

International  
**IR** Rectifier

Ignition IGBT

**IRGS14C40L**  
**IRGSL14C40L**  
**IRGB14C40LPbF**

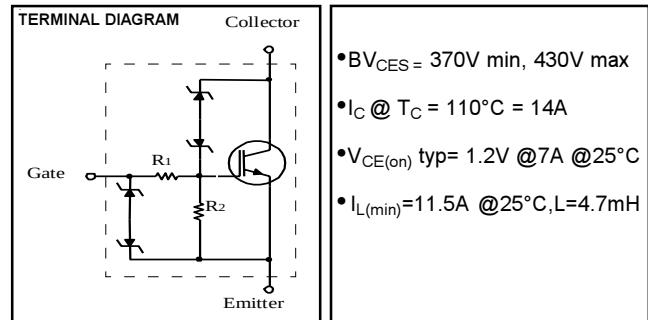
IGBT with on-chip Gate-Emitter and Gate-Collector clamps

### Features

- Most Rugged in Industry
- Logic-Level Gate Drive
- > 6KV ESD Gate Protection
- Low Saturation Voltage
- High Self-clamped Inductive Switching Energy
- TO-220 is available in PbF as a Lead-Free

### Description

The advanced IGBT process family includes a MOS gated, N-channel logic level device which is intended for coil-on-plug automotive ignition applications and small-engine ignition circuits. Unique features include on-chip active voltage clamps between the Gate-Emitter and Gate-Collector which provide over voltage protection capability in ignition circuits.



NOTE: IRGS14C40L is available in tape and reel. Add a suffix of TRR or TRL to the part number to determine the orientation of the device in the pocket, i.e, IRGS14C40LTRR or IRGS14C40LTRL.

### Absolute Maximum Ratings

|                           | Parameter                                | Max         | Unit       | Condition                         |
|---------------------------|------------------------------------------|-------------|------------|-----------------------------------|
| $V_{CES}$                 | Collector-to-Emitter Voltage             | Clamped     | V          | $R_G = 1K \text{ ohm}$            |
| $I_C @ T_C = 25^\circ C$  | Continuous Collector Current             | 20          | A          | $V_{GE} = 5V$                     |
| $I_C @ T_C = 110^\circ C$ | Continuous Collector Current             | 14          | A          | $V_{GE} = 5V$                     |
| $I_G$                     | Continuous Gate Current                  | 1           | mA         |                                   |
| $I_{Gp}$                  | Peak Gate Current                        | 10          | mA         | $t_{PK} = 1ms, f = 100Hz$         |
| $V_{GE}$                  | Gate-to-Emitter Voltage                  | Clamped     | V          |                                   |
| $P_D @ T_C = 25^\circ C$  | Maximum Power Dissipation                | 125         | W          |                                   |
| $P_D @ T = 110^\circ C$   | Maximum Power Dissipation                | 54          | W          |                                   |
| $T_J$                     | Operating Junction and                   | - 40 to 175 | $^\circ C$ |                                   |
| $T_{STG}$                 | Storage Temperature Range                | - 40 to 175 | $^\circ C$ |                                   |
| $V_{ESD}$                 | Electrostatic Voltage                    | 6           | KV         | $C = 100pF, R = 1.5K \text{ ohm}$ |
| $I_L$                     | Self-clamped Inductive Switching Current | 11.5        | A          | $L = 4.7mH, T = 25^\circ C$       |

### Thermal Resistance

|                 | Parameter                                              | Min | Typ | Max | Unit         |
|-----------------|--------------------------------------------------------|-----|-----|-----|--------------|
| $R_{\theta JC}$ | Thermal Resistance, Junction-to-Case                   |     |     | 1.2 | $^\circ C/W$ |
| $R_{\theta JA}$ | Thermal Resistance, Junction-to-Ambient                |     |     | 40  |              |
|                 | (PCB Mounted, Steady State)                            |     |     |     |              |
| $Z_{\theta JC}$ | Transient Thermal Impedance, Junction-to-Case (Fig.11) |     |     |     |              |

**Off-State Electrical Characteristics @  $T_J = 25^\circ\text{C}$  (unless otherwise specified)**

|            | Parameter                              | Min | Typ | Max | Unit          | Conditions                                                                 | Fig |
|------------|----------------------------------------|-----|-----|-----|---------------|----------------------------------------------------------------------------|-----|
| $BV_{CES}$ | Collector-to-Emitter Breakdown Voltage | 370 | 400 | 430 | V             | $R_G = 1\text{K ohm}$ , $I_C = 7\text{A}$ , $V_{GE} = 0\text{V}$           |     |
| $BV_{GES}$ | Gate-to-Emitter Breakdown Voltage      | 10  | 12  |     | V             | $I_G = 2\text{mA}$                                                         |     |
| $I_{CES}$  | Collector-to-Emitter Leakage Current   |     |     | 15  | $\mu\text{A}$ | $R_G = 1\text{K ohm}$ , $V_{CE} = 250\text{V}$                             |     |
|            |                                        |     |     | 100 | $\mu\text{A}$ | $R_G = 1\text{K ohm}$ , $V_{CE} = 250\text{V}$ , $T_J = 150^\circ\text{C}$ |     |
| $BV_{CER}$ | Emitter-to-Collector Breakdown Voltage | 24  | 28  |     | V             | $I_C = -10\text{mA}$                                                       |     |
| $R_1$      | Gate Series Resistance                 |     | 75  |     | ohm           |                                                                            |     |
| $R_2$      | Gate-to-Emitter Resistance             | 10  | 20  | 30  | K ohm         |                                                                            |     |

