



ON Semiconductor®

# BS170 / MMBF170 N-Channel Enhancement Mode Field Effect Transistor

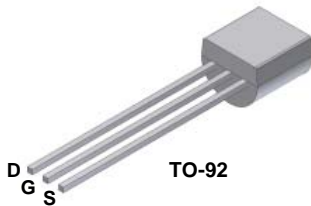
## General Description

These N-Channel enhancement mode field effect transistors are produced using ON Semiconductor's proprietary, high cell density, DMOS technology. These products have been designed to minimize on-state resistance while provide rugged, reliable, and fast switching performance. They can be used in most applications requiring up to 500mA DC. These products are particularly suited for low voltage, low current applications such as small servo motor control, power MOSFET gate drivers, and other switching applications.

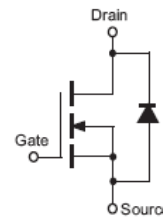
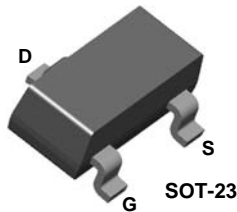
## Features

- High density cell design for low  $R_{DS(ON)}$ .
- Voltage controlled small signal switch.
- Rugged and reliable.
- High saturation current capability.

### BS170



### MMBF170



## Absolute Maximum Ratings $T_A = 25^\circ\text{C}$ unless otherwise noted

| Symbol         | Parameter   | BS170       | MMBF170 | Units            |
|----------------|---|-------------|---------|------------------|
| $V_{DSS}$      | Drain-Source Voltage  | 60          |         | V                |
| $V_{DGR}$      | Drain-Gate Voltage ( $R_{GS} \leq 1M\Omega$ )                                   | 60          |         | V                |
| $V_{GSS}$      | Gate-Source Voltage   | $\pm 20$    |         | V                |
| $I_D$          | Drain Current - Continuous<br>- Pulsed  | 500         | 500     | mA               |
|                |   | 1200        | 800     |                  |
| $T_J, T_{STG}$ | Operating and Storage Temperature Range   | - 55 to 150 |         | $^\circ\text{C}$ |
| $T_L$          | Maximum Lead Temperature for Soldering Purposes, 1/16" from Case for 10 Seconds | 300         |         | $^\circ\text{C}$ |

## Thermal Characteristics $T_A = 25^\circ\text{C}$ unless otherwise noted

| Symbol          | Parameter  | BS170 | MMBF170 | Units                     |
|-----------------|--|-------|---------|---------------------------|
| $P_D$           | Maximum Power Dissipation<br>Derate above $25^\circ\text{C}$ | 830   | 300     | mW                        |
|                 |  | 6.6   | 2.4     | mW/ $^\circ\text{C}$      |
| $R_{\theta JA}$ | Thermal Resistance, Junction to Ambient                      | 150   | 417     | $^\circ\text{C}/\text{W}$ |

