

## ICES15N60W N-Channel Enhancement Mode MOSFET

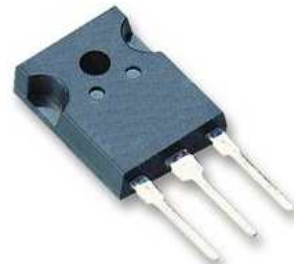
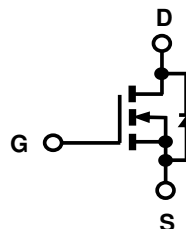
### Features

- 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



Lead Free

| Product Summary |                        |      |     |
|-----------------|------------------------|------|-----|
| $I_D$           | $T_A=25^\circ\text{C}$ | 15A  | Max |
| $V_{(BR)DSS}$   | $I_D=250\mu\text{A}$   | 600V | Min |
| $r_{DS(on)}$    | $V_{GS}=10\text{V}$    | 0.20 | Typ |
| $Q_g$           | $V_{DS}=480\text{V}$   | 52nC | Typ |



**TO247**  
1:G, 2:D,  
3:S  
(TO-247)

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

| Parameter                             | Symbol                | Conditions                                                           | Value       | Unit             |
|---------------------------------------|-----------------------|----------------------------------------------------------------------|-------------|------------------|
| Continuous drain current <sup>a</sup> | $I_D$                 | $T_c=25^\circ\text{C}$                                               | 15          | A                |
|                                       |                       | $T_c=100^\circ\text{C}$                                              | 9           |                  |
| Pulsed drain current                  | $I_{D, \text{pulse}}$ | $T_c=25^\circ\text{C}$                                               | 45          | A                |
| Avalanche energy, single pulse        | $E_{AS}$              | $I_D=9.5\text{A}$                                                    | 450         | mJ               |
| Avalanche current, repetitive         | $I_{AR}$              | limited by $T_{j\text{max}}$                                         | 9.5         | A                |
| MOSFET $dv/dt$ ruggedness             | $dv/dt$               | $V_{DS}=480\text{V}$ , $I_D=15\text{A}$ ,<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                     | $P_{\text{tot}}$      | $T_c=25^\circ\text{C}$                                               | 145         | W                |
| Operating and storage temperature     | $T_j, T_{\text{stg}}$ |                                                                      | -55 to +150 | $^\circ\text{C}$ |
| Mounting torque                       |                       | M 3 & 3.5 screws                                                     | 60          | Ncm              |

<sup>a</sup> When mounted on 1inch square 2oz copper clad FR-4

<sup>b</sup> Pulse width limited by  $T_{j\text{max}}$

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

### Thermal characteristics

|                                                             |            |                                     |   |   |      |      |
|-------------------------------------------------------------|------------|-------------------------------------|---|---|------|------|
| Thermal resistance, junction-case <sup>a</sup>              | $R_{thJC}$ |                                     | - | - | 0.86 | °C/W |
| Thermal resistance, junction-ambient <sup>a</sup>           | $R_{thJA}$ | leaded                              | - | - | 62   |      |
| 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   | $V_{(BR)DSS}$ | $V_{GS}=0\text{ V}$ , $I_D=250\mu\text{A}$                            | 600 | 640  | -    | 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  | $I_{DSS}$     | $V_{DS}=600\text{V}$ , $V_{GS}=0\text{V}$ , $T_j=25^{\circ}\text{C}$  | -   | 0.1  | 1    | $\mu\text{A}$ |
|                                  |               | $V_{DS}=600\text{V}$ , $V_{GS}=0\text{V}$ , $T_j=150^{\circ}\text{C}$ | -   | 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 | $R_{DS(on)}$  | $V_{GS}=10\text{V}$ , $I_D=7.5\text{A}$ , $T_j=25^{\circ}\text{C}$    | -   | 0.20 | 0.24 | $\Omega$      |
|                                  |               | $V_{GS}=10\text{V}$ , $I_D=7.5\text{A}$ , $T_j=150^{\circ}\text{C}$   | -   | 0.53 | -    |               |
| Gate resistance                  | $R_G$         | $f=1\text{ MHz}$ , open drain                                         | -   | 3    | -    | $\Omega$      |