**On-State Electrical Characteristics @  $T_J = 25^\circ\text{C}$  (unless otherwise specified)**

|              | Parameter                               | Min  | Typ  | Max  | Unit | Conditions                                                              | Fig  |
|--------------|-----------------------------------------|------|------|------|------|-------------------------------------------------------------------------|------|
| $V_{CE(on)}$ | Collector-to-Emitter Saturation Voltage |      | 1.2  | 1.40 | V    | $I_C = 7\text{A}$ , $V_{GE} = 4.5\text{V}$                              | 1    |
|              |                                         |      | 1.35 | 1.55 |      | $I_C = 10\text{A}$ , $V_{GE} = 4.5\text{V}$                             |      |
|              |                                         |      | 1.35 | 1.55 |      | $I_C = 10\text{A}$ , $V_{GE} = 4.5\text{V}$ , $T_C = -40^\circ\text{C}$ | 4    |
|              |                                         |      | 1.5  | 1.7  |      | $I_C = 14\text{A}$ , $V_{GE} = 5.0\text{V}$ , $T_C = -40^\circ\text{C}$ |      |
|              |                                         |      | 1.55 | 1.75 |      | $I_C = 14\text{A}$ , $V_{GE} = 5.0\text{V}$                             |      |
|              |                                         |      | 1.6  | 1.8  |      | $I_C = 14\text{A}$ , $V_{GE} = 5.0\text{V}$ , $T_C = 150^\circ\text{C}$ |      |
| $V_{GE(th)}$ | Gate Threshold Voltage                  | 1.3  | 1.8  | 2.2  | V    | $V_{CE} = V_{GE}$ , $I_C = 1\text{mA}$ , $T_C = 25^\circ\text{C}$       | 3, 5 |
|              |                                         | 0.75 |      | 1.8  |      | $V_{CE} = V_{GE}$ , $I_C = 1\text{mA}$ , $T_C = 150^\circ\text{C}$      | 8    |
| $g_{fs}$     | Transconductance                        | 10   | 15   | 19   | S    | $V_{CE} = 25\text{V}$ , $I_C = 10\text{A}$ , $T_C = 25^\circ\text{C}$   |      |
| $I_C$        | Collector Current                       | 20   |      |      | A    | $V_{CE} = 10\text{V}$ , $V_{GE} = 4.5\text{V}$                          |      |

**Switching Characteristics @  $T_J = 25^\circ\text{C}$  (unless otherwise specified)**

|              | Parameter                                | Min  | Typ | Max  | Unit          | Conditions                                                                               | Fig |
|--------------|------------------------------------------|------|-----|------|---------------|------------------------------------------------------------------------------------------|-----|
| $Q_g$        | Total Gate charge                        |      | 27  |      | nC            | $I_C = 10\text{A}$ , $V_{CE} = 12\text{V}$ , $V_{GE} = 5\text{V}$                        | 7   |
| $Q_{ge}$     | Gate - Emitter Charge                    |      | 2.5 |      |               | $I_C = 10\text{A}$ , $V_{CE} = 12\text{V}$ , $V_{GE} = 5\text{V}$                        | 15  |
| $Q_{gc}$     | Gate - Collector Charge                  |      | 10  |      |               | $I_C = 10\text{A}$ , $V_{CE} = 12\text{V}$ , $V_{GE} = 5\text{V}$                        |     |
| $t_{d(on)}$  | Turn - on delay time                     | 0.6  | 0.9 | 1.35 | $\mu\text{s}$ | $V_{GE} = 5\text{V}$ , $R_G = 1\text{K ohm}$ , $L = 1\text{mH}$ , $V_{CE} = 14\text{V}$  | 12  |
| $t_r$        | Rise time                                | 1.6  | 2.8 | 4    |               | $V_{GE} = 5\text{V}$ , $R_G = 1\text{K ohm}$ , $L = 1\text{mH}$ , $V_{CE} = 14\text{V}$  | 14  |
| $t_{d(off)}$ | Turn - off delay time                    | 3.7  | 6   | 8.3  |               | $V_{GE} = 5\text{V}$ , $R_G = 1\text{K ohm}$ , $L = 1\text{mH}$ , $V_{CE} = 300\text{V}$ |     |
| $C_{ies}$    | Input Capacitance                        |      | 550 | 825  | pF            | $V_{GE} = 0\text{V}$ , $V_{CE} = 25\text{V}$ , $f = 1\text{MHz}$                         | 6   |
| $C_{oes}$    | Output Capacitance                       |      | 100 | 150  |               | $V_{GE} = 0\text{V}$ , $V_{CE} = 25\text{V}$ , $f = 1\text{MHz}$                         |     |
| $C_{res}$    | Reverse Transfer Capacitance             |      | 12  | 18   |               | $V_{GE} = 0\text{V}$ , $V_{CE} = 25\text{V}$ , $f = 1\text{MHz}$                         |     |
| $I_L$        | Self-Clamped Inductive Switching Current | 25   |     |      | A             | $L = 0.7\text{mH}$ , $T_C = 25^\circ\text{C}$                                            | 9   |
|              |                                          | 15.5 |     |      |               | $L = 2.2\text{mH}$ , $T_C = 25^\circ\text{C}$                                            |     |
|              |                                          | 11.5 |     |      |               | $L = 4.7\text{mH}$ , $T_C = 25^\circ\text{C}$                                            | 10  |
|              |                                          | 16.5 |     |      |               | $L = 1.5\text{mH}$ , $T_C = 150^\circ\text{C}$                                           | 13  |
|              |                                          | 7.5  |     |      |               | $L = 4.7\text{mH}$ , $T_C = 150^\circ\text{C}$                                           | 14  |
|              |                                          | 6    |     |      |               | $L = 8.7\text{mH}$ , $T_C = 150^\circ\text{C}$                                           |     |
| $t_{sc}$     | Short Circuit Withstand Time             |      |     |      | $\mu\text{s}$ | $T_J = 150^\circ\text{C}$ ,                                                              | 14  |
|              |                                          | 120  |     |      |               | $V_{CC} = 16\text{V}$ , $L = 10\mu\text{H}$                                              |     |
|              |                                          |      |     |      |               | $R_G = 1\text{K ohm}$ , $V_{GE} = 5\text{V}$                                             |     |

