

## Features

- N-Channel, 10V Logic Level Control
- Enhancement mode
- Low on-resistance  $R_{DS(on)}$  @  $V_{GS}=10\text{ V}$
- Fast Switching
- Pb-free lead plating; RoHS compliant

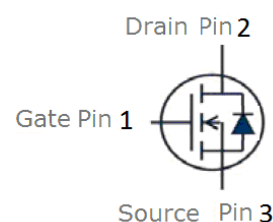


Halogen-Free

| Part ID  | Package Type | Marking | Tape and reel information |
|----------|--------------|---------|---------------------------|
| VS4N60AI | TO-251SL     | 4N60AI  | 75pcs/Tube                |

|                                       |     |          |
|---------------------------------------|-----|----------|
| $V_{DS}$                              | 600 | V        |
| $R_{DS(on),TYP} @ V_{GS}=10\text{ V}$ | 2.9 | $\Omega$ |
| $I_D$                                 | 4   | A        |

### TO-251SL



## Maximum ratings, at $T_A = 25^\circ\text{C}$ , unless otherwise specified

| Symbol         | Parameter                                      |                           | Rating     | Unit             |
|----------------|------------------------------------------------|---------------------------|------------|------------------|
| $V_{(BR)DSS}$  | Drain-Source breakdown voltage                 |                           | 600        | V                |
| $V_{GS}$       | Gate-Source voltage                            |                           | $\pm 30$   | V                |
| $I_S$          | Diode continuous forward current               | $T_C = 25^\circ\text{C}$  | 4          | A                |
| $I_D$          | Continuous drain current @ $V_{GS}=10\text{V}$ | $T_C = 25^\circ\text{C}$  | 4          | A                |
|                |                                                | $T_C = 100^\circ\text{C}$ | 2.5        | A                |
| $I_{DM}$       | Pulse drain current tested ①                   | $T_C = 25^\circ\text{C}$  | 16         | A                |
| $I_{DSM}$      | Continuous drain current @ $V_{GS}=10\text{V}$ | $T_A = 25^\circ\text{C}$  | 0.5        | A                |
|                |                                                | $T_A = 70^\circ\text{C}$  | 0.4        | A                |
| EAS            | Avalanche energy, single pulsed ②              |                           | 26         | mJ               |
| $P_D$          | Maximum power dissipation                      | $T_C = 25^\circ\text{C}$  | 63         | W                |
| $P_{DSM}$      | Maximum power dissipation ③                    | $T_A = 25^\circ\text{C}$  | 1.25       | W                |
| $T_{STG}, T_J$ | Storage and Junction Temperature Range         |                           | -55 to 150 | $^\circ\text{C}$ |

## Thermal Characteristics

| Symbol          | Parameter                               | Typical | Unit               |
|-----------------|-----------------------------------------|---------|--------------------|
| $R_{\theta JC}$ | Thermal Resistance, Junction-to-Case    | 2       | $^\circ\text{C/W}$ |
| $R_{\theta JA}$ | Thermal Resistance, Junction-to-Ambient | 100     | $^\circ\text{C/W}$ |