#### Dynamic characteristics

|                              |              |                                                                                           |                       |     |      |   |    |
|------------------------------|--------------|-------------------------------------------------------------------------------------------|-----------------------|-----|------|---|----|
| Input capacitance            | $C_{iss}$    | $V_{GS}=0\text{ V}$ , $f=1\text{ MHz}$                                                    | $V_{DS}=25\text{ V}$  | -   | 1742 | - | pF |
| Output capacitance           | $C_{oss}$    |                                                                                           | $V_{DS}=100\text{ V}$ | -   | 71   | - |    |
| Reverse transfer capacitance | $C_{rss}$    |                                                                                           | $V_{DS}=25\text{ V}$  | -   | 12   | - |    |
| Transconductance             | $g_{fs}$     | $V_{DS}>2 \cdot I_D \cdot R_{DS}$ , $I_D=7.5\text{A}$                                     | -                     | 11  | -    | - | S  |
| Turn-on delay time           | $t_{d(on)}$  | $V_{DS}=380\text{V}$ , $V_{GS}=10\text{V}$ , $I_D=7.5\text{A}$ , $R_G=4\Omega$ (External) | -                     | 21  | -    | - | ns |
| Rise time                    | $t_r$        |                                                                                           | -                     | 10  | -    | - |    |
| Turn-off delay time          | $t_{d(off)}$ |                                                                                           | -                     | 88  | -    | - |    |
| Fall time                    | $t_f$        |                                                                                           | -                     | 5.2 | -    | - |    |

