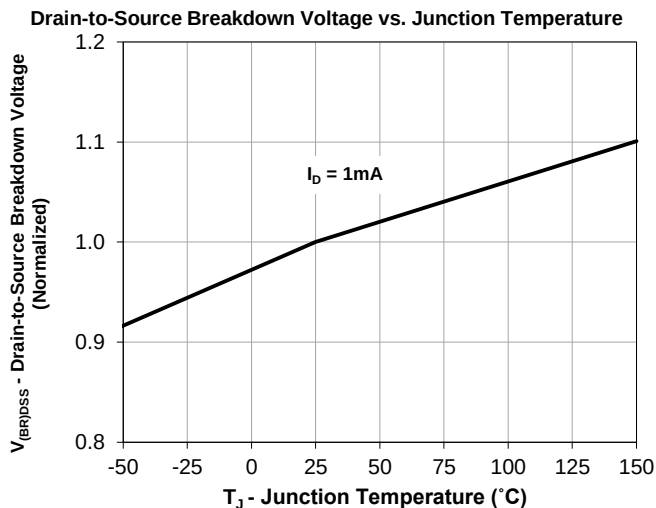
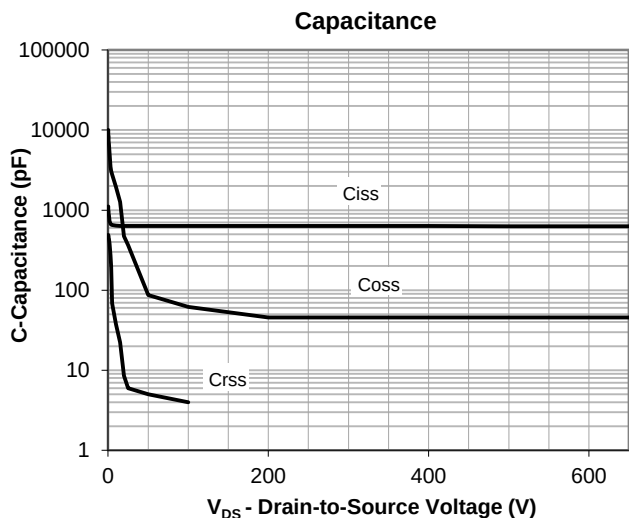


