



# CEU13N65S

650V ▲ 0.27Ω ▲ 12.3A ▲ Si MOSFET

SILICON Si MOSFET ▲ SMD type

N-channel enhancement mode

UL94V-0 rated flame retardant epoxy

TO252 (DPAK) package ▲ MSL 3

Super high dense cell density for extremely low  $R_{DS(ON)}$

**High power and current handling capability**

## MAXIMUM RATINGS

| Parameter ( $T_C = 25^\circ\text{C}$ , unless otherwise noted) |                | Characteristics                             |
|--|----------------|---|
| Drain-Source Voltage   | $V_{DS}$       | 650V  |
| Gate-Source Voltage  | $V_{GS}$       | $\pm 30\text{V}$                            |
| Continuous Drain Current at $T_C = 25^\circ\text{C}$           | $I_D$          | 12.3A                                       |
| Continuous Drain Current at $T_C = 100^\circ\text{C}$          | $I_D$          | 7.8A  |
| Pulsed Drain Current <sup>Note 1</sup>                         | $I_{DM}$       | 49.2A                                       |
| Maximum Power Dissipation at $T_C = 25^\circ\text{C}$          | $P_D$          | 125W  |
| Power Dissipation Derating above $25^\circ\text{C}$            | $\Delta P_D$   | 1W/ $^\circ\text{C}$                        |
| Single Pulsed Avalanche Energy <sup>Note 5</sup>               | $E_{AS}$       | 306mJ                                       |
| Single Pulsed Avalanche Current <sup>Note 5</sup>              | $I_{AS}$       | 3.5A  |
| Operating and Storage Temperature Range                        | $T_J, T_{STG}$ | $-55^\circ\text{C}$ to $+150^\circ\text{C}$ |

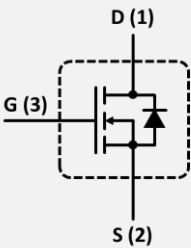
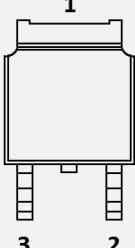
## THERMAL CHARACTERISTICS

| Parameter                               | Symbol       | Limit                 |
|---|--------------|-----------------------|
| Thermal Resistance, Junction-to-Case    | $R_{TH\_JC}$ | 1 $^\circ\text{C/W}$  |
| Thermal Resistance, Junction-to-Ambient | $R_{TH\_JA}$ | 50 $^\circ\text{C/W}$ |

## APPLICATIONS

| EV Charging   | Industrial Inverters  | Motors & Drives   | Power Factor Correction   | Renewable Energy   | SMPS  | UPS   |
|---|---|---|---|--|---|---|
|  |  |  |  |  |  |  |

## PIN DESCRIPTION

| Circuit Diagram   | Outline - Bottom View   | Pin No.     | Description             |
|---|---|-------------|-------------------------|
|  |  | 1<br>2<br>3 | Drain<br>Source<br>Gate |

