

SuperMOS –TO-252 60V  $BV_{DSS}$ , 26m $\Omega$   $R_{DS(on)}$ , N-channel MOSFET

## 1. Description

The IRFR024NTRPBF-ES is N-Channel enhancement MOS Field Effect Transistor. Uses advanced technology and design to provide excellent  $R_{DS(on)}$  with low gate charge. Device is suitable for use in DC-DC conversion, power switch and charging circuit. Standard Product IRFR024NTRPBF-ES is Pb-free.

## 2. Features

- 60V,  $R_{DS(on)}=26m\Omega$ (TYP.) @ $V_{GS}=10V$   
 $R_{DS(on)}=33m\Omega$ (TYP.) @ $V_{GS}=4.5V$
- High density cell design for low  $R_{DS(on)}$
- Material: Halogen free
- Reliable and rugged
- Avalanche Rated
- Low leakage current

## 3. Applications

- PWM applications
- Load switch
- Power management in portable/desktop PCs
- DC/DC conversion

100% UIS TESTED!

## 4. Ordering Information

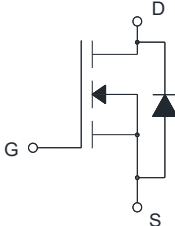
| Part Number      | Package | Marking          | Material     | Packaging   | Quantity per reel | Flammability Rating | Reel Size |
|------------------|---------|------------------|--------------|-------------|-------------------|---------------------|-----------|
| IRFR024NTRPBF-ES | TO-252  | ES35N06A/LO<br>T | Halogen free | Tape & Reel | 2,500 PCS         | UL 94V-0            | 13 inches |

## 5. Pin Configuration and Functions

| Pin | Function | Outline | Circuit Diagram |
|-----|----------|---------|-----------------|
| 1   | Gate     | Note b  |                 |
| 3   | Source   |         |                 |

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|   |       |                                                                                   |                                                                                     |
|---|-------|-----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| 2 | Drain |  |  |
|---|-------|-----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|

## 6. Specification

## Absolute Maximum Rating &amp; Thermal Characteristics

Ratings at 25 °C ambient temperature unless otherwise specified.

| Parameter                                     |                          | Symbol     | Limit      | Unit               |
|-----------------------------------------------|--------------------------|------------|------------|--------------------|
| Drain-Source Voltage                          |                          | $BV_{DSS}$ | 60         | V                  |
| Gate-Source Voltage                           |                          | $V_{GS}$   | $\pm 20$   | V                  |
| Continuous Drain Current                      | $T_C=25^{\circ}\text{C}$ | $I_D$      | 20         | A                  |
|                                               | $T_C=75^{\circ}\text{C}$ |            | 16         |                    |
| Maximum Power Dissipation                     |                          | $P_D$      | 25         | W                  |
| Pulsed Drain Current                          |                          | $I_{DM}$   | 80         | A                  |
| Avalanche Current, Single Pulsed <sup>a</sup> |                          | $I_{AS}$   | 16         | A                  |
| Avalanche Energy, Single Pulsed <sup>a</sup>  |                          | $E_{AS}$   | 16         | mJ                 |
| Operating Junction Temperature                |                          | $T_J$      | 150        | $^{\circ}\text{C}$ |
| Lead Temperature                              |                          | $T_L$      | 260        | $^{\circ}\text{C}$ |
| Storage Temperature Range                     |                          | $T_{stg}$  | -55 to 150 | $^{\circ}\text{C}$ |

## Thermal resistance ratings

| Single Operation                    |              |                 |     |     |                      |
|-------------------------------------|--------------|-----------------|-----|-----|----------------------|
| Parameter                           |              | Symbol          | Typ | Max | Unit                 |
| Junction-to-Case Thermal Resistance | Steady State | $R_{\theta JC}$ |     | 5   | $^{\circ}\text{C/W}$ |

Note:

a:  $T_J=25^{\circ}\text{C}$ ,  $V_{DD}=60\text{V}$ ,  $V_G=10\text{V}$ ,  $L=0.3\text{mH}$ ,  $R_g=25\Omega$ 

b: This diagram is only an electrical schematic, and the actual pin size is based on POD.