| Symbol                                                                               | Parameter                                              | Condition                                                                                     | Min. | Typ. | Max. | Unit |
|--------------------------------------------------------------------------------------|--------------------------------------------------------|-----------------------------------------------------------------------------------------------|------|------|------|------|
| Static Electrical Characteristics @ T <sub>j</sub> =25°C (unless otherwise stated)   |                                                        |                                                                                               |      |      |      |      |
| V <sub>(BR)DSS</sub>                                                                 | Drain-Source Breakdown Voltage                         | V <sub>GS</sub> =0V, I <sub>D</sub> =250μA                                                    | 600  | 668  | --   | V    |
| I <sub>DSS</sub>                                                                     | Zero Gate Voltage Drain Current                        | V <sub>DS</sub> =600V,V <sub>GS</sub> =0V                                                     | --   | --   | 1    | μA   |
|                                                                                      | Zero Gate Voltage Drain Current(T <sub>j</sub> =125°C) | V <sub>DS</sub> =480V,V <sub>GS</sub> =0V                                                     | --   | --   | 50   | μA   |
| I <sub>GSS</sub>                                                                     | Gate-Body Leakage Current                              | V <sub>GS</sub> =±30V,V <sub>DS</sub> =0V                                                     | --   | --   | ±100 | nA   |
| V <sub>GS(TH)</sub>                                                                  | Gate Threshold Voltage                                 | V <sub>DS</sub> =V <sub>GS</sub> ,I <sub>D</sub> =250μA                                       | 2.4  | 3    | 3.6  | V    |
| R <sub>DS(ON)</sub>                                                                  | Drain-Source On-State Resistance ④                     | V <sub>GS</sub> =10V, I <sub>D</sub> =2A                                                      | --   | 2.9  | 3.6  | Ω    |
| Dynamic Electrical Characteristics @ T <sub>j</sub> = 25°C (unless otherwise stated) |                                                        |                                                                                               |      |      |      |      |
| C <sub>iss</sub>                                                                     | Input Capacitance                                      | V <sub>DS</sub> =30V,V <sub>GS</sub> =0V,<br>f=1MHz                                           | 300  | 380  | 460  | pF   |
| C <sub>oss</sub>                                                                     | Output Capacitance                                     |                                                                                               | 25   | 40   | 55   | pF   |
| C <sub>rss</sub>                                                                     | Reverse Transfer Capacitance                           |                                                                                               | --   | 6    | 10   | pF   |
| R <sub>g</sub>                                                                       | Gate Resistance                                        | f=1MHz                                                                                        | --   | 6.9  | --   | Ω    |
| Q <sub>g</sub>                                                                       | Total Gate Charge                                      | V <sub>DS</sub> =480V,I <sub>D</sub> =4A,<br>V <sub>GS</sub> =10V                             | --   | 13   | --   | nC   |
| Q <sub>gs</sub>                                                                      | Gate-Source Charge                                     |                                                                                               | --   | 4.7  | --   | nC   |
| Q <sub>gd</sub>                                                                      | Gate-Drain Charge                                      |                                                                                               | --   | 5.8  | --   | nC   |
| Switching Characteristics                                                            |                                                        |                                                                                               |      |      |      |      |
| t <sub>d(on)</sub>                                                                   | Turn-on Delay Time                                     | V <sub>DD</sub> =300V,<br>I <sub>D</sub> =4A,<br>R <sub>G</sub> =25Ω,<br>V <sub>GS</sub> =10V | --   | 20   | --   | ns   |
| t <sub>r</sub>                                                                       | Turn-on Rise Time                                      |                                                                                               | --   | 35   | --   | ns   |
| t <sub>d(off)</sub>                                                                  | Turn-Off Delay Time                                    |                                                                                               | --   | 33   | --   | ns   |
| t <sub>f</sub>                                                                       | Turn-Off Fall Time                                     |                                                                                               | --   | 28   | --   | ns   |
| Source- Drain Diode Characteristics@ T <sub>j</sub> = 25°C (unless otherwise stated) |                                                        |                                                                                               |      |      |      |      |
| V <sub>SD</sub>                                                                      | Forward on voltage                                     | I <sub>SD</sub> =4A,V <sub>GS</sub> =0V                                                       | --   | 0.9  | 1.2  | V    |
| t <sub>rr</sub>                                                                      | Reverse Recovery Time                                  | T <sub>j</sub> =25°C ,I <sub>sd</sub> =4A,<br>V <sub>GS</sub> =0V                             | --   | 89   | --   | ns   |
| Q <sub>rr</sub>                                                                      | Reverse Recovery Charge                                | di/dt=100A/μs                                                                                 | --   | 0.2  | --   | μC   |

NOTE:

- ① Repetitive rating; pulse width limited by max. junction temperature.
- ② Limited by  $T_{jmax}$ , starting  $T_j = 25^{\circ}\text{C}$ ,  $L = 1\text{mH}$ ,  $R_G = 25\Omega$ ,  $I_{AS} = 7A$ ,  $V_{GS} = 10V$ . Part not recommended for use above this value
- ③ The power dissipation  $P_{DSM}$  is based on  $R_{\theta JA}$  and the maximum allowed junction temperature of  $150^{\circ}\text{C}$ .
- ④ Pulse width  $\leq 300\mu s$ ; duty cycles  $\leq 2\%$ .



## Typical Characteristics

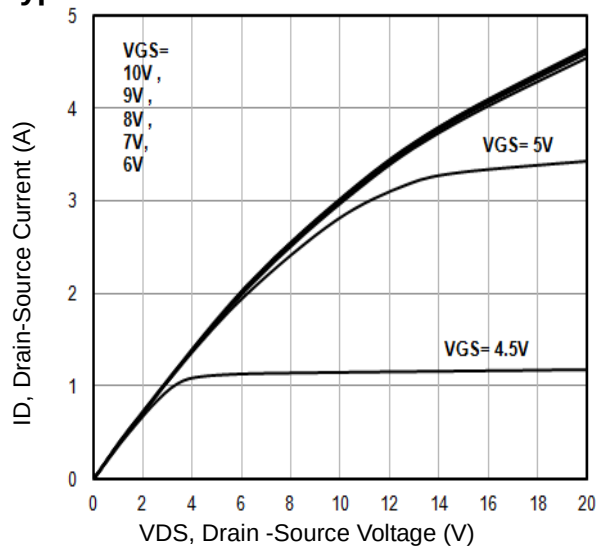


Fig1. Typical Output Characteristics

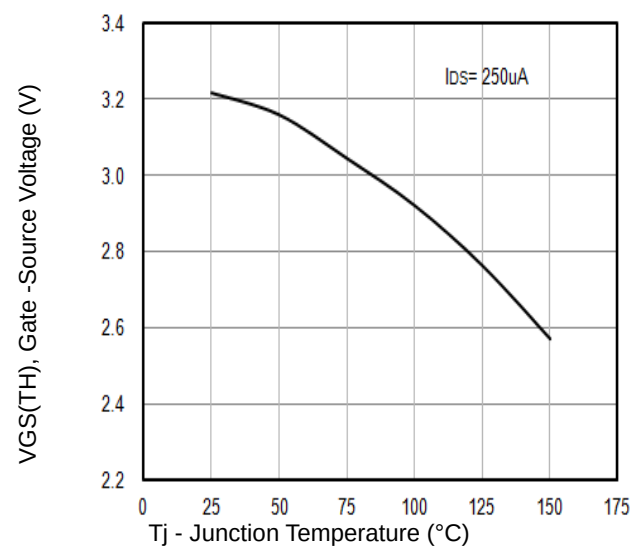


Fig2.  $V_{GS(TH)}$  Gate-Source Voltage Vs.  $T_j$

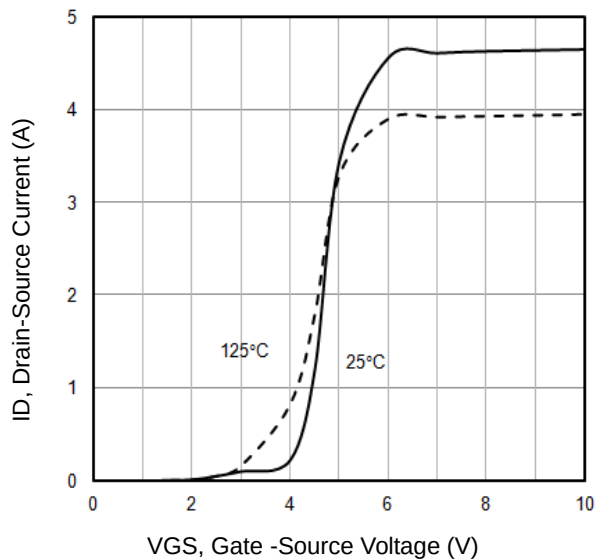