**Electrical Characteristics**  $T_A=25^\circ\text{C}$  unless otherwise noted

| Symbol                                     | Parameter                         | Conditions  | Type    | Min. | Typ. | Max. | Units    |
|--|-----------------------------------|---|---------|------|------|------|----------|
| <b>OFF CHARACTERISTICS</b>                 |                                   |   |         |      |      |      |          |
| $BV_{DSS}$                                 | Drain-Source Breakdown Voltage    | $V_{GS} = 0V, I_D = 100\mu A$                                 | All     | 60   |      |      | V        |
| $I_{DSS}$                                  | Zero Gate Voltage Drain Current   | $V_{DS} = 25V, V_{GS} = 0V$                                   | All     |      |      | 0.5  | $\mu A$  |
| $I_{GSSF}$                                 | Gate - Body Leakage, Forward      | $V_{GS} = 15V, V_{DS} = 0V$                                   | All     |      |      | 10   | nA       |
| <b>ON CHARACTERISTICS (Notes 1)</b>        |                                   |   |         |      |      |      |          |
| $V_{GS(th)}$                               | Gate Threshold Voltage            | $V_{DS} = V_{GS}, I_D = 1mA$                                  | All     | 0.8  | 2.1  | 3    | V        |
| $R_{DS(on)}$                               | Static Drain-Source On-Resistance | $V_{GS} = 10V, I_D = 200mA$                                   | All     |      | 1.2  | 5    | $\Omega$ |
| $g_{FS}$                                   | Forward Transconductance          | $V_{DS} = 10V, I_D = 200mA$                                   | BS170   |      | 320  |      | mS       |
|  |                                   | $V_{DS} \geq 2 V_{DS(on)}, I_D = 200mA$                       | MMBF170 |      | 320  |      |          |
| <b>Dynamic Characteristics</b>             |                                   |   |         |      |      |      |          |
| $C_{iss}$                                  | Input Capacitance                 | $V_{DS} = 10V, V_{GS} = 0V, f = 1.0MHz$                       | All     |      | 24   | 40   | pF       |
| $C_{oss}$                                  | Output Capacitance                |   | All     |      | 17   | 30   | pF       |
| $C_{rss}$                                  | Reverse Transfer Capacitance      |   | All     |      | 7    | 10   | pF       |
| <b>Switching Characteristics (Notes 1)</b> |                                   |   |         |      |      |      |          |
| $t_{on}$                                   | Turn-On Time                      | $V_{DD} = 25V, I_D = 200mA, V_{GS} = 10V, R_{GEN} = 25\Omega$ | BS170   |      |      | 10   | ns       |
|  |                                   | $V_{DD} = 25V, I_D = 500mA, V_{GS} = 10V, R_{GEN} = 50\Omega$ | MMBF170 |      |      | 10   |          |
| $t_{off}$                                  | Turn-Off Time                     | $V_{DD} = 25V, I_D = 200mA, V_{GS} = 10V, R_{GEN} = 25\Omega$ | BS170   |      |      | 10   | ns       |
|  |                                   | $V_{DD} = 25V, I_D = 500mA, V_{GS} = 10V, R_{GEN} = 50\Omega$ | MMBF170 |      |      | 10   |          |

**Note:**

1. Pulse Test: Pulse Width  $\leq 300\mu s$ , Duty Cycle  $\leq 2.0\%$ .

**Ordering Information**

| Part Number | Package | Package Type  | Lead Frame | Pin array |
|-------------|---------|---------------|------------|-----------|
| BS170       | TO-92   | BULK          | STRAIGHT   | D G S     |
| BS170-D26Z  | TO-92   | Tape and Reel | FORMING    | D G S     |
| BS170-D27Z  | TO-92   | Tape and Reel | FORMING    | D G S     |
| BS170-D74Z  | TO-92   | AMMO          | FORMING    | D G S     |
| BS170-D75Z  | TO-92   | AMMO          | FORMING    | D G S     |
| MMBF170     | SOT-23  | Tape and Reel |            |           |

## Typical Electrical Characteristics

BS170 / MMBF170

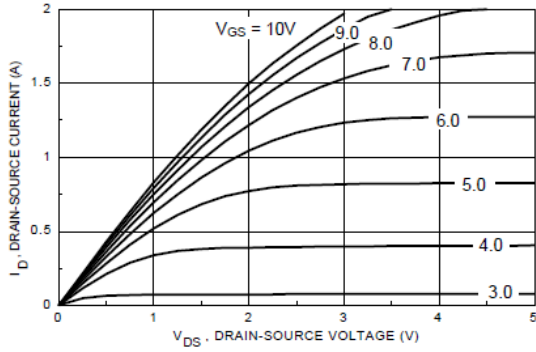


Figure 1. On-Region Characteristics.

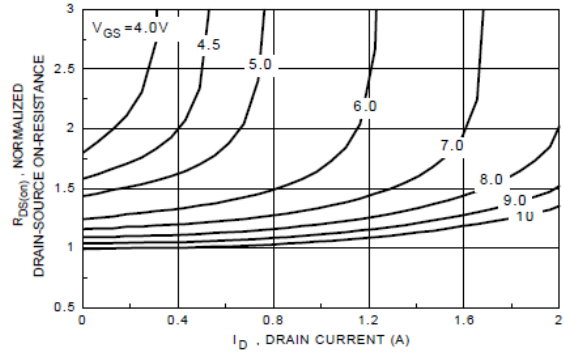


Figure 2. On-Resistance Variation with Gate Voltage and Drain Current.

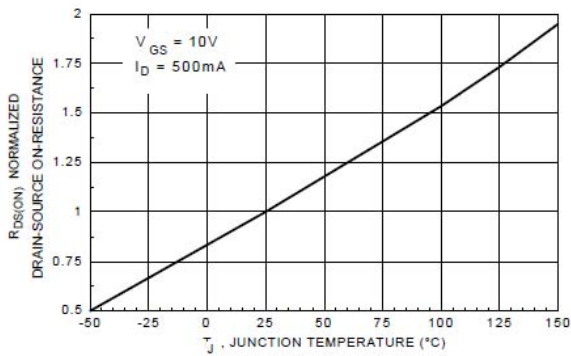


Figure 3. On-Resistance Variation with Temperature.