## Electrical Characteristics

At TA = 25°C unless otherwise specified

| Parameter                                 | Symbol              | Test Conditions                                                                         | Min. | Typ. | Max. | Unit |
|-------------------------------------------|---------------------|-----------------------------------------------------------------------------------------|------|------|------|------|
| OFF CHARACTERISTICS                       |                     |                                                                                         |      |      |      |      |
| Drain-to-Source Breakdown Voltage         | BV <sub>DSS</sub>   | V <sub>GS</sub> =0V, I <sub>D</sub> =250uA                                              | 60   |      |      | V    |
| Zero Gate Voltage Drain Current           | I <sub>DSS</sub>    | V <sub>DS</sub> =60V, V <sub>GS</sub> =0V                                               |      |      | 1.0  | uA   |
| Gate-to-source Leakage Current            | I <sub>GSS</sub>    | V <sub>DS</sub> =0V, V <sub>GS</sub> =±20V                                              |      |      | ±100 | nA   |
| ON CHARACTERISTICS                        |                     |                                                                                         |      |      |      |      |
| Gate Threshold Voltage                    | V <sub>GS(TH)</sub> | V <sub>GS</sub> =V <sub>DS</sub> , I <sub>D</sub> =250uA                                | 1.0  | 1.6  | 2.5  | V    |
| Drain-to-source On-resistance             | R <sub>DS(on)</sub> | V <sub>GS</sub> =10V, I <sub>D</sub> =20A                                               |      | 26   | 33   | mΩ   |
|                                           |                     | V <sub>GS</sub> =4.5V, I <sub>D</sub> =10A                                              |      | 33   | 45   |      |
| Forward Trans conductance                 | g <sub>FS</sub>     | V <sub>DS</sub> =5.0V, I <sub>D</sub> =20A                                              |      |      | 40   | S    |
| CHARGES, CAPACITANCES AND GATE RESISTANCE |                     |                                                                                         |      |      |      |      |
| Input Capacitance                         | C <sub>ISS</sub>    | V <sub>GS</sub> =0V, f=1MHz,<br>V <sub>DS</sub> =25V                                    |      | 860  |      | pF   |
| Output Capacitance                        | C <sub>OSS</sub>    |                                                                                         |      | 62   |      |      |
| Reverse Transfer Capacitance              | C <sub>RSS</sub>    |                                                                                         |      | 51   |      |      |
| Total Gate Charge                         | Q <sub>G(TOT)</sub> | V <sub>GS</sub> =10V, V <sub>DS</sub> =30V,<br>I <sub>D</sub> =10A                      |      | 20.3 |      | nC   |
| Gate-to-Source Charge                     | Q <sub>GS</sub>     |                                                                                         |      | 3.8  |      |      |
| Gate-to-Drain Charge                      | Q <sub>GD</sub>     |                                                                                         |      | 5.5  |      |      |
| SWITCHING CHARACTERISTICS                 |                     |                                                                                         |      |      |      |      |
| Turn-On Delay Time                        | t <sub>d(ON)</sub>  | V <sub>GS</sub> =10V, V <sub>DS</sub> =30V,<br>I <sub>D</sub> =5A, R <sub>G</sub> =1.8Ω |      | 6    |      | ns   |
| Rise Time                                 | t <sub>r</sub>      |                                                                                         |      | 6    |      |      |
| Turn-Off Delay Time                       | t <sub>d(OFF)</sub> |                                                                                         |      | 19   |      |      |
| Fall Time                                 | t <sub>f</sub>      |                                                                                         |      | 3    |      |      |
| BODY DIODE CHARACTERISTICS                |                     |                                                                                         |      |      |      |      |
| Forward Voltage                           | V <sub>SD</sub>     | V <sub>GS</sub> =0V, I <sub>S</sub> =10A                                                |      | 0.7  | 1.5  | V    |