Fig.1 - Typ. Output Characteristics  
 $T_J = 25^\circ\text{C}$

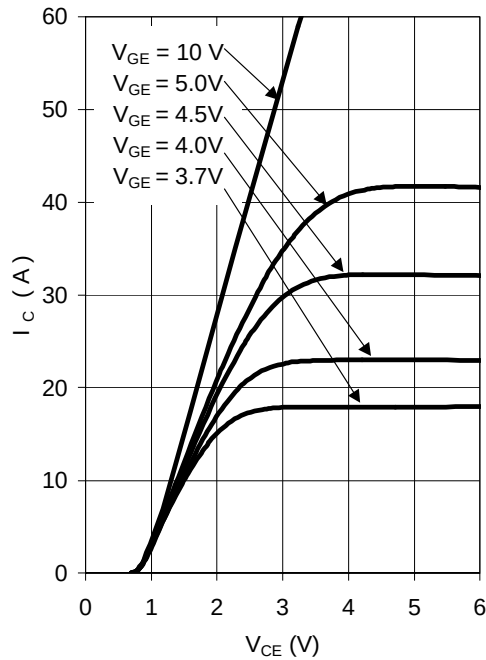


Fig.2 - Typ. Output Characteristics  
 $T_J = 125^\circ\text{C}$

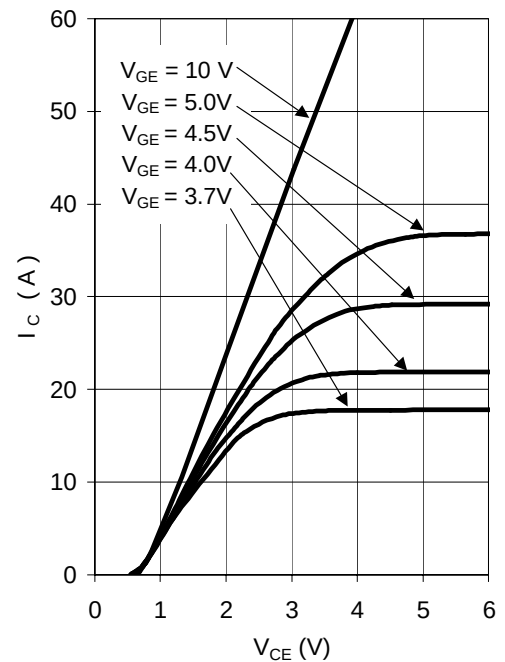


Fig.3 - Transfer Characteristics  
 $V_{CE} = 20\text{V}$ ;  $t_p = 20\mu\text{s}$

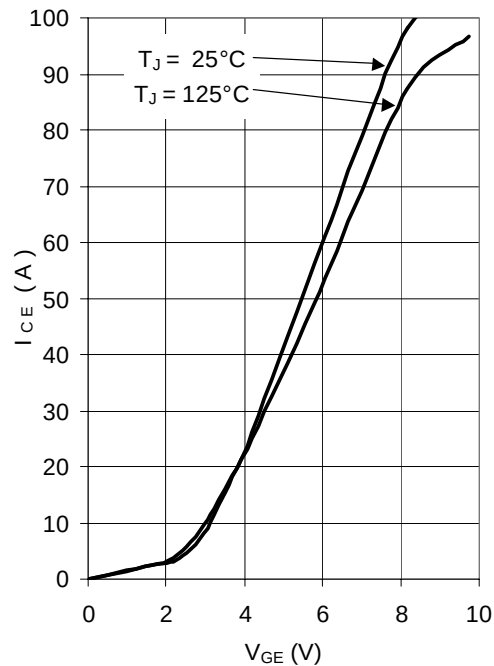
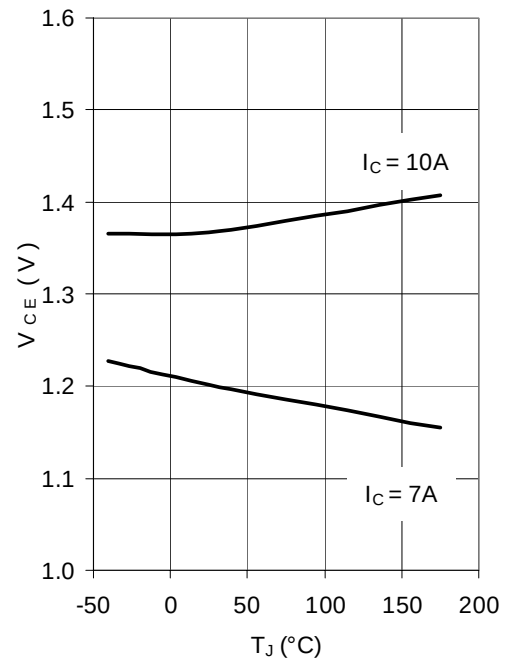