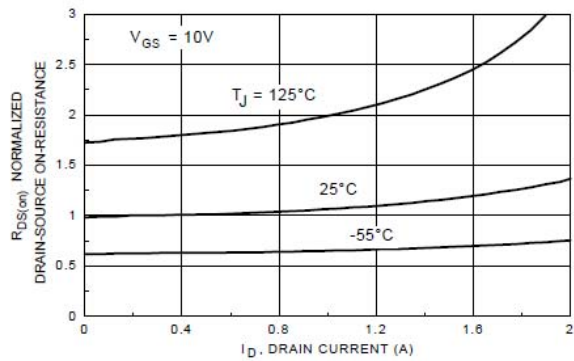


Figure 4. On-Resistance Variation with Drain Current and Temperature.

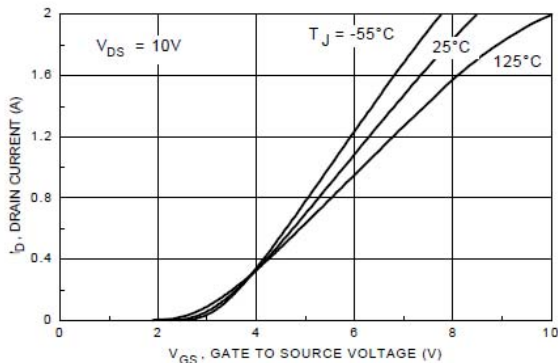


Figure 5. Transfer Characteristics.

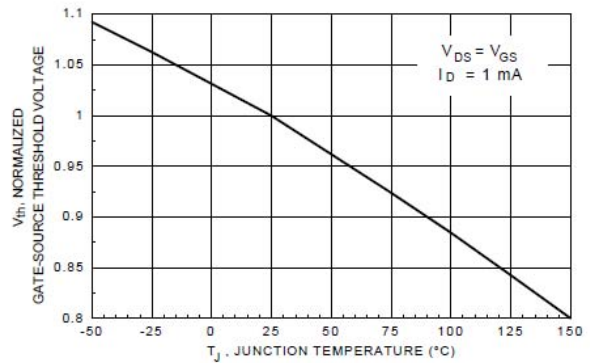


Figure 6. Gate Threshold Variation with Temperature.

Typical Electrical Characteristics (continued)

BS170 / MMBF170

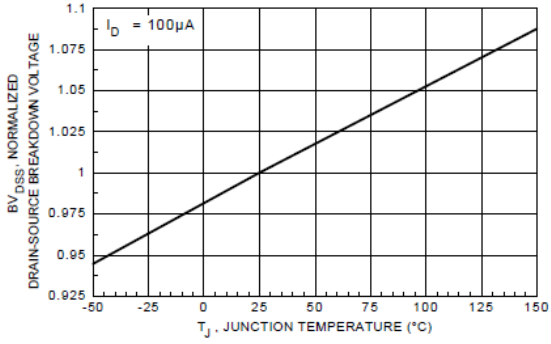


Figure 7. Breakdown Voltage Variation with Temperature.

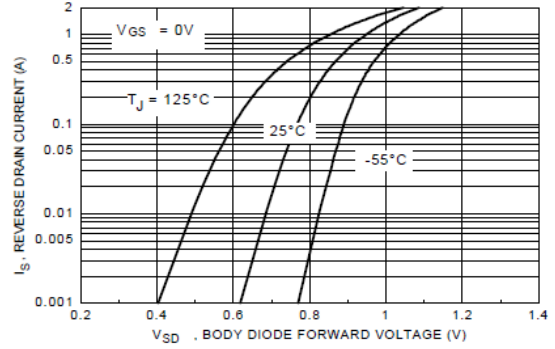


Figure 8. Body Diode Forward Voltage Variation with Current and Temperature.