## ELECTRICAL CHARACTERISTICS ▲ $T_C = 25^\circ\text{C}$ , unless otherwise noted

| Item  | Condition  | Symbol       | Min. | Typ. | Max. | Unit     |
|---|--|--------------|------|------|------|----------|
| <b>Off Characteristics</b>                                    |  |              |      |      |      |          |
| Drain-Source Breakdown Voltage                                | $V_{GS} = 0V, I_D = 250\mu A$                                  | $BV_{DSS}$   | 650  |      |      | V        |
| Zero Gate Voltage Drain Current                               | $V_{DS} = 650V, V_{GS} = 0V$                                   | $I_{DSS}$    |      |      | 1    | $\mu A$  |
| Gate Body Leakage Current, Forward                            | $V_{GS} = 30V, V_{DS} = 0V$                                    | $I_{GSSF}$   |      |      | 100  | nA       |
| Gate Body Leakage Current, Reverse                            | $V_{GS} = -30V, V_{DS} = 0V$                                   | $I_{GSSR}$   |      |      | -100 | nA       |
| <b>On Characteristics</b> <sup>Note 3</sup>                   |  |              |      |      |      |          |
| Gate Threshold Voltage  | $V_{GS} = V_{DS}, I_D = 250\mu A$                              | $V_{GS(th)}$ | 2.5  |      | 4.5  | V        |
| Static Drain-Source On-Resistance                             | $V_{GS} = 10V, I_D = 5.5A$                                     | $R_{DS(ON)}$ |      | 0.27 | 0.32 | $\Omega$ |
| Gate Input Resistance   | $f = 1\text{MHz}$ , Open Drain                                 | $R_G$        |      | 8    |      | $\Omega$ |
| <b>Dynamic Characteristics</b> <sup>Note 4</sup>              |  |              |      |      |      |          |
| Input Capacitance   | $V_{DS} = 150V, V_{GS} = 0V, f = 1\text{MHz}$                  | $C_{ISS}$    |      | 910  |      | pF       |
| Output Capacitance  | $V_{DS} = 150V, V_{GS} = 0V, f = 1\text{MHz}$                  | $C_{OSS}$    |      | 60   |      | pF       |
| Reverse Transfer Capacitance                                  | $V_{DS} = 150V, V_{GS} = 0V, f = 1\text{MHz}$                  | $C_{RSS}$    |      | 15   |      | pF       |
| <b>Switching Characteristics</b> <sup>Note 4</sup>            |  |              |      |      |      |          |
| Turn-On Delay Time  | $V_{DD} = 400V, V_{GS} = 10V, I_D = 6A, R_{G(ext)} = 10\Omega$ | $t_{D(ON)}$  |      | 30   |      | ns       |
| Turn-On Rise Time   | $V_{DD} = 400V, V_{GS} = 10V, I_D = 6A, R_{G(ext)} = 10\Omega$ | $t_R$        |      | 13   |      | ns       |
| Turn-Off Delay Time   | $V_{DD} = 400V, V_{GS} = 10V, I_D = 6A, R_{G(ext)} = 10\Omega$ | $t_{D(OFF)}$ |      | 65   |      | ns       |
| Turn-Off Fall Time  | $V_{DD} = 400V, V_{GS} = 10V, I_D = 6A, R_{G(ext)} = 10\Omega$ | $t_F$        |      | 11   |      | ns       |
| Total Gate Charge   | $V_{DS} = 400V, V_{GS} = 10V, I_D = 1A$                        | $Q_G$        |      | 25   |      | nC       |
| Gate Source Charge  | $V_{DS} = 400V, V_{GS} = 10V, I_D = 1A$                        | $Q_{GS}$     |      | 4    |      | nC       |
| Gate Drain Charge   | $V_{DS} = 400V, V_{GS} = 10V, I_D = 1A$                        | $Q_{GD}$     |      | 10   |      | nC       |
| <b>Drain-Source Diode Characteristics and Maximum Ratings</b> |  |              |      |      |      |          |
| Drain-Source Diode Forward Current                            |  | $I_S$        |      |      | 12.3 | A        |
| Drain-Source Diode Forward Voltage                            | $V_{GS} = 0V, I_S = 6A$  | $V_{SD}$     |      |      | 1.2  | V        |
| Reverse Recovery Time   | $I_D = 6A, di/dt = 100A/\mu s$                                 | $t_{RR}$     |      | 240  |      | ns       |
| Reverse Recovery Charge                                       | $I_D = 6A, di/dt = 100A/\mu s$                                 | $Q_{RR}$     |      | 2.35 |      | $\mu C$  |
| Peak Reverse Recovery Current                                 | $I_D = 6A, di/dt = 100A/\mu s$                                 | $I_{RR}$     |      | 16.8 |      | A        |

### Notes

- 1: Repetitive Rating: Pulse width limited by maximum junction temperature.
- 2: Surface Mounted on FR4 Board,  $t < 10$  sec.
- 3: Pulse Test: Pulse Width  $\leq 300\mu s$ , Duty Cycle  $\leq 2\%$ .
- 4: Guaranteed by design, not subject to production testing.
- 5:  $L = 50\text{mH}$ ,  $I_{AS} = 3.5A$ ,  $V_{DD} = 50V$ ,  $R_G = 25\Omega$ , Starting  $T_J = 25^\circ\text{C}$