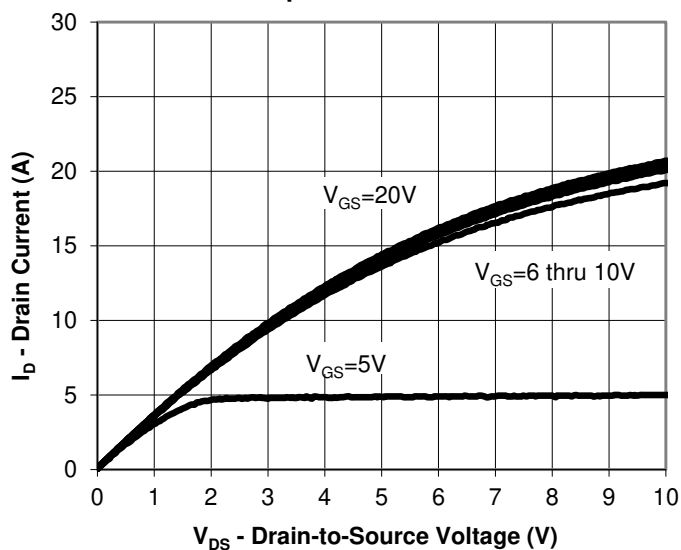
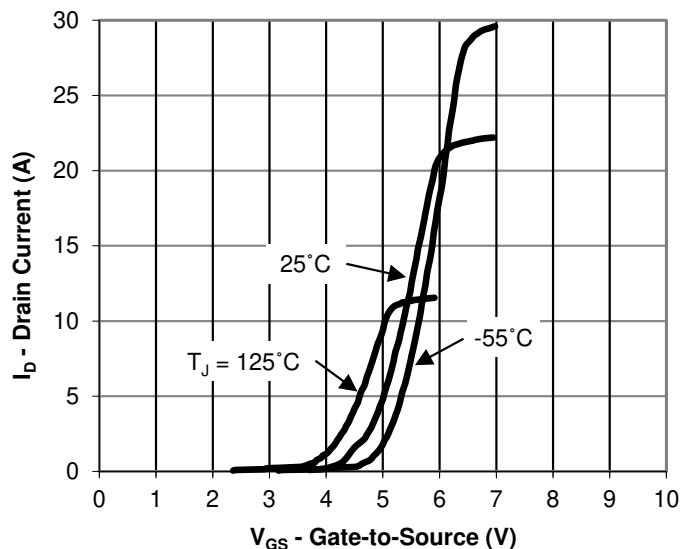
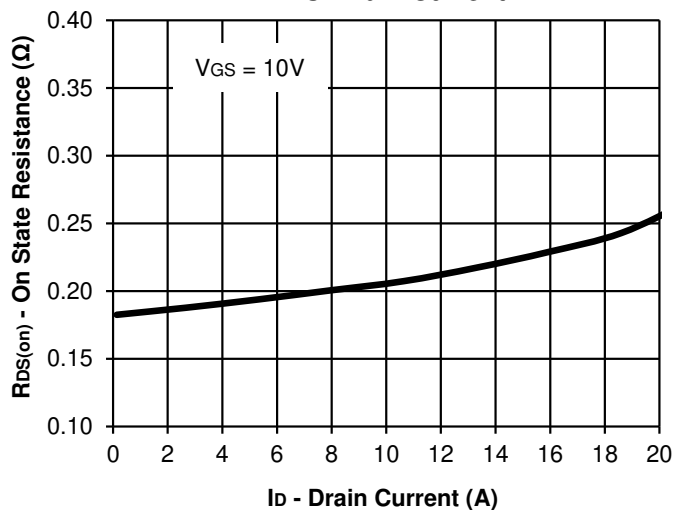
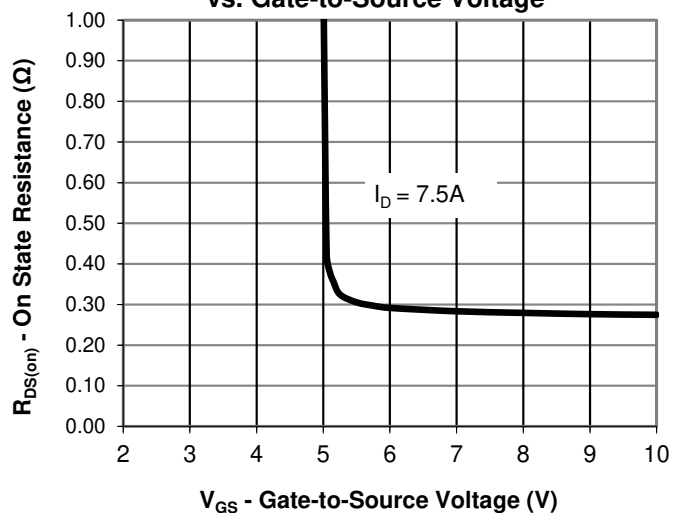
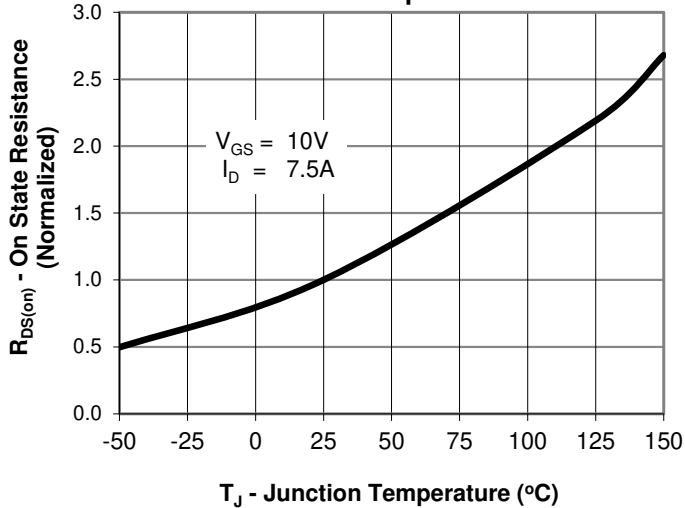
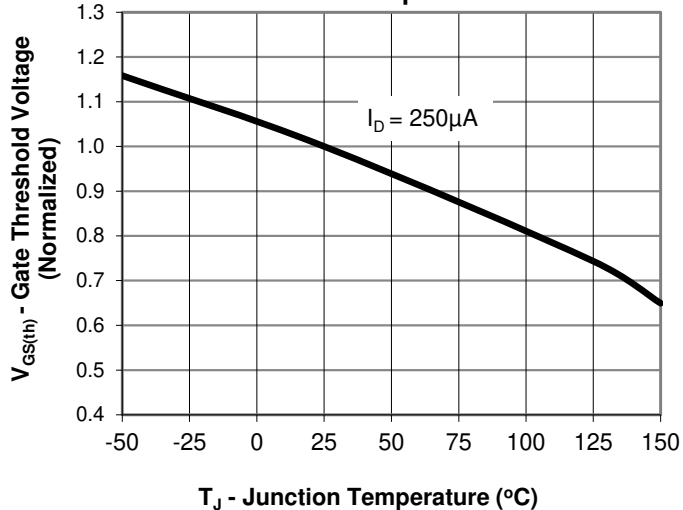
| Parameter | Symbol | Conditions | Values |     |     | Unit |
|-----------|--------|------------|--------|-----|-----|------|
|           |        |            | Min    | Typ | Max |      |