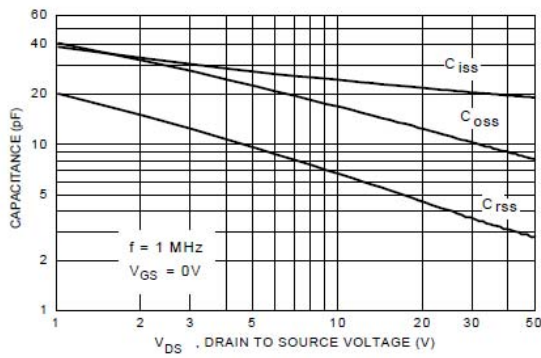


Figure 9. Capacitance Characteristics.

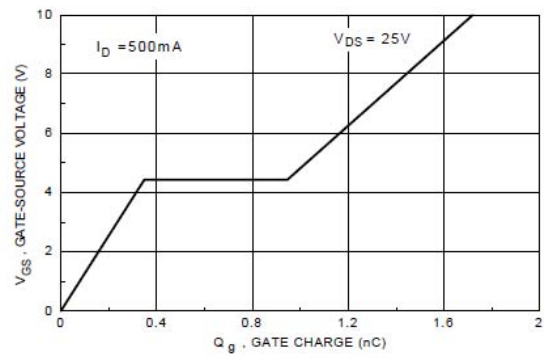


Figure 10. Gate Charge Characteristics.

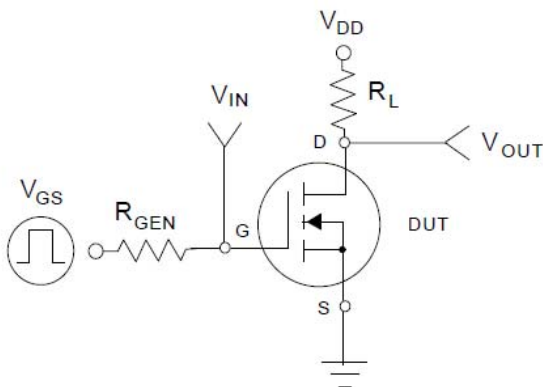


Figure 11. Switching Test Circuit.

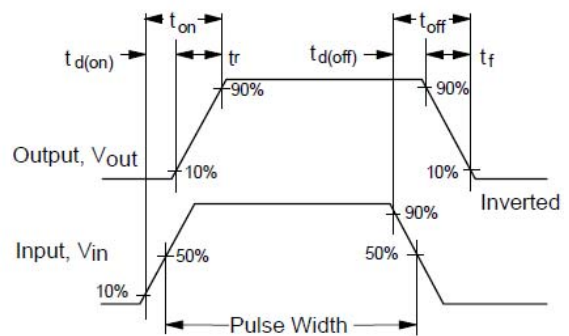


Figure 12. Switching Waveforms.

Typical Electrical Characteristics (continued)

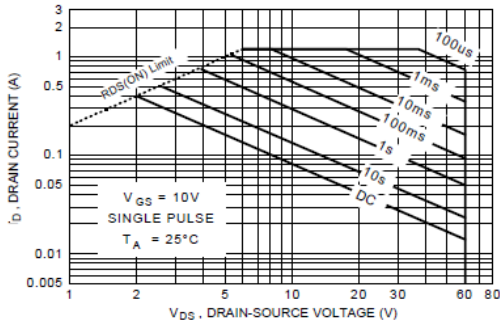


Figure 13. BS170 Maximum Safe Operating Area.

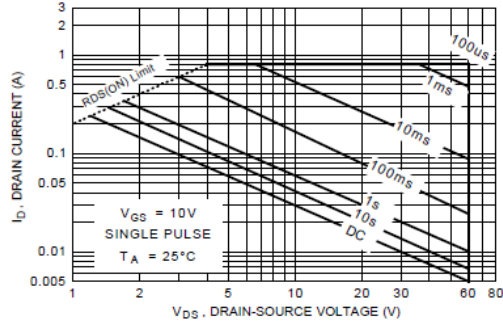


Figure 14. MMBF170 Maximum Safe Operating Area.