Fig.4 - Typical  $V_{CE}$  vs  $T_J$   
 $V_{GE} = 4.5\text{V}$



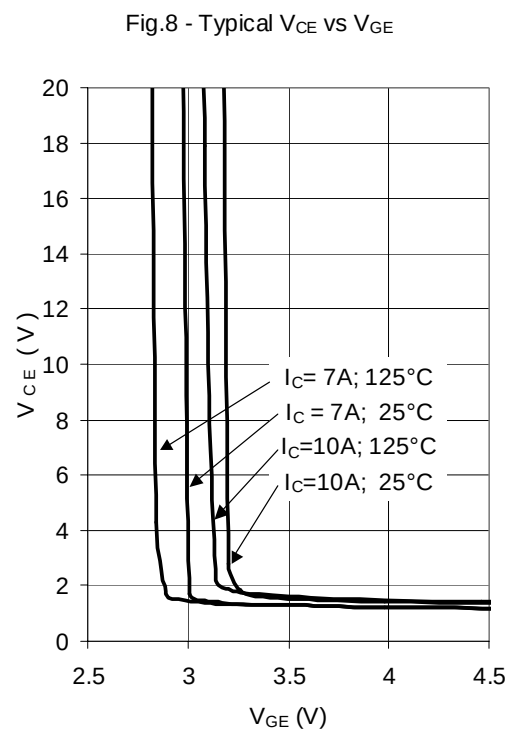
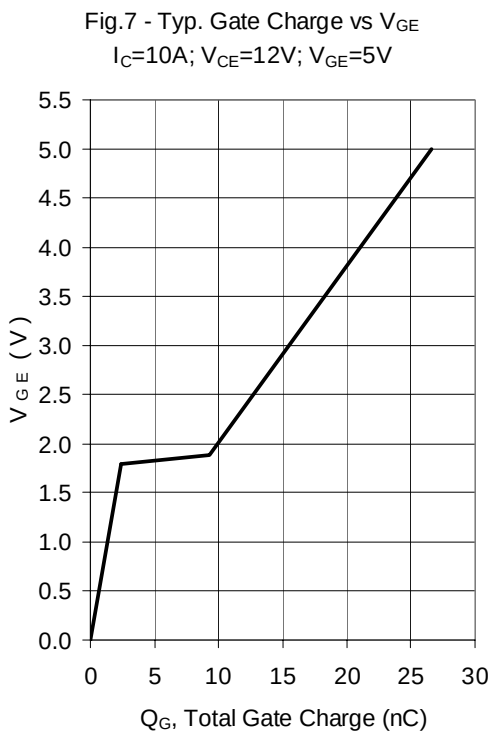
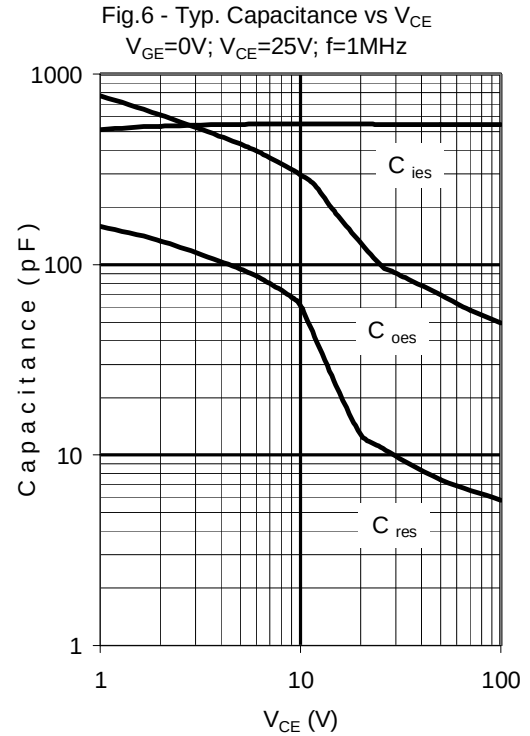
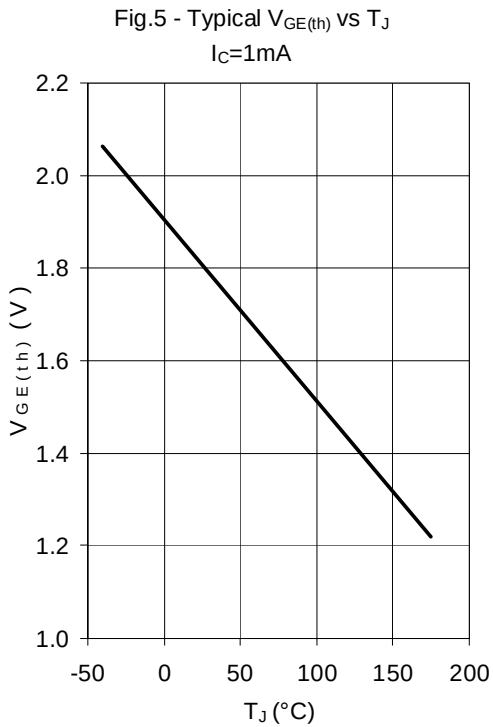