Fig3. Typical Transfer Characteristics

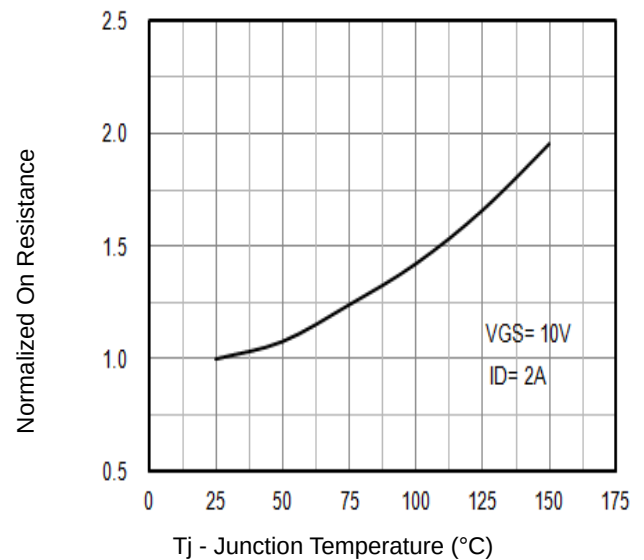


Fig4. Normalized On-Resistance Vs.  $T_j$

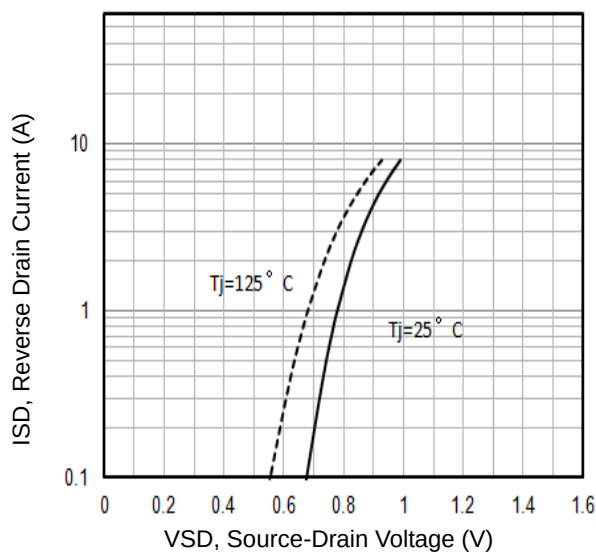


Fig5. Typical Source-Drain Diode Forward Voltage

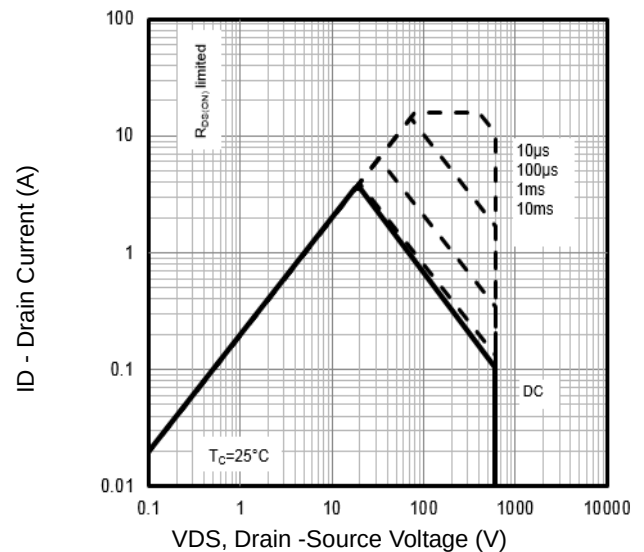
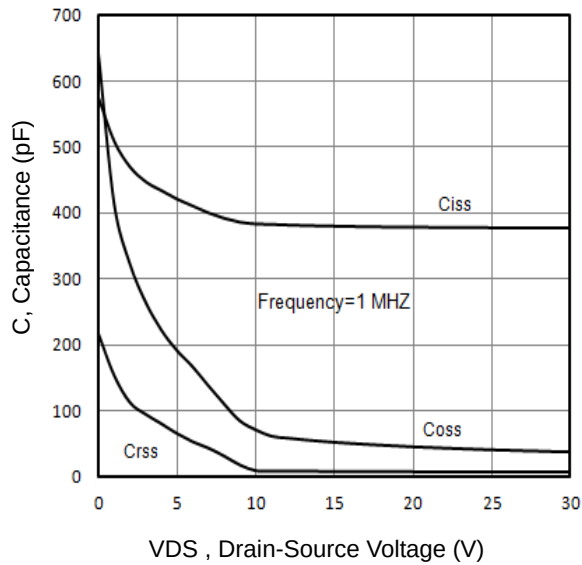
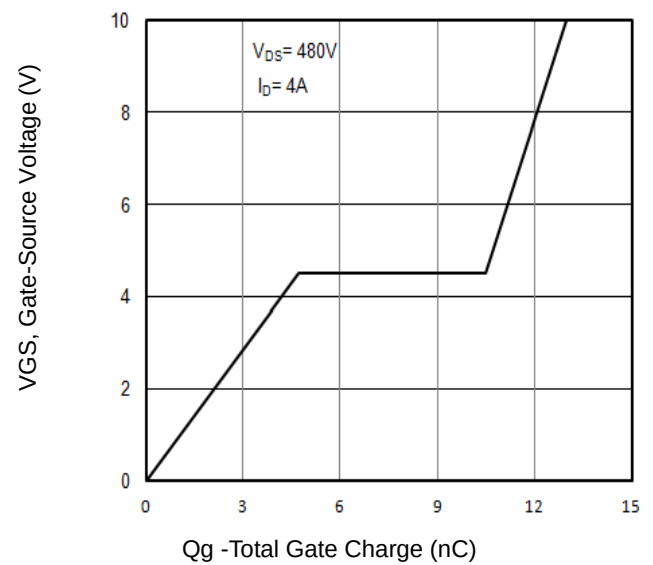