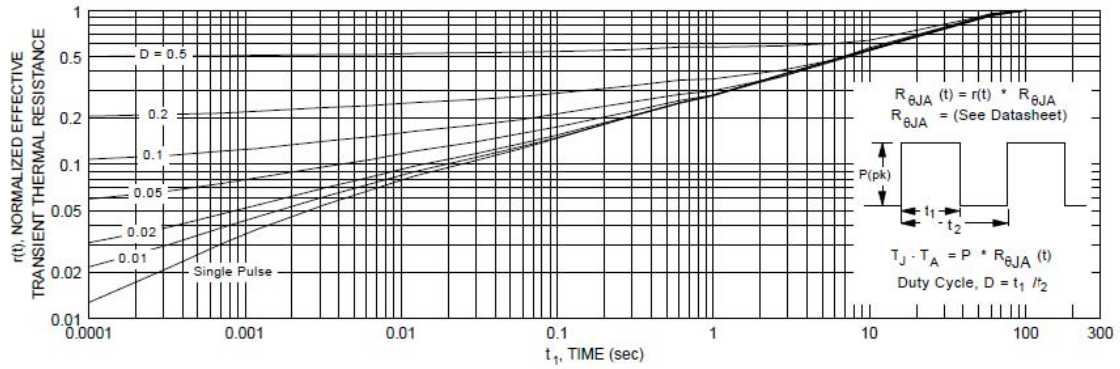


Figure 15. TO-92, BS170 Transient Thermal Response Curve.

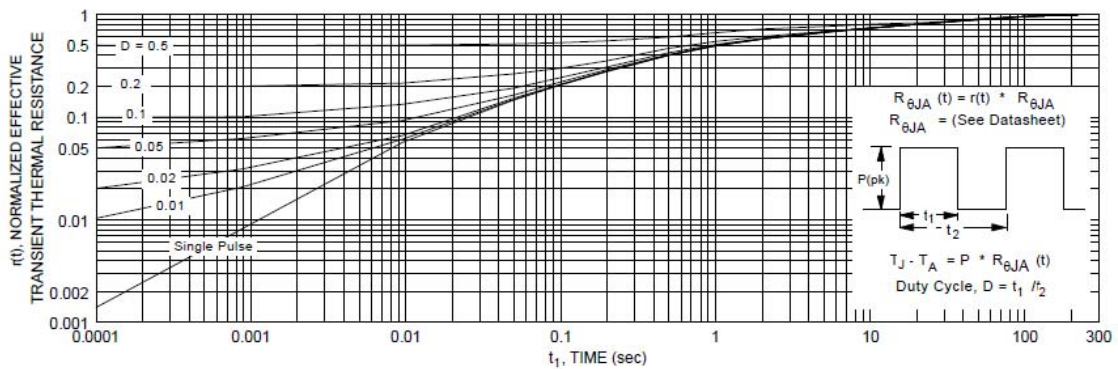


Figure 16. SOT-23, MMBF170 Transient Thermal Response Curve.



## TO-92 Tape and Reel Data, continued

### TO-92 Packing




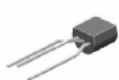

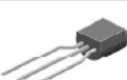
Information: Figure 2.0

TO-92 TNR/AMMO PACKING INFORMATION TABLE

| Packing | Style | Quantity | EOL code |
|---------|-------|----------|----------|
| Reel    | A     | 2,000    | D26Z     |
|         | B     | 2,000    | D11Z     |
|         | C     | 2,000    | D28Z     |
|         | D     | 2,000    | D10Z     |
|         | E     | 2,000    | D27Z     |
|         | F     | 2,000    | D81Z     |
|         | G     | 2,000    | D29Z     |
|         | H     | 2,000    | D89Z     |
| Ammo    | M     | 2,000    | D74Z     |
|         | P     | 2,000    | D75Z     |

Unit weight = 0.22 gm  
 Reel weight with components = 1.04 kg  
 Ammo weight with components = 1.02 kg  
 Max quantity per intermediate box = 10,000 units

TO-92 BULK PACKING INFORMATION TABLE

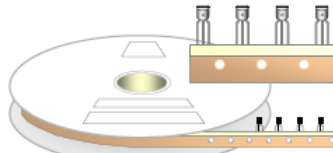
| EOL CODE / FLOW OPTION | DESCRIPTION           | LEADCLIP DIMENSION | MINIMUM ORDER QTY | LEADFORM OUTLINE  |
|------------------------|-----------------------|--------------------|-------------------|---|
| NO EOL CODE            | STRAIGHT LEADS        | NO LEAD CLIP       | 2.0K / BOX        |  |
| J18Z                   | TO-18 OPTION STD      | NO LEAD CLIP       | 2.0K / BOX        |  |
| J35Z                   | TO-18 OPTION REVERSE  | NO LEAD CLIP       | 2.0K / BOX        |  |
| J05Z                   | TO-5 OPTION STD       | NO LEAD CLIP       | 1.5K / BOX        |  |
| J60Z                   | TO-5 OPTION REVERSE   | NO LEAD CLIP       | 1.5K / BOX        |  |
| J61Z                   | IN LINE 0.200 SPACING | NO LEAD CLIP       | 1.5K / BOX        |  |