Fig.9 - Self-clamp Avalanche Current vs Inductance @ 25°C

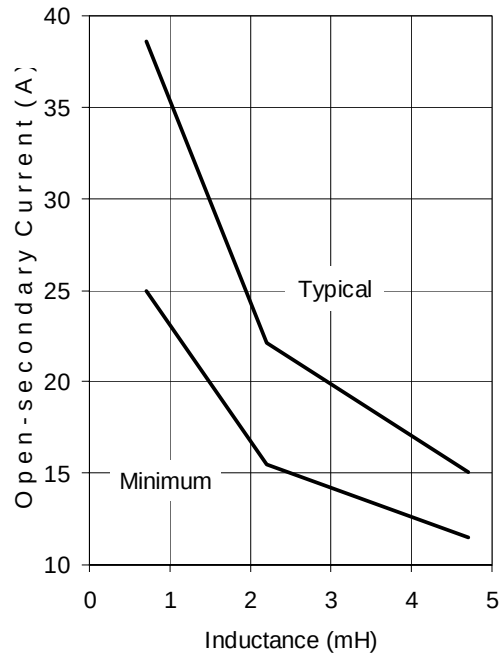


Fig.10 - Self-clamp Avalanche Current vs Inductance @ 150°C

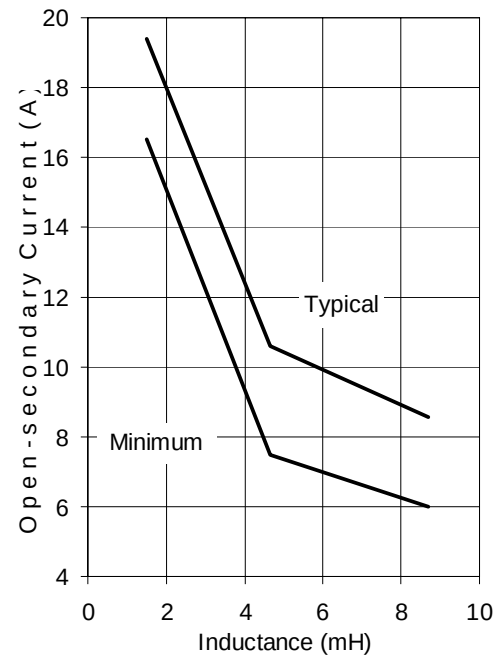


Fig.11 - Transient Thermal Impedance, Junction-to-Case

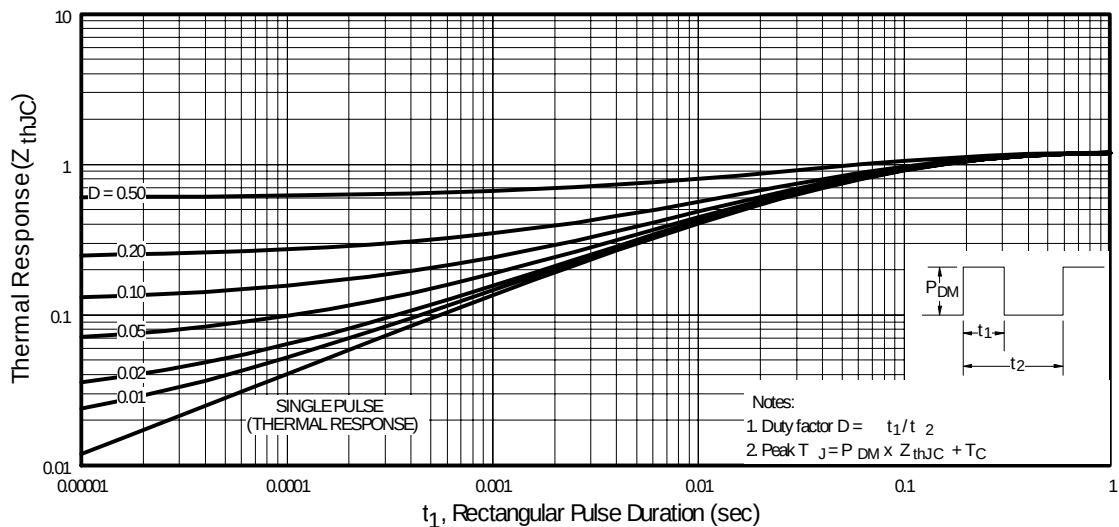


Fig.12 - Switching Waveform for Time Measurement

$V_{GE}=5V$ ;  $R_G=1K\Omega$ ;  $L=1mH$ ;  $V_{CE}=14V$ ; used circuit in Fig.14