Fig6. Maximum Safe Operating Area

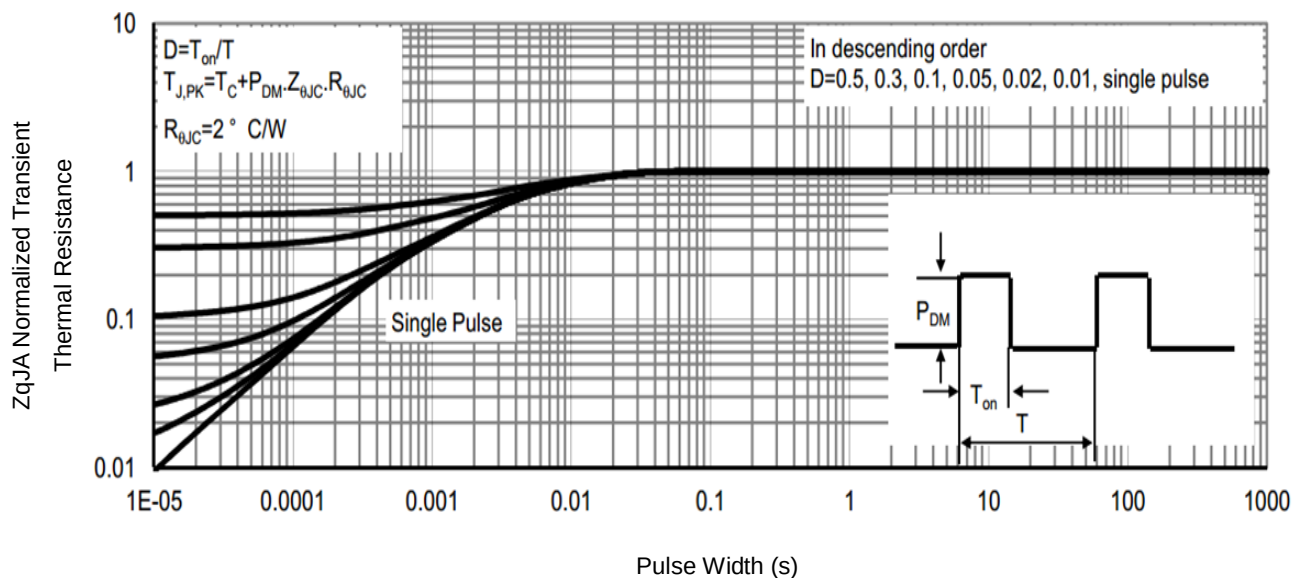
## Typical Characteristics



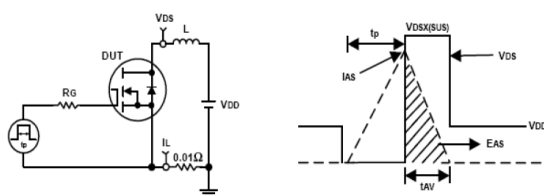
**Fig7.** Typical Capacitance Vs. Drain-Source Voltage



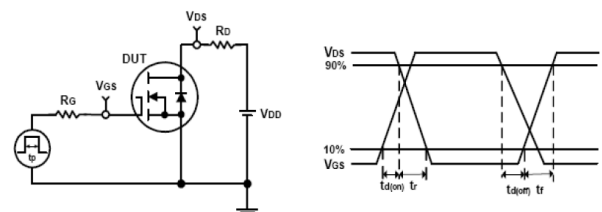
**Fig8.** Typical Gate Charge Vs. Gate-Source Voltage



**Fig9.** Normalized Maximum Transient Thermal Impedance



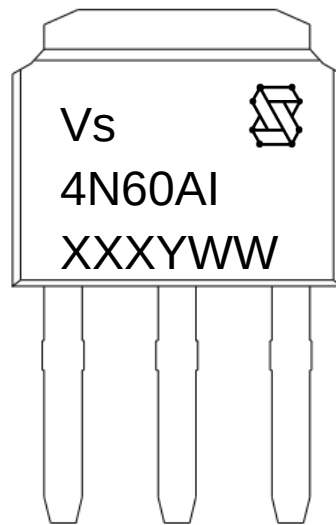
**Fig10.** Unclamped Inductive Test Circuit and waveforms