7. Typical Characteristic

Figure1: Output Characteristics

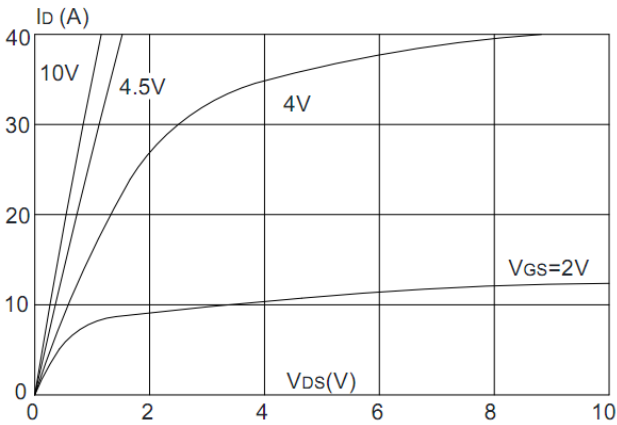


Figure 2: Typical Transfer Characteristics

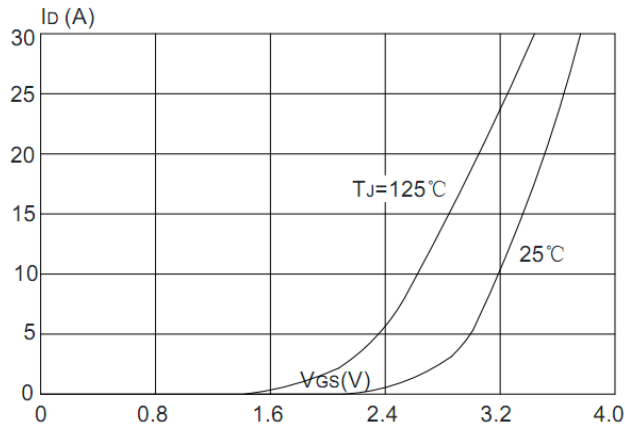


Figure 3: On-resistance vs. Drain Current

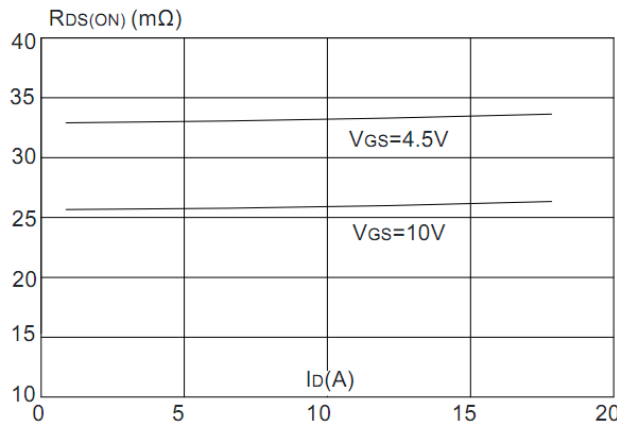