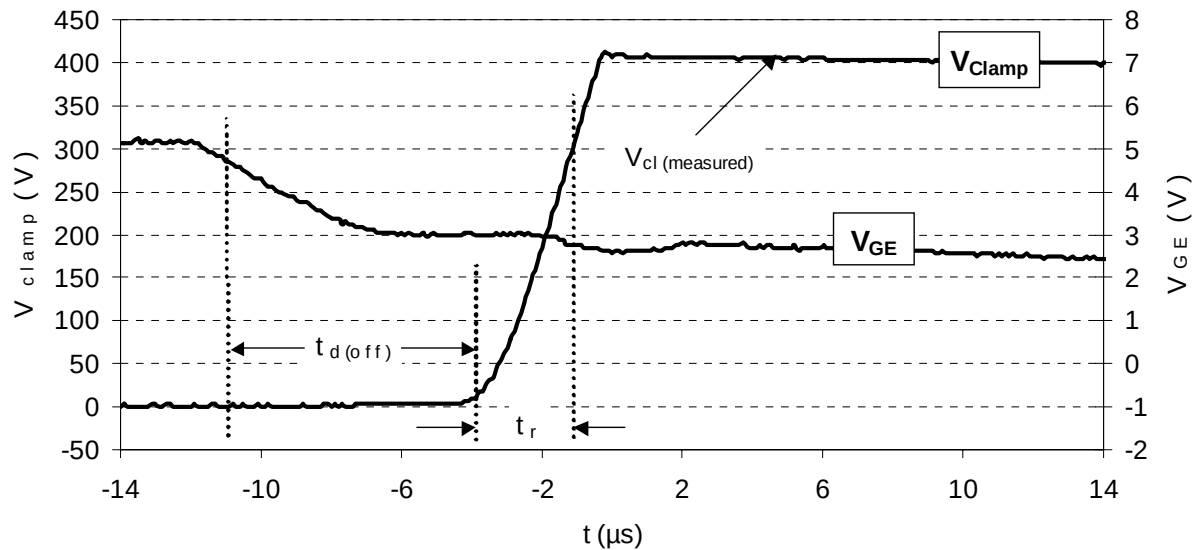


Fig.13 - Self-clamped Inductive Switching Waveform

$L=4.7mH$ ;  $T_C=25^\circ C$ ; used circuit in Fig.14

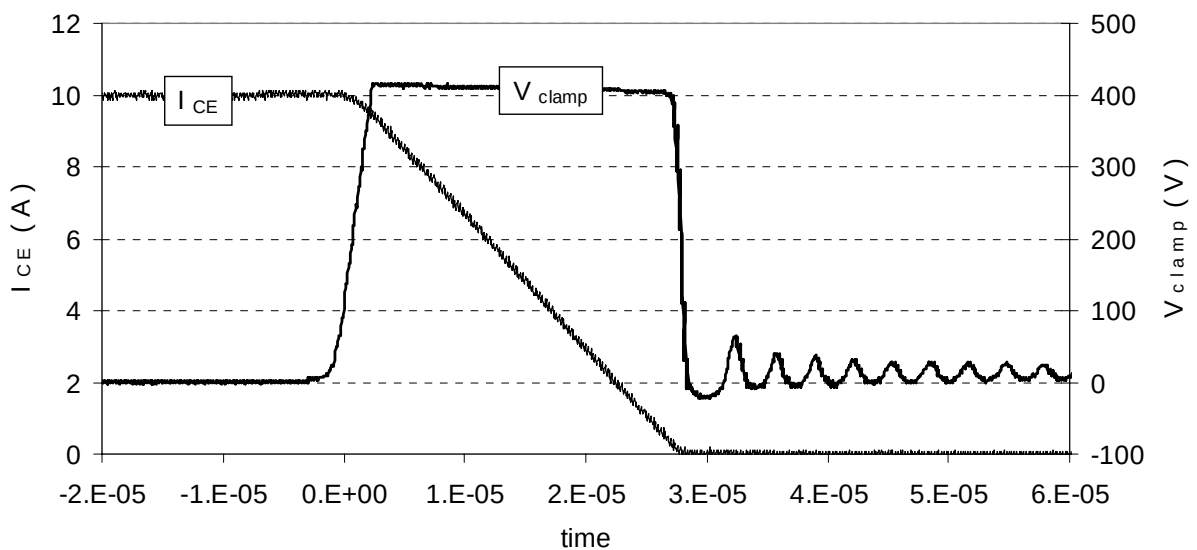


Fig.14 - Test Circuit

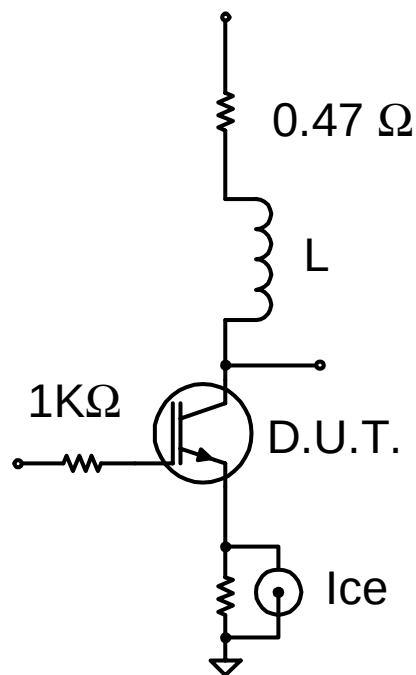
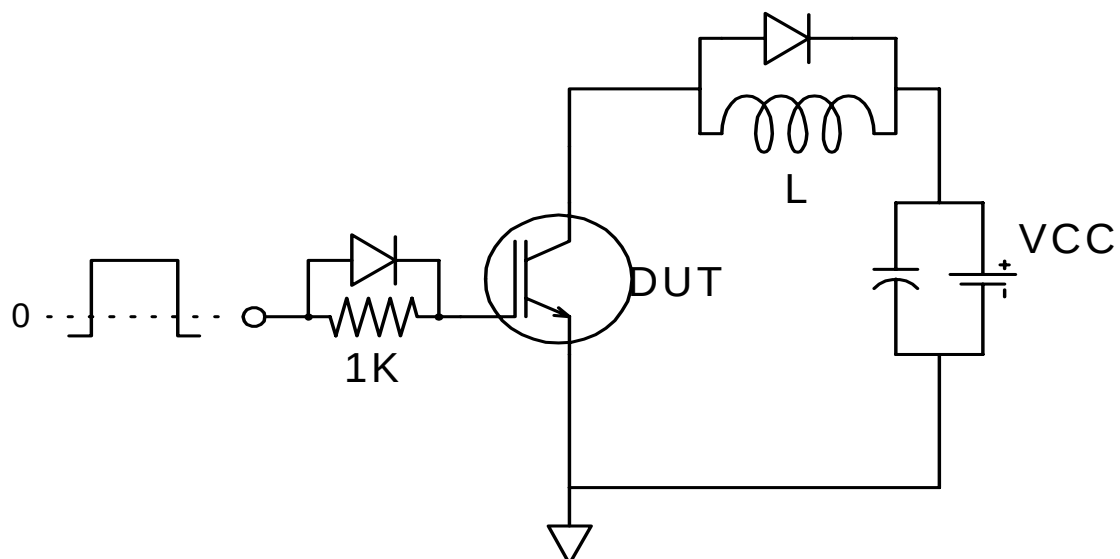
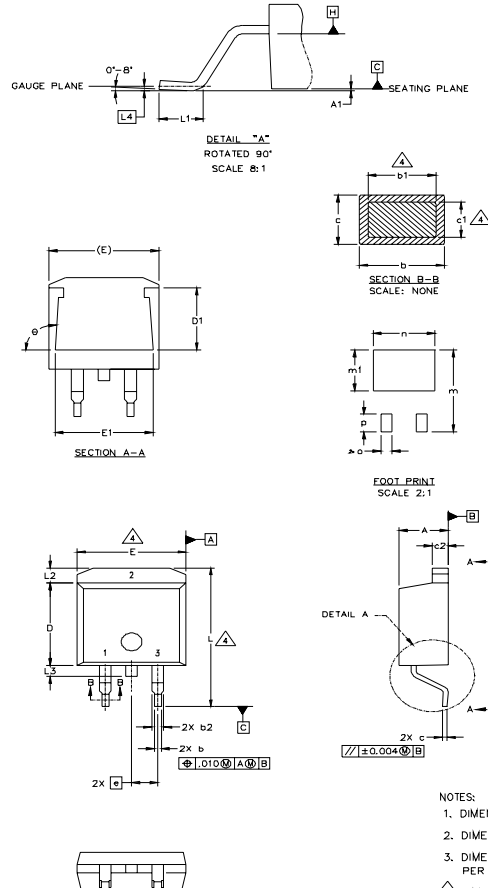


Fig.15 - Gate Charge Circuit



## D<sup>2</sup>Pak Package Outline

Dimensions are shown in millimeters (inches)



| SYMBOL | DIMENSIONS  |       |          |      | NOTES |
|--------|-------------|-------|----------|------|-------|
|        | MILLIMETERS |       | INCHES   |      |       |
|        | MIN.        | MAX.  | MIN.     | MAX. |       |
| A      | 4.06        | 4.83  | .160     | .190 | 4     |
| A1     |             | 0.127 |          | .005 |       |
| b      | 0.51        | 0.99  | .020     | .039 |       |
| b1     | 0.51        | 0.89  | .020     | .035 |       |
| b2     | 1.14        | 1.40  | .045     | .055 | 4     |
| c      | 0.43        | 0.63  | .017     | .025 |       |
| c1     | 0.38        | 0.74  | .015     | .029 |       |
| c2     | 1.14        | 1.40  | .045     | .055 |       |
| D      | 8.51        | 9.65  | .335     | .380 | 3     |
| D1     | 5.33        |       | .210     |      |       |
| E      | 9.65        | 10.67 | .380     | .420 | 3     |
| E1     | 6.22        |       | .245     |      |       |
| e      | 2.54 BSC    |       | .100 BSC |      |       |
| L      | 14.61       | 15.88 | .575     | .625 |       |
| L1     | 1.78        | 2.79  | .070     | .110 |       |
| L2     |             | 1.65  |          | .065 |       |
| L3     | 1.27        | 1.78  | .050     | .070 |       |
| L4     | 0.25 BSC    |       | .010 BSC |      |       |
| m      | 17.78       |       | .700     |      |       |
| m1     | 8.89        |       | .350     |      |       |
| n      | 11.43       |       | .450     |      |       |
| o      | 2.08        |       | .082     |      |       |
| p      | 3.81        |       | .150     |      |       |
| θ      | 90°         | 93°   | 90°      | 93°  |       |

### LEAD ASSIGNMENTS

| HEXFET     | IGBTs, CoPACK | DIODES      |
|------------|---------------|-------------|
| 1.- GATE   | 1.- GATE      | 1.- ANODE * |
| 2.- DRAIN  | 2.- COLLECTOR | 2.- CATHODE |
| 3.- SOURCE | 3.- EMITTER   | 3.- ANODE   |

\* PART DEPENDENT.