### Gate Charge

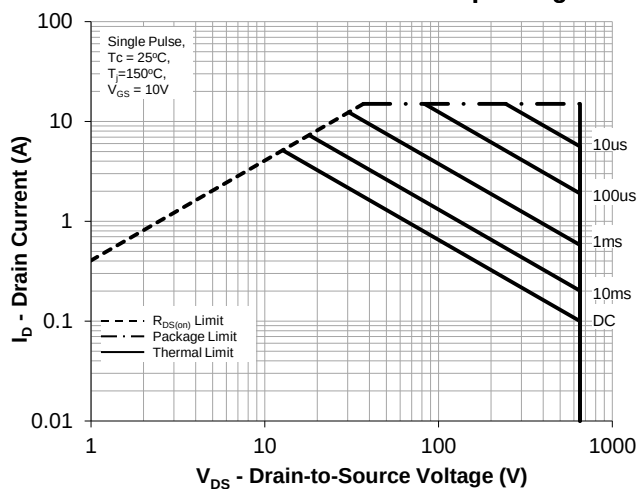


### Gate Threshold Voltage vs Junction Temperature

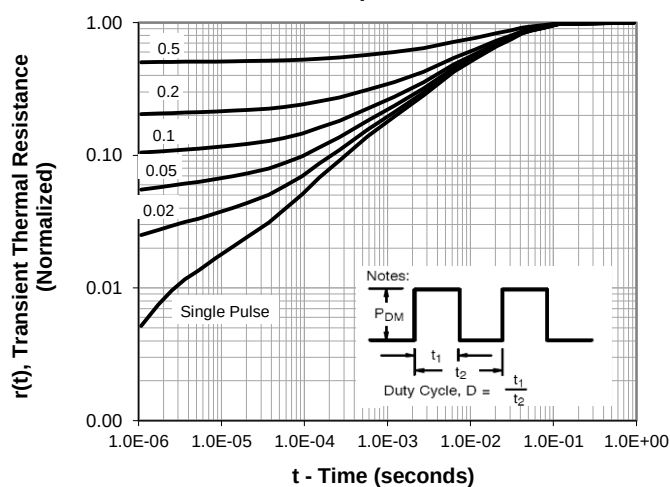


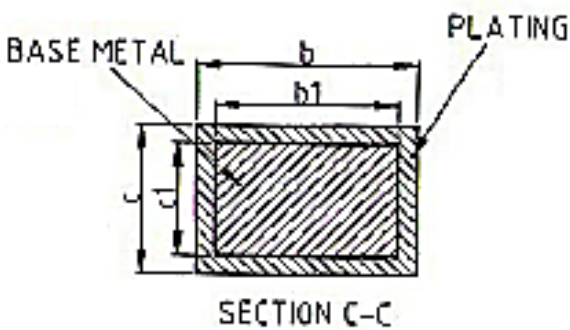
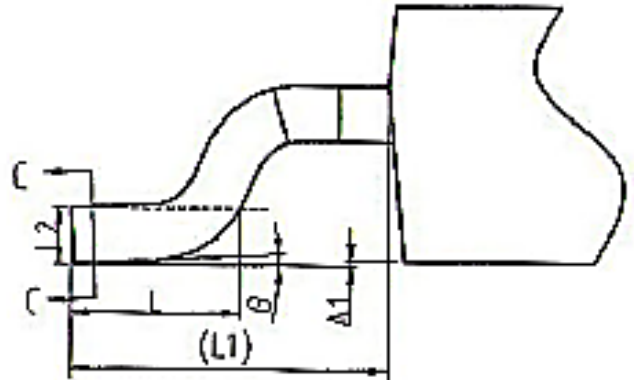
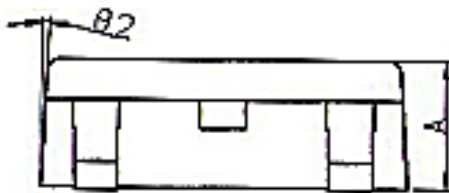
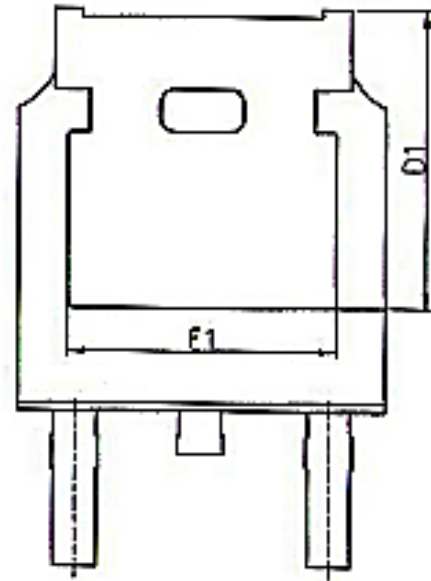
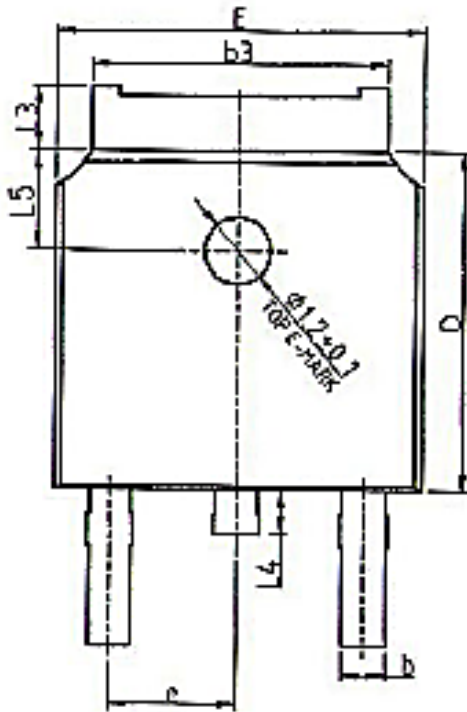


### Maximum Rated Forward Biased Safe Operating Area



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





NOTES

1. ALL DIMENSIONS REFER TO JEDEC STANDARD TO-252 AA,  
DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.

**COMMON DIMENSIONS**

| <b>SYMBOL</b> | <b>mm</b>        |              |              |
|---------------|------------------|--------------|--------------|
|               | <b>MIN</b>       | <b>NOM</b>   | <b>MAX</b>   |
| <b>A</b>      | <b>2.20</b>      | <b>2.30</b>  | <b>2.38</b>  |
| <b>A1</b>     | <b>0.00</b>      | <b>-</b>     | <b>0.10</b>  |
| <b>A2</b>     | <b>0.97</b>      | <b>1.07</b>  | <b>1.17</b>  |
| <b>b</b>      | <b>0.72</b>      | <b>0.78</b>  | <b>0.85</b>  |
| <b>b1</b>     | <b>0.71</b>      | <b>0.76</b>  | <b>0.81</b>  |
| <b>b3</b>     | <b>5.23</b>      | <b>5.33</b>  | <b>5.46</b>  |
| <b>c</b>      | <b>0.47</b>      | <b>0.53</b>  | <b>0.58</b>  |
| <b>c1</b>     | <b>0.46</b>      | <b>0.51</b>  | <b>0.56</b>  |
| <b>D</b>      | <b>6.00</b>      | <b>6.10</b>  | <b>6.20</b>  |
| <b>D1</b>     | <b>5.30 REF</b>  |              |              |
| <b>E</b>      | <b>6.50</b>      | <b>6.60</b>  | <b>6.70</b>  |
| <b>E1</b>     | <b>4.70</b>      | <b>4.83</b>  | <b>4.92</b>  |
| <b>e</b>      | <b>2.286 BSC</b> |              |              |
| <b>H</b>      | <b>9.90</b>      | <b>10.10</b> | <b>10.30</b> |
| <b>L</b>      | <b>1.40</b>      | <b>1.50</b>  | <b>1.70</b>  |
| <b>L1</b>     | <b>2.90 REF</b>  |              |              |
| <b>L2</b>     | <b>0.51 BSC</b>  |              |              |
| <b>L3</b>     | <b>0.90</b>      | <b>-</b>     | <b>1.25</b>  |
| <b>L4</b>     | <b>0.60</b>      | <b>0.80</b>  | <b>1.00</b>  |
| <b>L5</b>     | <b>1.70</b>      | <b>1.80</b>  | <b>1.90</b>  |
| <b>θ</b>      | <b>0°</b>        | <b>-</b>     | <b>8°</b>    |
| <b>θ1</b>     | <b>5°</b>        | <b>7°</b>    | <b>9°</b>    |
| <b>θ2</b>     | <b>5°</b>        | <b>7°</b>    | <b>9°</b>    |

## **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

**XXXX** = Wafer Lot ID

**00** = may be used for wafer ID in a special case.  
= "00" is used unless specified.

**ICE5N65** = ICE is Icemos logo and 5N65 is a designated device part number