Figure 4: Body Diode Characteristics

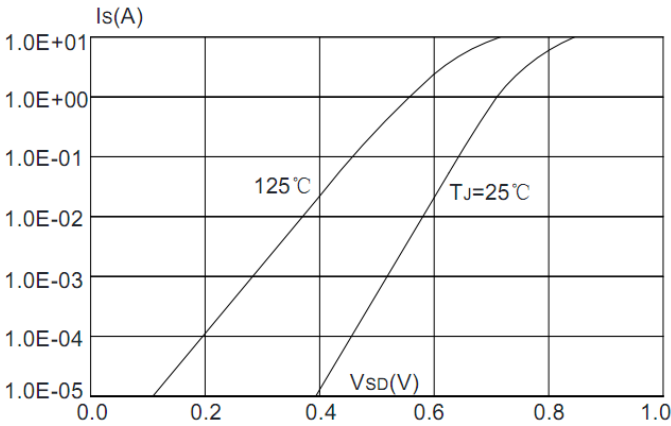


Figure 5: Capacitance Characteristics

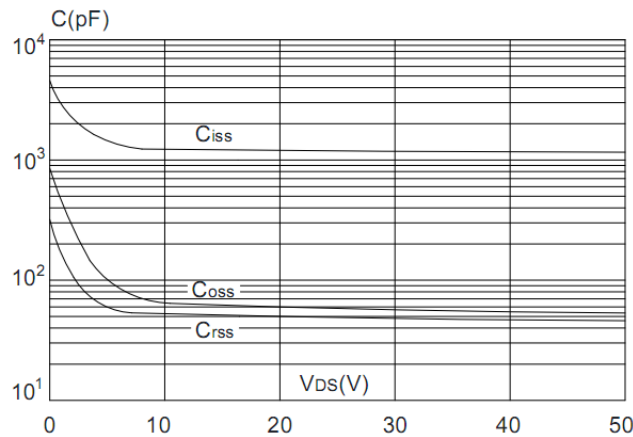
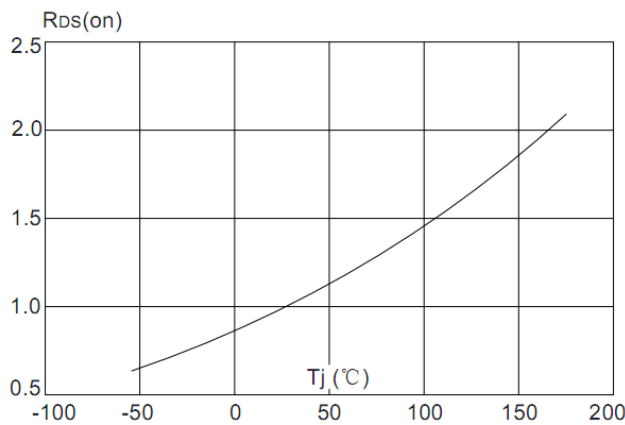
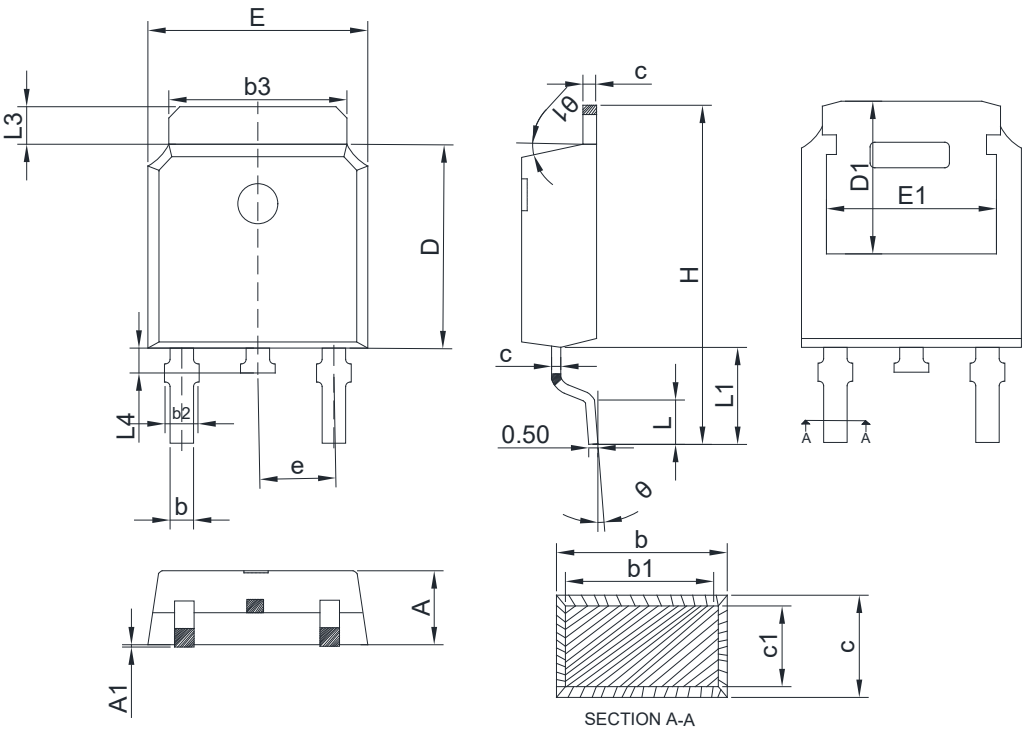