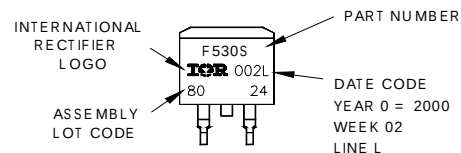
### NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994
2. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
3. DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.127 [0.005"] PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTMOST EXTREMES OF THE PLASTIC BODY.
4. DIMENSION b1 AND c1 APPLY TO BASE METAL ONLY.
5. CONTROLLING DIMENSION: INCH.

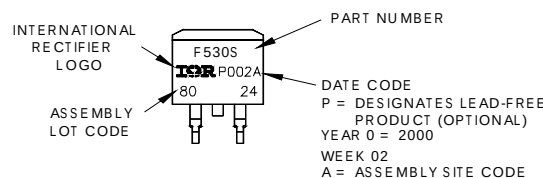
## D<sup>2</sup>Pak Part Marking Information (Lead-Free)

EXAMPLE: THIS IS AN IRF530S WITH  
LOT CODE 8024  
ASSEMBLED ON WW 02, 2000  
IN THE ASSEMBLY LINE "L"

Note: "P" in assembly line  
position indicates "Lead-Free"



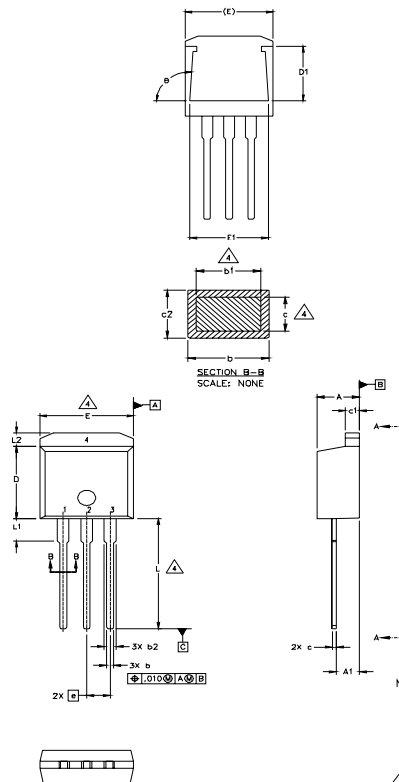
**OR**





## TO-262 Package Outline

Dimensions are shown in millimeters (inches)



| SYMBOL | DIMENSIONS  |       |        |      | NOTES |
|--------|-------------|-------|--------|------|-------|
|        | MILLIMETERS |       | INCHES |      |       |
|        | MIN.        | MAX.  | MIN.   | MAX. |       |
| A      | 4.06        | 4.83  | .160   | .190 |       |
| A1     | 2.03        | 2.92  | .080   | .115 |       |
| b      | 0.51        | 0.99  | .020   | .039 |       |
| b1     | 0.51        | 0.89  | .020   | .035 | 4     |
| b2     | 1.14        | 1.40  | .045   | .055 |       |
| c      | 0.38        | 0.63  | .015   | .025 | 4     |
| c1     | 1.14        | 1.40  | .045   | .055 |       |
| c2     | 0.43        | .063  | .017   | .029 |       |
| D      | 8.51        | 9.65  | .335   | .380 | 3     |
| D1     | 5.33        |       | .210   |      |       |
| E      | 9.65        | 10.67 | .380   | .420 | 3     |
| E1     | 6.22        |       | .245   |      |       |
| e      | 2.54        | BSC   | .100   | BSC  |       |
| L      | 13.46       | 14.09 | .530   | .555 |       |
| L1     | 3.56        | 3.71  | .140   | .146 |       |
| L2     |             | 1.65  |        | .065 |       |

### LEAD ASSIGNMENTS

#### HEXFET

- 1.- GATE
- 2.- DRAIN
- 3.- SOURCE
- 4.- DRAIN

#### IGBT

- 1 - GATE
- 2 - COLLECTOR
- 3 - EMITTER

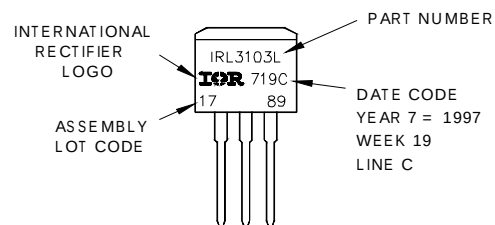
#### NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994
2. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
3. DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.127 [0.005"] PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTMOST EXTREMES OF THE PLASTIC BODY.
4. DIMENSION b1 AND c1 APPLY TO BASE METAL ONLY.
5. CONTROLLING DIMENSION: INCH.

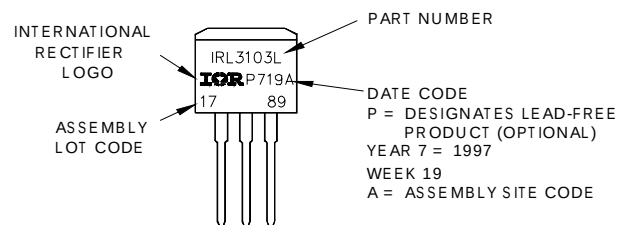
## TO-262 Part Marking Information

EXAMPLE: THIS IS AN IRL3103L  
LOT CODE 1789  
ASSEMBLED ON WW 19, 1997  
IN THE ASSEMBLY LINE "C"

Note: "P" in assembly line position indicates "Lead-Free"