## REFERENCE DATA ▲ TYPICAL DEVICE PERFORMANCE

Fig. 1 • Output Characteristics

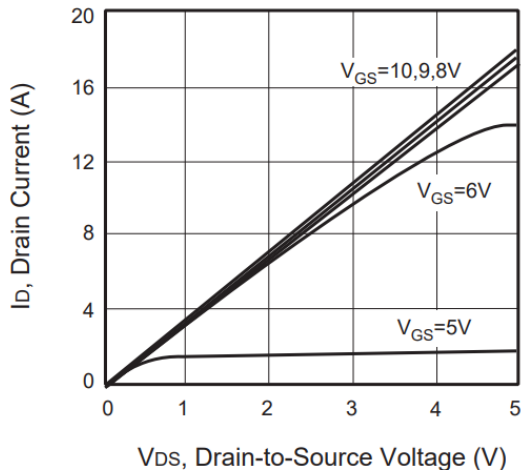


Fig. 2 • Transfer Characteristics

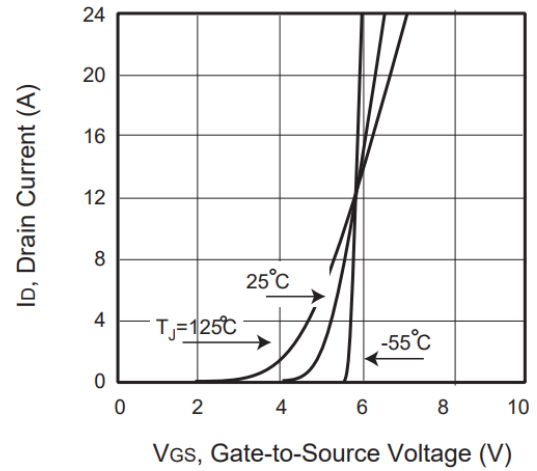


Fig. 3 • Capacitance

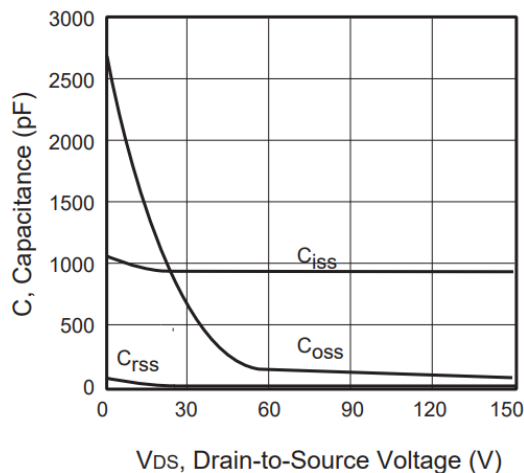


Fig. 4 • On-Resistance Variation with Temperature

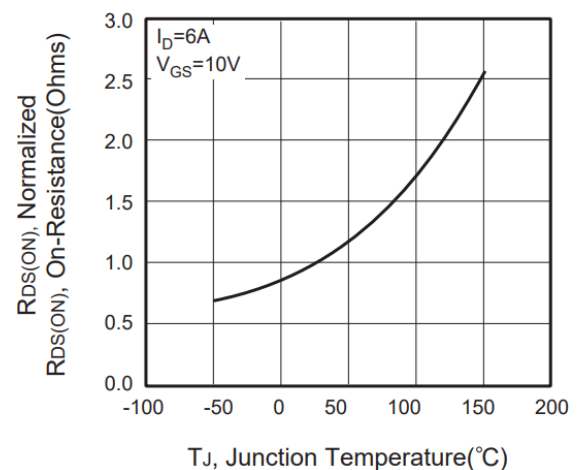


Fig. 5 • Gate Threshold Variation with Temperature

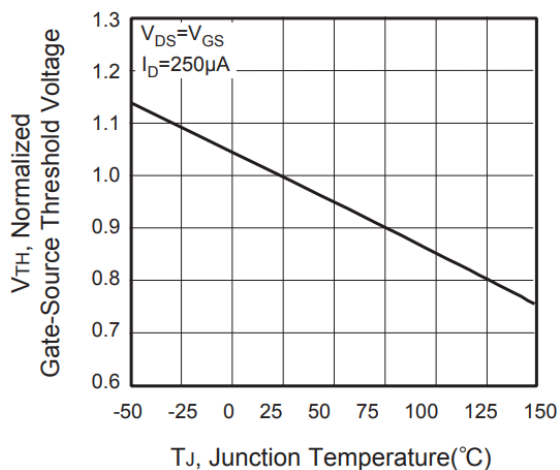
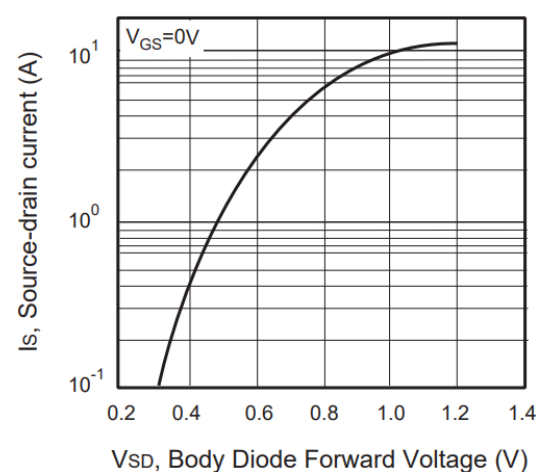