### Gate charge characteristics

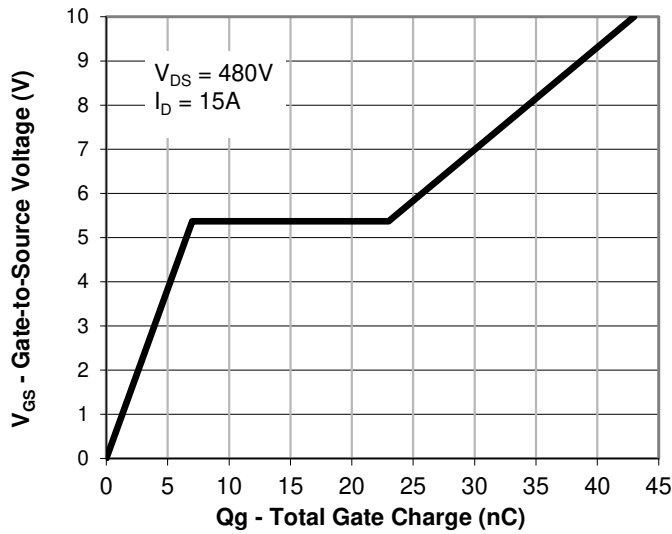
|                       |                      |                                                                             |   |     |   |    |
|-----------------------|----------------------|-----------------------------------------------------------------------------|---|-----|---|----|
| Gate to source charge | $Q_{gs}$             | $V_{DS}=480\text{ V}, I_D=15\text{ A},$<br>$V_{GS}=0\text{ to }10\text{ V}$ | - | 9   | - | nC |
| Gate to drain charge  | $Q_{gd}$             |                                                                             | - | 18  | - |    |
| Gate charge total     | $Q_g$                |                                                                             | - | 52  | - |    |
| Gate plateau voltage  | $V_{\text{plateau}}$ |                                                                             | - | 5.4 | - | V  |

### Reverse Diode

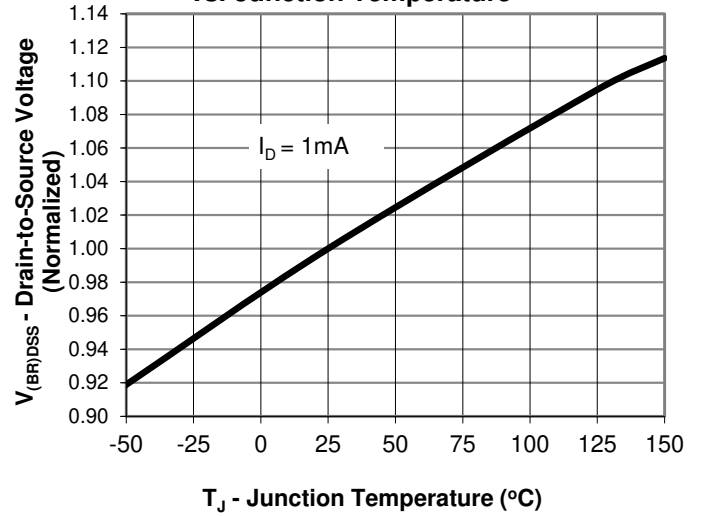
|                               |          |                                                                          |   |     |     |               |
|-------------------------------|----------|--------------------------------------------------------------------------|---|-----|-----|---------------|
| Continuous forward current    | $I_S$    | $V_{GS}=0\text{ V}$                                                      | - | -   | 15  | A             |
| Diode forward voltage         | $V_{SD}$ | $V_{GS}=0\text{ V}, I_S=I_F$                                             | - | 0.9 | 1.2 | V             |
| Reverse recovery time         | $t_{rr}$ | $V_{RR}=300\text{ V}, I_S=I_F,$<br>$d_{iF}/d_t=100\text{ A}/\mu\text{S}$ | - | 340 | -   | ns            |
| Reverse recovery charge       | $Q_{rr}$ |                                                                          | - | 5.6 | -   | $\mu\text{C}$ |
| Peak reverse recovery current | $I_{rm}$ |                                                                          | - | 29  | -   | A             |