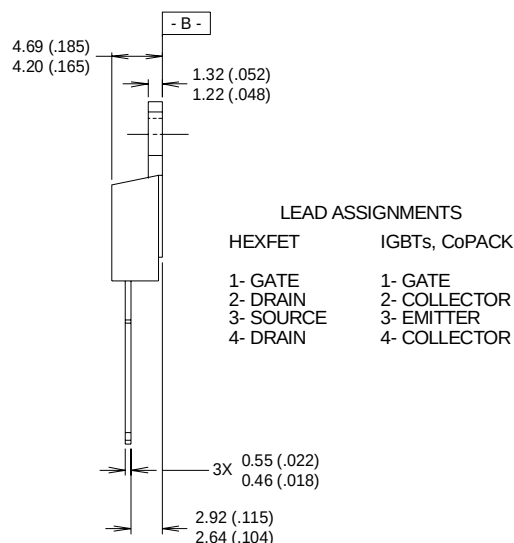
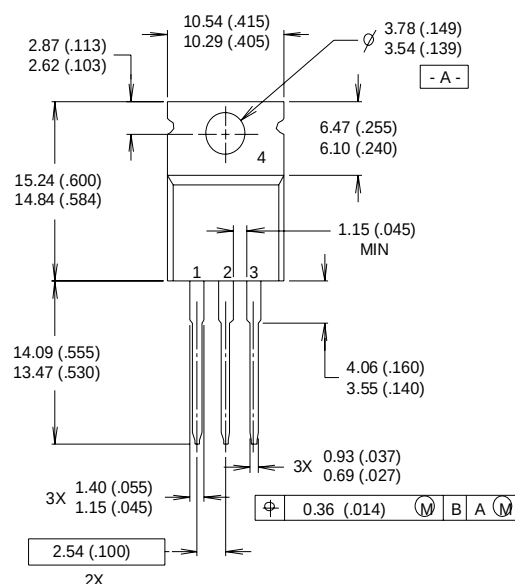


OR



## TO-220AB Package Outline

Dimensions are shown in millimeters (inches)



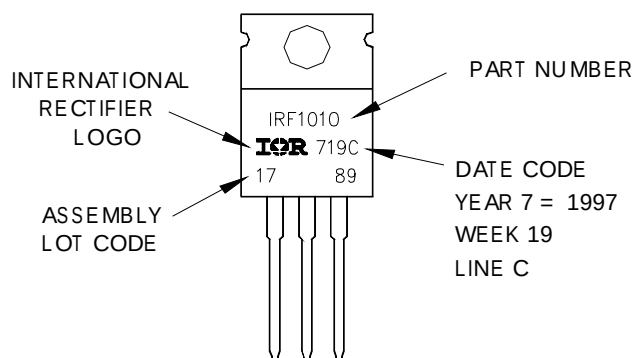
NOTES:

- 1 DIMENSIONING & TOLERANCING PER ANSI Y14.5M, 1982. 3 OUTLINE CONFORMS TO JEDEC OUTLINE TO-220AB.  
2 CONTROLLING DIMENSION : INCH 4 HEATSINK & LEAD MEASUREMENTS DO NOT INCLUDE BURRS.

## TO-220AB Part Marking Information

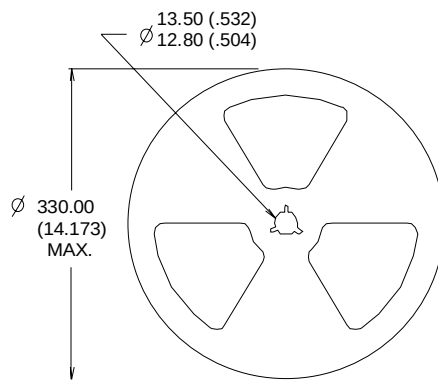
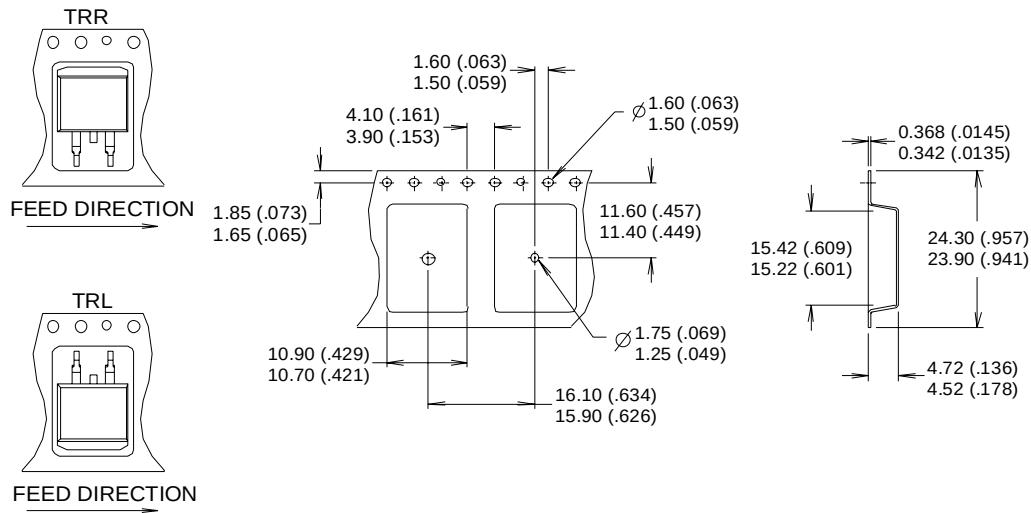
EXAMPLE: THIS IS AN IRF1010  
LOT CODE 1789  
ASSEMBLED ON WW 19, 1997  
IN THE ASSEMBLY LINE "C"

**Note:** "P" in assembly line position indicates "Lead-Free"

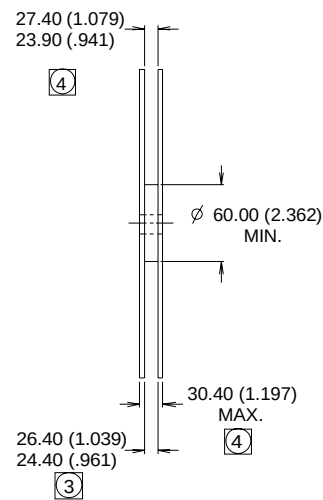


### D<sup>2</sup>Pak Tape & Reel Information

Dimensions are shown in millimeters (inches)



- NOTES :
1. COMFORMS TO EIA-418.
  2. CONTROLLING DIMENSION: MILLIMETER.
  3. DIMENSION MEASURED @ HUB.
  4. INCLUDES FLANGE DISTORTION @ OUTER EDGE.



Data and specifications subject to change without notice.

Note: For the most current drawings please refer to the IR website at:  
<http://www.irf.com/package/>