Fig. 6 • Body Diode Forward Voltage Variation with Source Current



## REFERENCE DATA ▲ TYPICAL DEVICE PERFORMANCE

Fig. 7 • Gate Charge

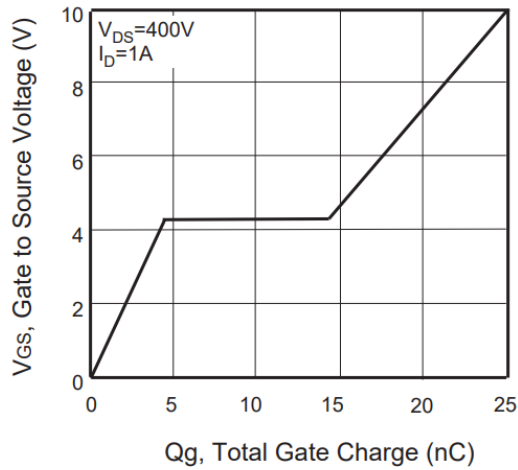


Fig. 8 • Maximum Safe Operating Area

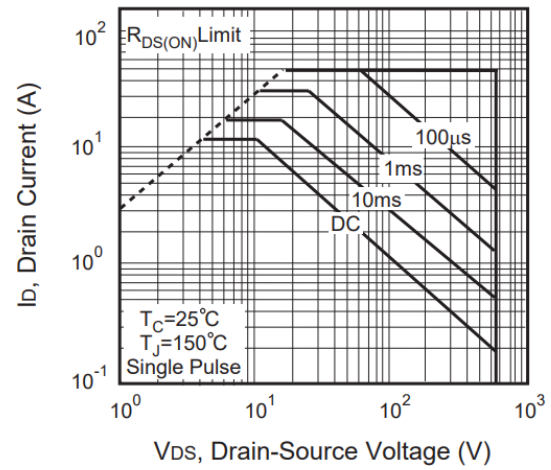


Fig. 9 • Breakdown Voltage Variation vs. Temperature

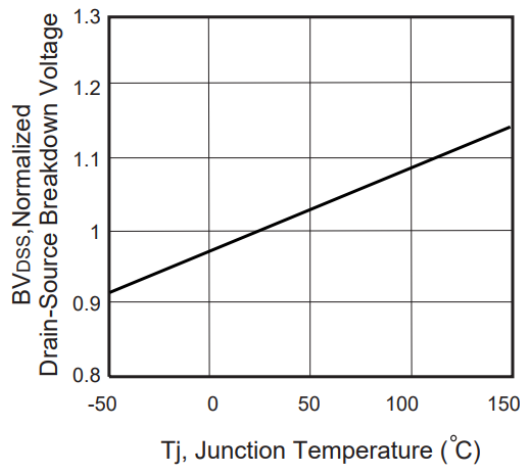
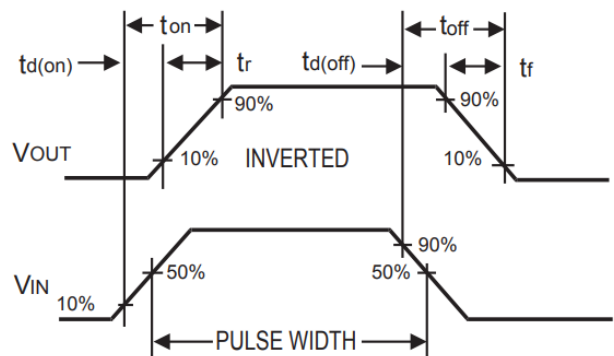