TO-92 Tape and Reel Data, continued

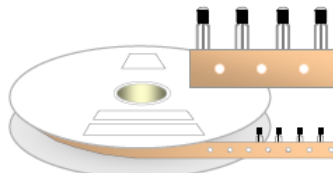
TO-92 Reeling Style

Configuration: Figure 3.0

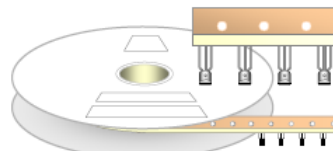
Machine Option "A" (H)



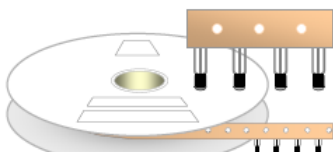
Style "A", D26Z



Style "B", D11Z

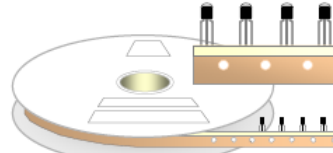


Style "C", D28Z

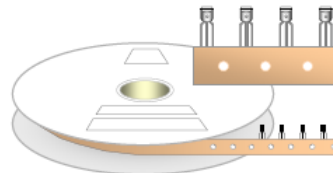


Style "D", D10Z

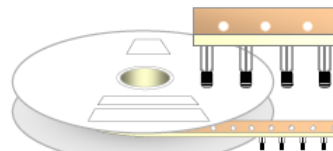
Machine Option "E" (J)



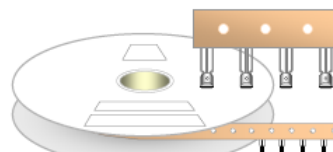
Style "E", D27Z



Style "F", D81Z



Style "G", D29Z

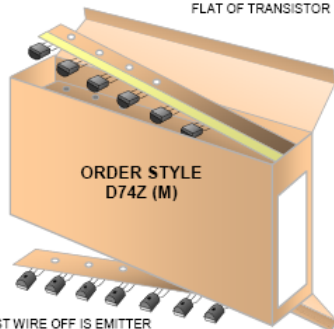


Style "H", D89Z

TO-92 Radial Ammo Packaging

Configuration: Figure 4.0

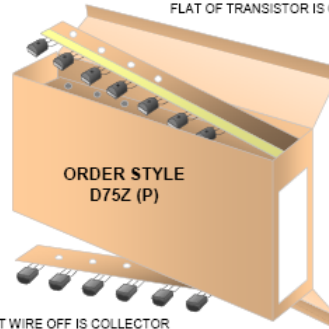
FIRST WIRE OFF IS COLLECTOR  
ADHESIVE TAPE IS ON THE TOP SIDE  
FLAT OF TRANSISTOR IS ON TOP



ORDER STYLE  
D74Z (M)

FIRST WIRE OFF IS EMITTER  
ADHESIVE TAPE IS ON BOTTOM SIDE  
FLAT OF TRANSISTOR IS ON BOTTOM

FIRST WIRE OFF IS EMITTER  
ADHESIVE TAPE IS ON THE TOP SIDE  
FLAT OF TRANSISTOR IS ON BOTTOM



ORDER STYLE  
D75Z (P)

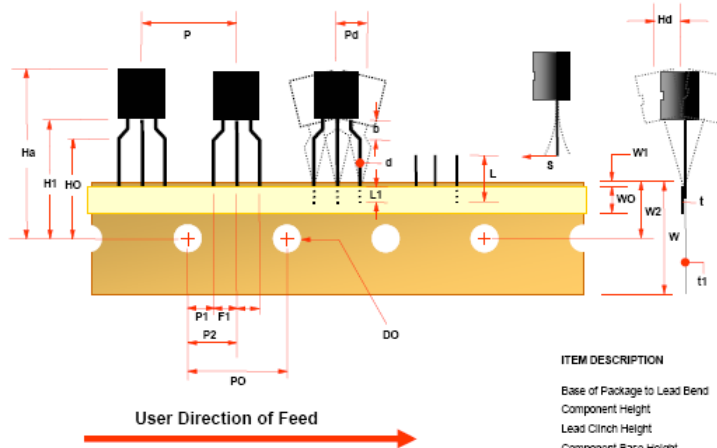
FIRST WIRE OFF IS COLLECTOR  
ADHESIVE TAPE IS ON BOTTOM SIDE  
FLAT OF TRANSISTOR IS ON TOP