Figure 6: Normalized on Resistance vs. Junction Temperature



8. Dimension (TO-252)

POD A(Q)

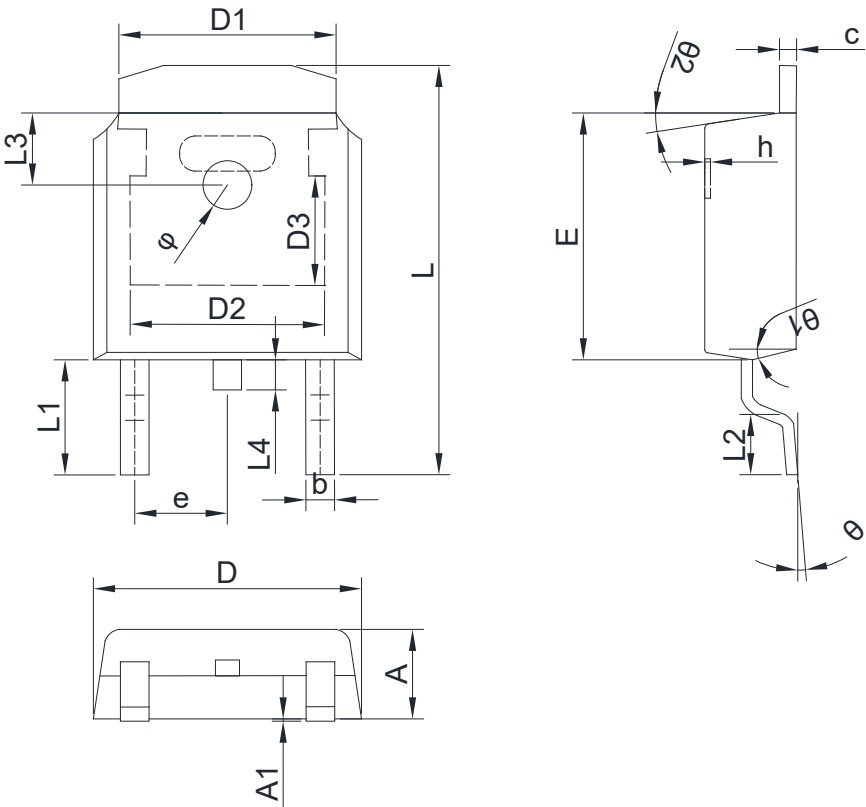


| COMMON DIMENSIONS CUNITS MEASURE=MILLIMETER |      |      |      |            |         |      |       |
|---------------------------------------------|------|------|------|------------|---------|------|-------|
| SYMBOL                                      | MIN  | TYP  | MAX  | SYMBOL     | MIN     | TYP  | MAX   |
| A                                           | 2.20 | 2.30 | 2.40 | D1         | 5.21    | -    | -     |
| A1                                          | 0.00 | -    | 0.12 | E          | 6.50    | 6.60 | 6.70  |
| b                                           | 0.65 | -    | 0.89 | E1         | 4.32    | -    | -     |
| b1                                          | 0.64 | 0.76 | 0.79 | H          | 9.70    | 9.95 | 10.20 |
| b2                                          | 0.76 | 0.86 | 1.10 | L          | 1.40    | 1.50 | 1.60  |
| b3                                          | 5.20 | 5.33 | 5.46 | L1         | 2.84REF |      |       |
| c                                           | 0.48 | -    | 0.60 | e          | 2.29BSC |      |       |
| c1                                          | 0.47 | 0.51 | 0.55 | $\theta$   | 0°      | -    | 10°   |
| D                                           | 6.00 | 6.10 | 6.20 | $\theta 1$ | 0°      | -    | 15°   |
| L3                                          | 0.90 | -    | 1.27 | L4         | 0.60    | 0.80 | 1.00  |