Fig. 10 • Switching Test Circuit

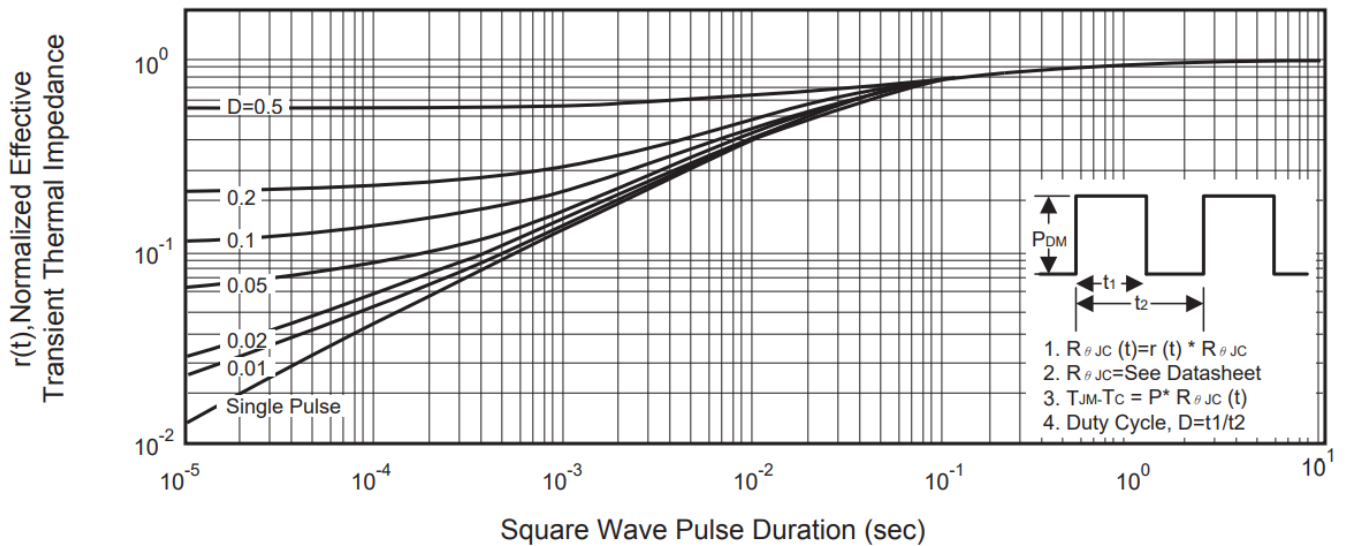


Fig. 11 • Switching Waveforms

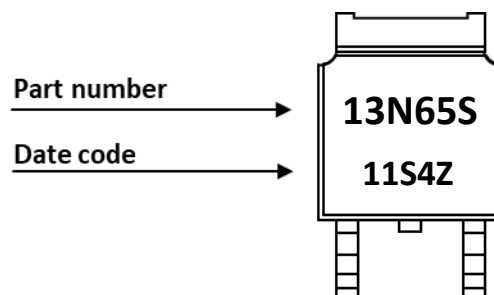


## REFERENCE DATA ▲ TYPICAL DEVICE PERFORMANCE

Fig. 12 • Normalized Thermal Transient Impedance Curve

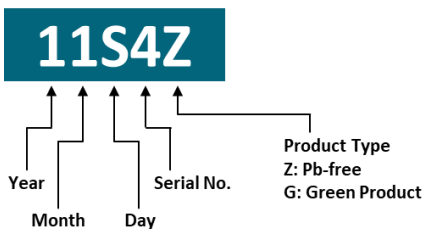


## PART MARKING



## DATE CODE

Example: 11S4Z



Coding list for „Day“

|    |    |    |    |    |    |    |    |    |    |
|----|----|----|----|----|----|----|----|----|----|
| 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | A  |
| 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 |
| B  | C  | D  | E  | F  | G  | H  | I  | J  | K  |
| 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| L  | M  | N  | O  | P  | Q  | R  | S  | T  | U  |
| 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
| V  |    |    |    |    |    |    |    |    |    |
| 31 |    |    |    |    |    |    |    |    |    |

Coding list for „Month“

|     |     |     |     |     |     |
|-----|-----|-----|-----|-----|-----|
| 1   | 2   | 3   | 4   | 5   | 6   |
| Jan | Feb | Mar | Apr | May | Jun |
| 7   | 8   | 9   | A   | B   | C   |
| Jul | Aug | Sep | Oct | Nov | Dec |

Coding list for „Year“

|      |      |      |      |      |
|------|------|------|------|------|
| 0    | 1    | 2    | 3    | 4    |
| 2020 | 2021 | 2022 | 2023 | 2024 |
| 5    | 6    | 7    | 8    | 9    |
| 2025 | 2026 | 2027 | 2028 | 2029 |

## PACKAGE OUTLINE



| Sym | Millimeters<br>(Min.) | Millimeters<br>(Typ.) | Millimeters<br>(Max.) |
|-----|-----------------------|-----------------------|-----------------------|
| A   | 2.20                  | 2.30                  | 2.38                  |
| A1  | 0.00                  | -                     | 0.20                  |