## TO-92 Tape and Reel Data, continued

### TO-92 Tape and Reel Taping

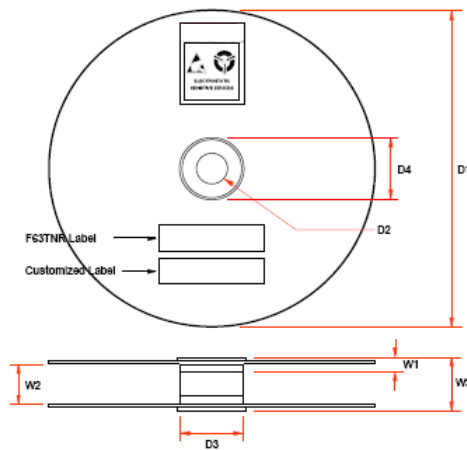
Dimension Configuration: Figure 5.0



| ITEM DESCRIPTION                   | SYMBOL | DIMENSION              |
|------------------------------------|--------|------------------------|
| Base of Package to Lead Bend       | b      | 0.098 (max)            |
| Component Height                   | Ha     | 0.929 (+/- 0.025)      |
| Lead Clinch Height                 | HO     | 0.630 (+/- 0.020)      |
| Component Base Height              | H1     | 0.748 (+/- 0.020)      |
| Component Alignment ( side/side )  | Pd     | 0.040 (max)            |
| Component Alignment ( front/back ) | Hd     | 0.031 (max)            |
| Component Pitch                    | P      | 0.500 (+/- 0.020)      |
| Feed Hole Pitch                    | PO     | 0.500 (+/- 0.008)      |
| Hole Center to First Lead          | P1     | 0.150 (+0.009, -0.010) |
| Hole Center to Component Center    | P2     | 0.247 (+/- 0.007)      |
| Lead Spread                        | F1/F2  | 0.104 (+/- 0.010)      |
| Lead Thickness                     | d      | 0.018 (+0.002, -0.003) |
| Cut Lead Length                    | L      | 0.429 (max)            |
| Taped Lead Length                  | L1     | 0.209 (+0.051, -0.052) |
| Taped Lead Thickness               | t      | 0.032 (+/- 0.006)      |
| Carrier Tape Thickness             | t1     | 0.021 (+/- 0.006)      |
| Carrier Tape Width                 | W      | 0.708 (+0.020, -0.019) |
| Hold - down Tape Width             | WO     | 0.236 (+/- 0.012)      |
| Hold - down Tape position          | W1     | 0.035 (max)            |
| Feed Hole Position                 | W2     | 0.360 (+/- 0.025)      |
| Sprocket Hole Diameter             | DO     | 0.157 (+0.008, -0.007) |
| Lead Spring Out                    | S      | 0.004 (max)            |