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POD B(X)

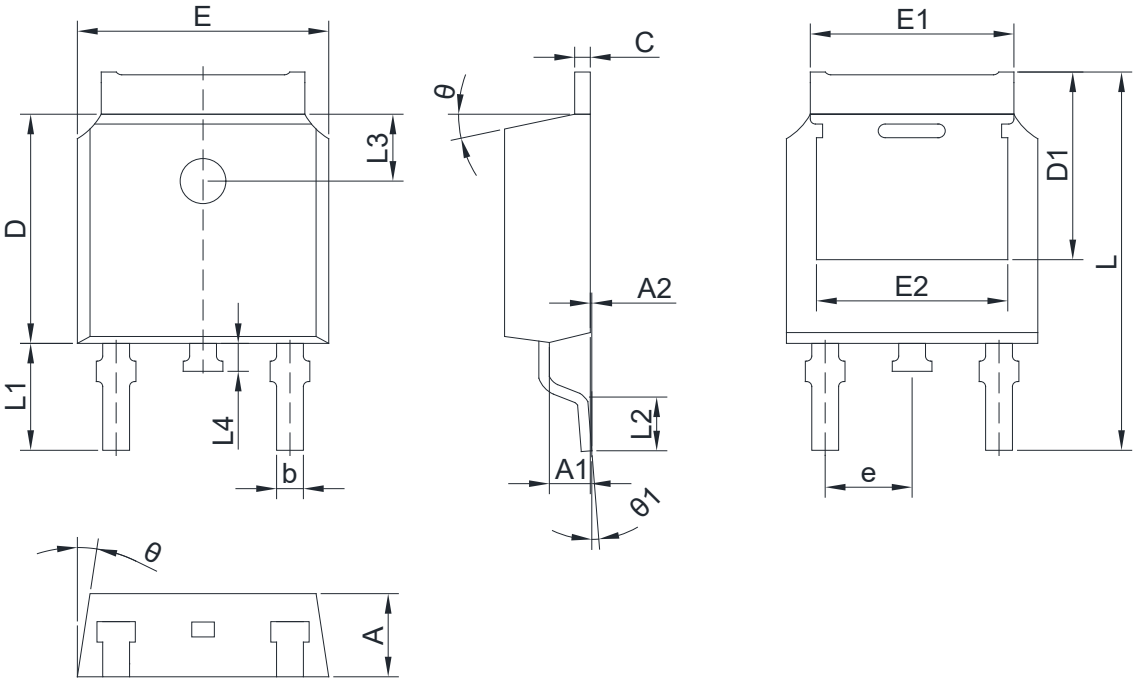


| COMMON DIMENSIONS CUNITS MEASURE=MILLIMETER |           |       |       |            |           |        |        |
|---------------------------------------------|-----------|-------|-------|------------|-----------|--------|--------|
| SYMBOL                                      | MIN       | TYP   | MAX   | SYMBOL     | MIN       | TYP    | MAX    |
| A                                           | 2.200     | 2.300 | 2.400 | h          | 0.000     | 0.100  | 0.200  |
| A1                                          | 0.000     |       | 0.127 | L          | 9.900     | 10.100 | 10.300 |
| b                                           | 0.640     | 0.690 | 0.740 | L1         | 2.888 REF |        |        |
| c(电镀后)                                      | 0.460     | 0.520 | 0.580 | L2         | 1.400     | 1.550  | 1.700  |
| D                                           | 6.500     | 6.600 | 6.700 | L3         | 1.600 REF |        |        |
| D1                                          | 5.334 REF |       |       | L4         | 0.600     | 0.800  | 1.000  |
| D2                                          | 4.826 REF |       |       | $\phi$     | 1.100     | 1.200  | 1.300  |
| D3                                          | 3.166 REF |       |       | $\theta$   | 0°        |        | 8°     |
| E                                           | 6.000     | 6.100 | 6.200 | $\theta_1$ | 9° TYP    |        |        |
| e                                           | 2.286 TYP |       |       | $\theta_2$ | 9° TYP    |        |        |