**Fig11.** Switching Time Test Circuit and waveforms

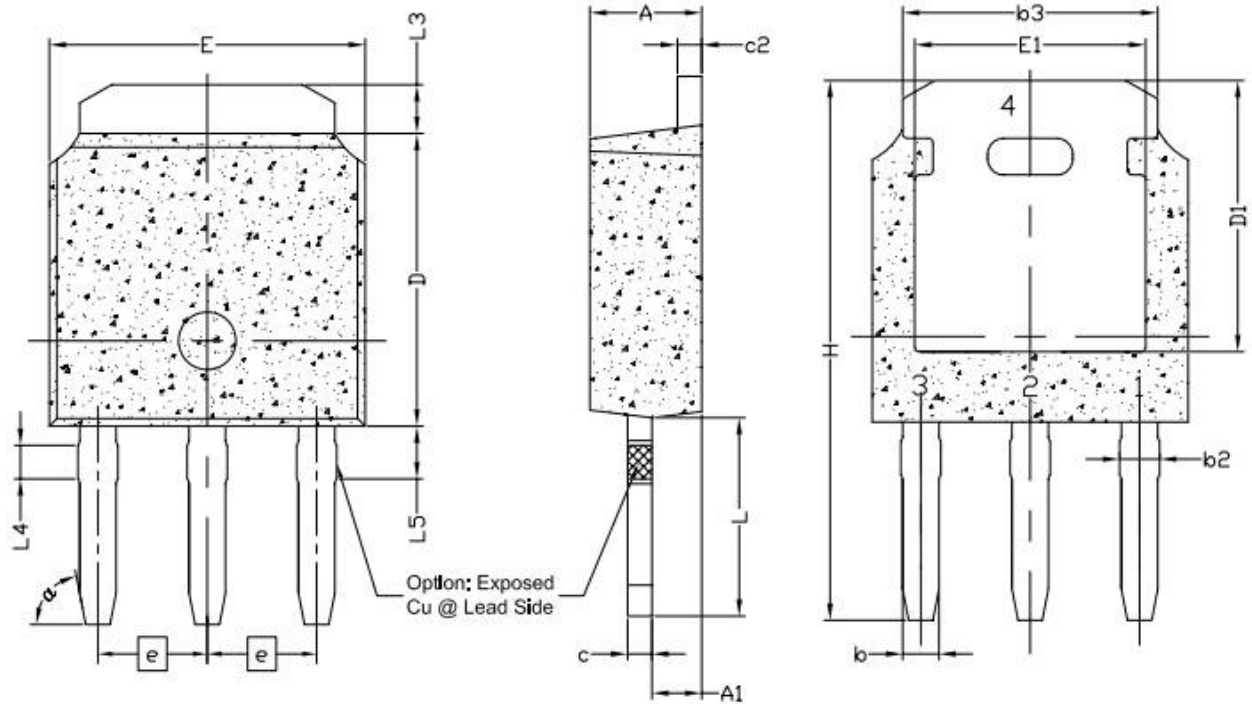


## Marking Information



- 1st line: Vanguard Code (Vs), Vanguard Logo  
2nd line: Part Number (4N60AI)  
3rd line: Date code (XXXYWW)  
XXX: Wafer Lot Number  
Y: Year Code, e.g. E means 2017  
WW: Week Code

## TO-251SL Package Outline Data



| Symbol | Dimensions (unit: mm) |       |       |
|--------|-----------------------|-------|-------|
|        | Min                   | Typ   | Max   |
| A      | 2.20                  | 2.30  | 2.39  |
| A1     | 0.89                  | 1.04  | 1.15  |
| b      | 0.64                  | 0.76  | 0.89  |
| b2     | 0.77                  | 0.84  | 1.14  |
| b3     | 5.21                  | 5.34  | 5.46  |
| c      | 0.46                  | 0.50  | 0.60  |
| c2     | 0.46                  | 0.50  | 0.60  |
| D      | 5.98                  | 6.10  | 6.223 |
| D1     | 5.10                  | --    | --    |
| E      | 6.40                  | 6.60  | 6.731 |
| E1     | 4.40                  | --    | --    |
| e      | 2.286 BSC             |       |       |
| H      | 11.05                 | 11.25 | 11.45 |
| L      | 3.98                  | 4.13  | 4.35  |
| L3     | 0.89                  | --    | 1.27  |
| L4     | 0.698 REF             |       |       |
| L5     | 0.972                 | 1.099 | 1.226 |
| α      | 79° REF               |       |       |

### Notes:

1. Dimension "D" and "E" do NOT include mold flash, protrusion or gate burrs. Mold flash, protrusion or gate burrs shall not exceed 0.1mm per side.

## Customer Service

### Sales and Service:

[sales@vgsemi.com](mailto:sales@vgsemi.com)

### Vanguard Semiconductor CO., LTD

TEL: (86-755) -26902410

FAX: (86-755) -26907027

WEB: [www.vgsemi.com](http://www.vgsemi.com)