**Output Characteristics**

**Transfer Characteristics**

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

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

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

**Gate Threshold Voltage vs. Junction Temperature**


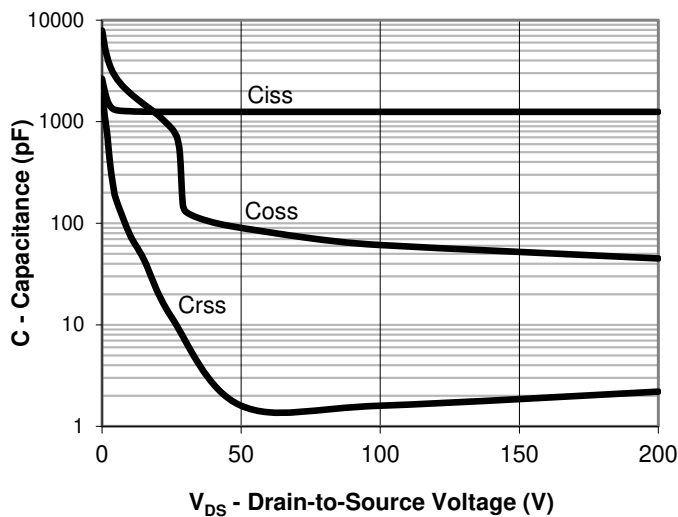
### Gate Charge



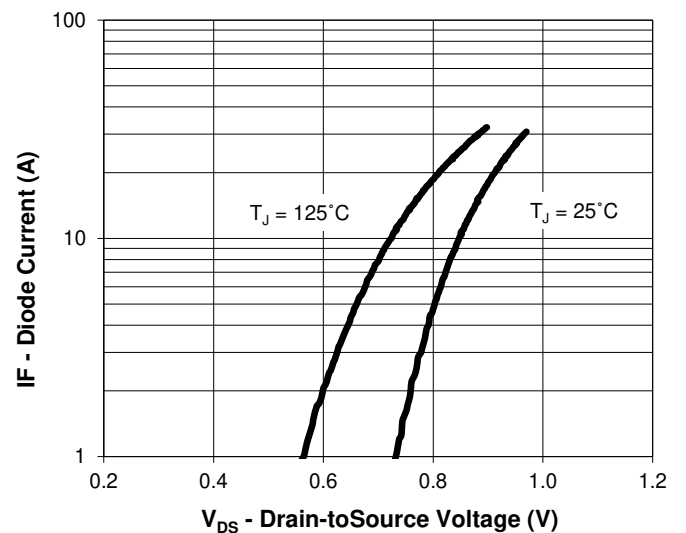
### Drain-to-Source Breakdown Voltage vs. Junction Temperature