| A2  | 0.90                  | 1.07                  | 1.17                  |
| b   | 0.68                  | 0.78                  | 0.90                  |
| b3  | 5.23                  | 5.33                  | 5.46                  |
| c   | 0.43                  | 0.53                  | 0.61                  |
| D   | 5.98                  | 6.10                  | 6.22                  |
| D1  | 5.30 REF              |                       |                       |
| E   | 6.40                  | 6.60                  | 6.73                  |
| E1  | 4.63                  | -                     | -                     |

| Sym | Millimeters<br>(Min.) | Millimeters<br>(Typ.) | Millimeters<br>(Max.) |
|-----|-----------------------|-----------------------|-----------------------|
| e   |                       | 2.286 BSC             |                       |
| H   | 9.40                  | 10.10                 | 10.50                 |
| L   | 1.38                  | 1.50                  | 1.75                  |
| L1  | 2.90 REF              |                       |                       |
| L2  | 0.51 BSC              |                       |                       |
| L3  | 0.88                  | -                     | 1.28                  |
| L4  | 0.50                  | .                     | 1.00                  |
| L5  | 1.65                  | 1.80                  | 1.95                  |
| θ   | 0°                    | -                     | 8°                    |

## ORDERING INFORMATION

| Part Number | Package      | Packing | Reel Qty. | Inner Box Qty. | Outer Box Qty. |
|-------------|--------------|---------|-----------|----------------|----------------|
| CEU13N65S   | TO252 (DPAK) | Reel    | 2,500pcs  | 5,000pcs       | 40,000pcs      |