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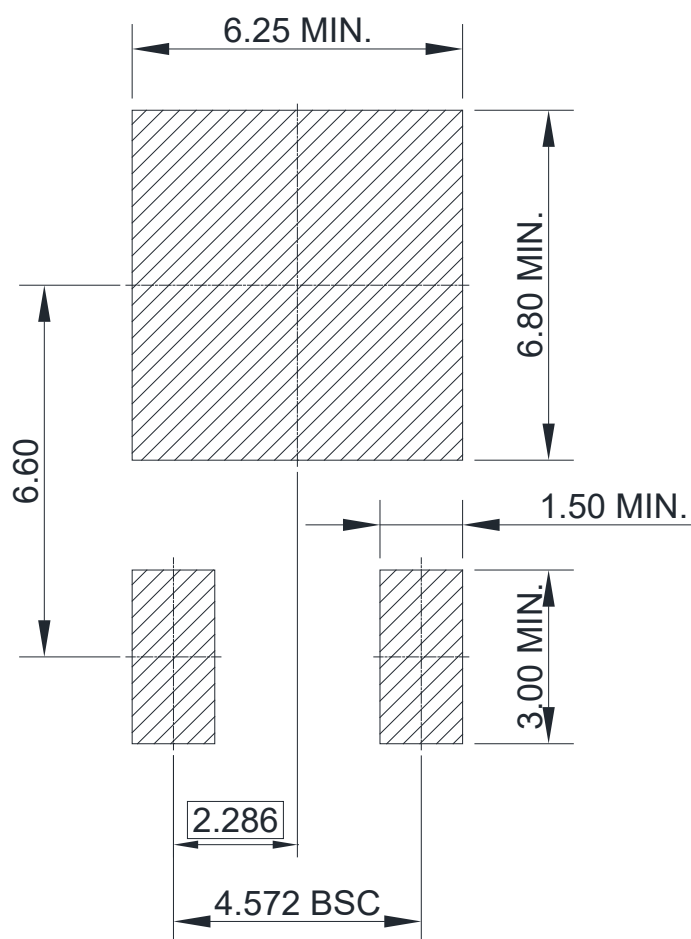
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POD C(J)



| COMMON DIMENSIONS CUNITS MEASURE=MILLIMETER |      |      |      |        |           |       |       |
|---------------------------------------------|------|------|------|--------|-----------|-------|-------|
| SYMBOL                                      | MIN  | TYP  | MAX  | SYMBOL | MIN       | TYP   | MAX   |
| A                                           | 2.10 | 2.30 | 2.50 | E2     | 4.63      | 4.83  | 5.03  |
| A1                                          | 0.97 | 1.07 | 1.17 | L      | 9.90      | 10.10 | 10.30 |
| A2                                          | 0.00 | -    | 0.12 | L1     | 2.74      | 2.94  | 3.14  |
| b                                           | 0.66 | 0.76 | 0.86 | L2     | 1.40      | 1.50  | 1.70  |
| C                                           | 0.45 | 0.51 | 0.60 | L3     | 1.65      | 1.80  | 1.95  |
| D                                           | 5.90 | 6.10 | 6.30 | L4     | 0.60      | 0.80  | 1.00  |
| D1                                          | 5.10 | 5.30 | 5.45 | e      | 2.286 BSC |       |       |
| E                                           | 6.40 | 6.60 | 6.80 | θ      | 5°        | 7°    | 10°   |
| E1                                          | 5.10 | 5.33 | 5.45 | θ1     | 0°        | -     | 3°    |

## 9. Recommended Soldering Footprint



DIMENSIONS: MILLIMETERS



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