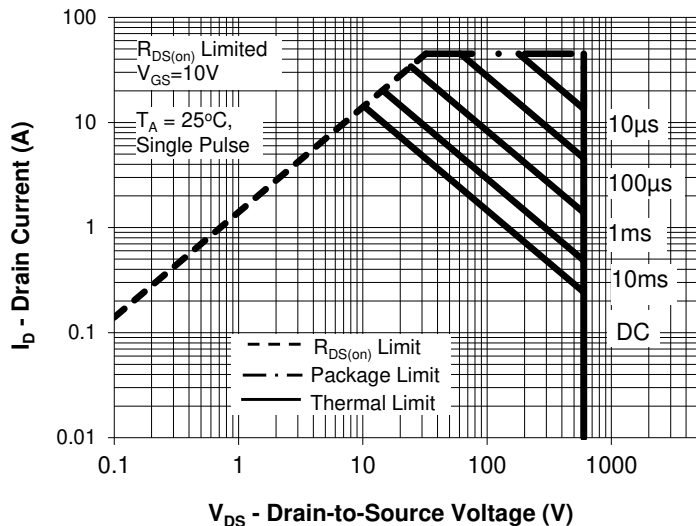
### Capacitance



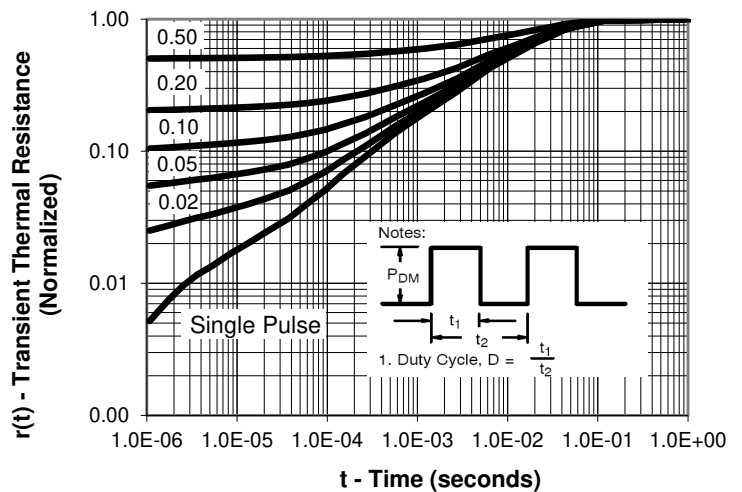
### Drain-Source Diode Forward Voltage



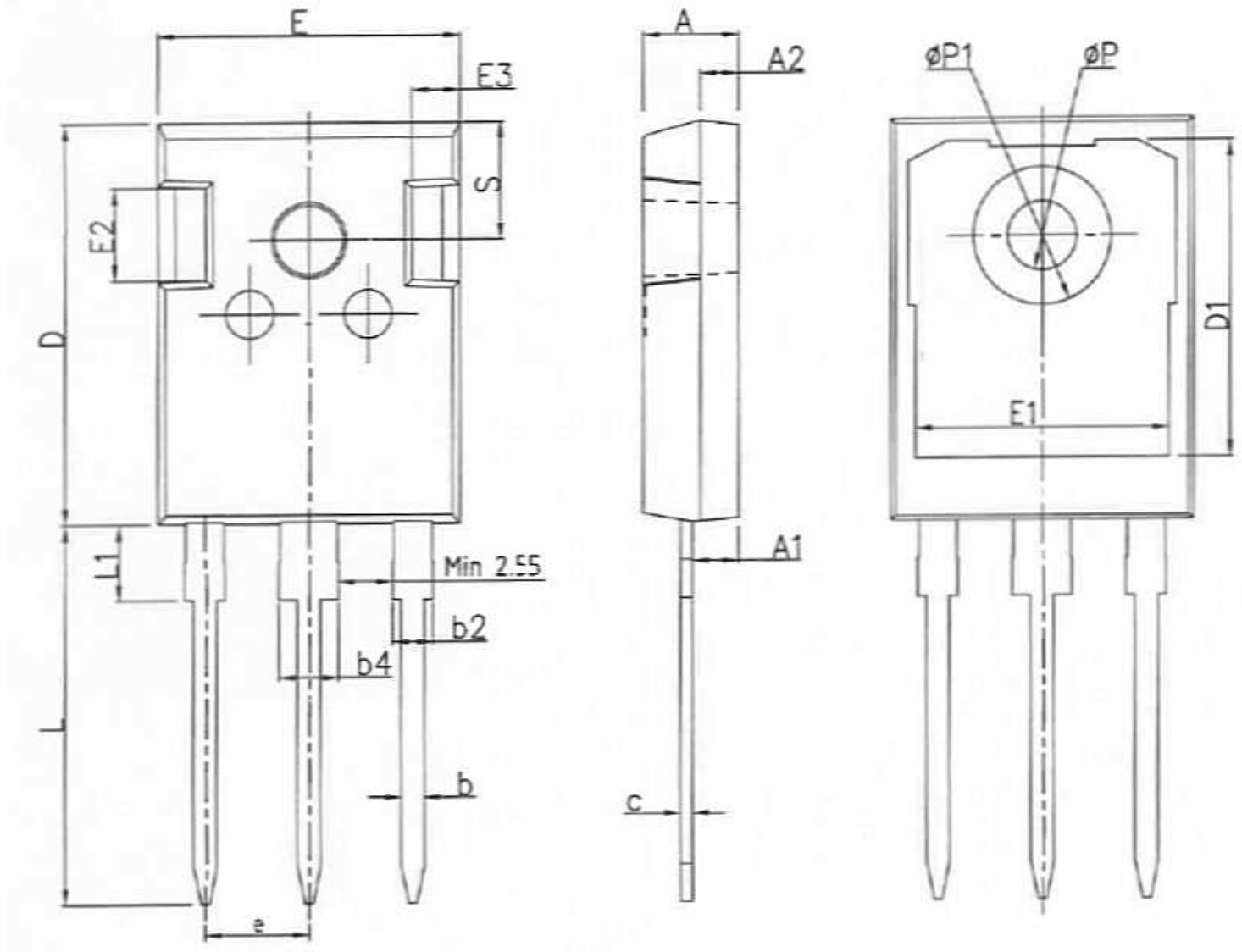
### Maximum Rated Forward Biased Safe Operating Area