## RECOMMENDED PAD LAYOUT



| Sym | Millimeters<br>(Min.) | Millimeters<br>(Typ.) | Millimeters<br>(Max.) |
|-----|-----------------------|-----------------------|-----------------------|
| F1  | -                     | 6.00                  | -                     |
| F2  | -                     | 6.25                  | -                     |
| F3  | -                     | 1.40                  | -                     |
| F4  | -                     | 2.29                  | -                     |

| Sym | Millimeters<br>(Min.) | Millimeters<br>(Typ.) | Millimeters<br>(Max.) |
|-----|-----------------------|-----------------------|-----------------------|
| F5  | -                     | 2.29                  | -                     |
| F6  | -                     | 1.40                  | -                     |
| F7  | -                     | 3.00                  | -                     |
| F8  | -                     | 6.50                  | -                     |

### Notes:

1. The suggested land pattern dimensions have been provided for reference only.
2. For further information, please reference document IPC-7351A.

**REEL DIMENSIONS ▲ All dimensions in mm**


| Tape Size | Reel Size | M       | N       | T     | H     | K              | S              |
|-----------|-----------|---------|---------|-------|-------|----------------|----------------|
| 16mm      | Ø330      | Ø330.00 | Ø100.00 | 2.10  | 22.00 | 13.00          | 2.00           |
|           |           | ±2.00   | ±0.50   | ±0.20 | ±0.50 | +0.50<br>-0.20 | +0.50<br>-0.20 |

**TAPE DIMENSIONS ▲ All dimensions in mm**


| Package         | A0    | B0    | K0    | D0   | D1    | E              | E1    | E2    | P0    | P1    | P2    | T     |
|-----------------|-------|-------|-------|------|-------|----------------|-------|-------|-------|-------|-------|-------|
| TO252<br>(DPAK) | 6.90  | 10.50 | 2.70  | 1.50 | 1.50  | 16.00          | 1.75  | 7.50  | 8.00  | 4.00  | 2.00  | 0.30  |
|                 | ±0.10 | ±0.10 | ±0.10 | MIN  | ±0.10 | +0.30<br>-0.20 | ±0.10 | ±0.10 | ±0.10 | ±0.10 | ±0.10 | ±0.05 |

**Note:** All dimensions meet EIA-481-D requirements.



## RECOMMENDED REFLOW SOLDERING PROFILE



### Recommended reflow soldering conditions ▲ Refer to JEDEC J-STD-020E

| Profile Features   |              | Sn-Pb Eutetic Assembly | Pb-Free Assembly |
|--|--------------|------------------------|------------------|
| Preheat temperature min.   | $T_{s \min}$ | 100 °C                 | 150 °C           |
| Preheat temperature max.   | $T_{s \max}$ | 150 °C                 | 200 °C           |
| Preheat time $t_s$ from $T_{s \min}$ to $T_{s \max}$                     | $t_s$        | 120 seconds            | 120 seconds      |
| Ramp-up rate ( $T_L$ to $T_p$ )  |              | max. 3 °C/second       | max. 3 °C/second |
| Liquidous temperature  | $T_L$        | 183 °C                 | 217 °C           |
| Time $t_L$ maintained above $T_L$  | $t_L$        | 150 seconds max.       | 150 seconds max. |
| Peak package body temperature  | $T_p$        | 235°C                  | 260°C            |
| Timeframe of within 5°C below and up to max actual peak body temperature | $t_p$        | 20 seconds max.        | 30 seconds max.  |
| Ramp-down rate ( $T_L$ to $T_p$ )  |              | max. 6 °C/second       | max. 6 °C/second |
| Time 25°C to peak temperature  |              | max. 6 minutes         | max. 8 minutes   |

## REVISION TABLE

| Revision | Date       | Status          | Notes               |
|----------|------------|-----------------|---------------------|
| 001      | 30/09/2022 | Initial release | Initial publication |
|          |            |                 |                     |
|          |            |                 |                     |
|          |            |                 |                     |
|          |            |                 |                     |
|          |            |                 |                     |

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