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



## Package Outline: TO-247



## Package Outline: TO-247

| SYMBOL | unit : mm |       |       |
|--------|-----------|-------|-------|
|        | MIN       | NOM   | MAX   |
| A      | 4.8       | 5     | 5.2   |
| A1     | 2.21      | 2.41  | 2.59  |
| A2     | 1.85      | 2     | 2.15  |
| b      | 1.11      | 1.21  | 1.36  |
| b      | 1.91      | 2.01  | 2.21  |
| b4     | 2.91      | 3.01  | 3.21  |
| c      | 0.51      | 0.61  | 0.75  |
| D      | 20.7      | 21    | 21.3  |
| D1     | 16.25     | 16.55 | 16.85 |
| E      | 15.5      | 15.8  | 16.1  |
| E1     | 13        | 13.3  | 13.6  |
| E2     | 4.8       | 5     | 5.2   |
| E3     | 2.3       | 2.5   | 2.7   |
| e      | 5.44BSC   |       |       |
| L      | 19.62     | 19.92 | 20,22 |
| L1     | -         | -     | 4.3   |
| ΦP     | 3.4       | 3.6   | 3.8   |
| ΦP1    | -         | -     | 7.3   |
| S      | 6.15BSC   |       |       |

## Marking Information

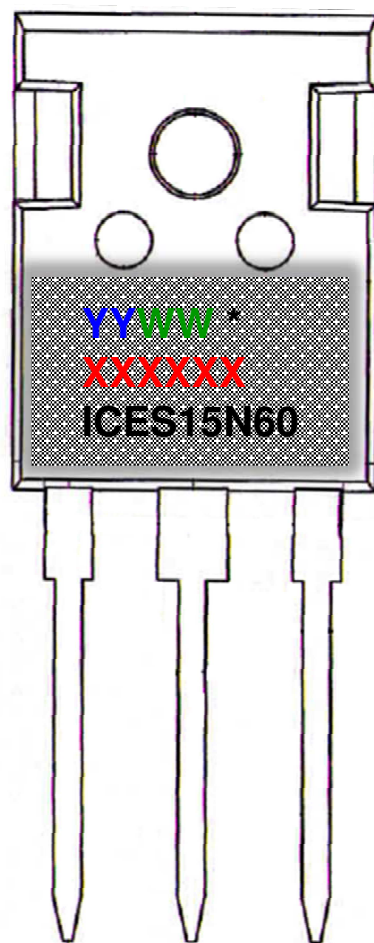
**YY** = Last two digits of the year

**WW** = Work week

**\*** = Site ID

**XXXXXX** = Lot ID

**ICES15N60** = ICE is IceMOS logo and  
S15N60 is a designated device part  
number



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