### TO-92 Reel

Configuration: Figure 6.0

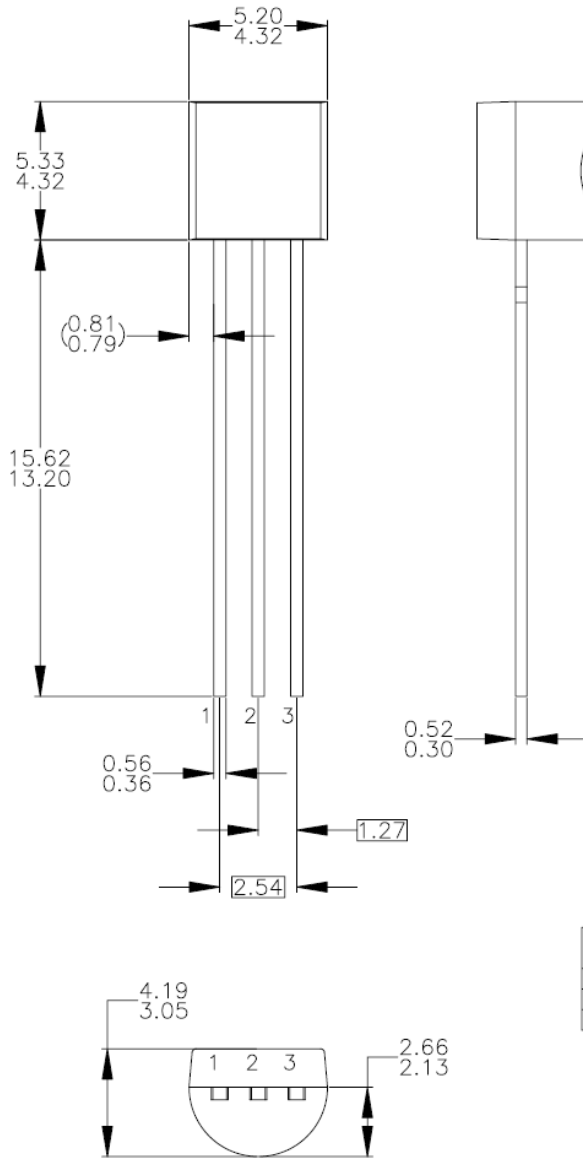


| ITEM DESCRIPTION               | SYMBOL | MINIMUM | MAXIMUM |
|--------------------------------|--------|---------|---------|
| Reel Diameter                  | D1     | 13.975  | 14.025  |
| Arbor Hole Diameter (Standard) | D2     | 1.160   | 1.200   |
| (Small Hole)                   | D2     | 0.650   | 0.700   |
| Core Diameter                  | D3     | 3.100   | 3.300   |
| Hub Recess Inner Diameter      | D4     | 2.700   | 3.100   |
| Hub Recess Depth               | W1     | 0.370   | 0.570   |
| Flange to Flange Inner Width   | W2     | 1.630   | 1.690   |
| Hub to Hub Center Width        | W3     |         | 2.090   |

Note: All dimensions are in inches

Mechanical Dimensions ( TO-92 )

TO-92



NOTES: UNLESS OTHERWISE SPECIFIED

- A) DRAWING WITH REFERENCE TO JEDEC TO-92 RECOMMENDATIONS.
- B) ALL DIMENSIONS ARE IN MILLIMETERS.
- C) DRAWING CONFORMS TO ASME Y14.5M-1994.
- D) TO-92 (92,94,96,97,98) PIN CONFIGURATION:

| PIN | 92 |   |   | 94 |   |   | 96 |   |   | 97 |   |   | 98 |   |   |
|-----|----|---|---|----|---|---|----|---|---|----|---|---|----|---|---|
|     | P  | F | M | P  | F | M | P  | F | M | P  | F | M | P  | F | M |
| 1   | E  | S | S | E  | S | S | B  | D | G | C  | G | D | C  | G | D |
| 2   | B  | D | G | C  | G | D | E  | S | S | B  | D | G | E  | S | S |
| 3   | C  | G | D | B  | D | G | C  | G | D | E  | S | S | B  | D | G |

LEGEND:

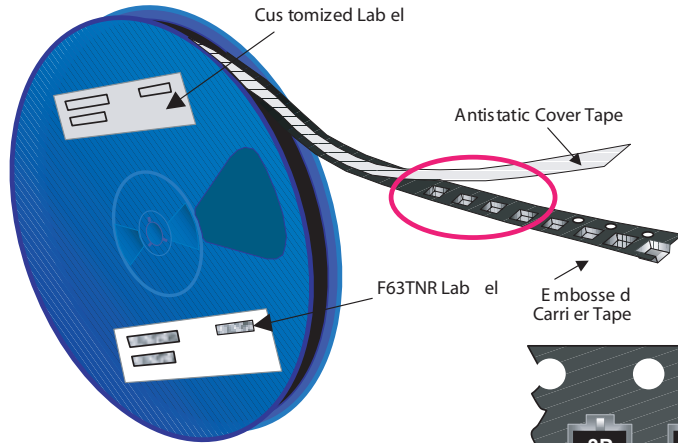
P - BIPOLAR      E - EMITTER      D - DRAIN  
 F - JFET          B - BASE            S - SOURCE  
 M - DMOS        C - COLLECTOR      G - GATE

- E) FOR PACKAGE 92, 94, 96, 97 AND 98: PIN CONFIGURATION DRAIN "D" AND SOURCE "S" ARE INTERCHANGEABLE AT JFET "F" OPTION.
- F) DRAWING FILENAME: MKT-2A03DREV3.

Dimensions in Millimeters

## SOT-23 Std Tape and Reel Data

### SOT23-3L Packaging Configuration: Figure 1.0

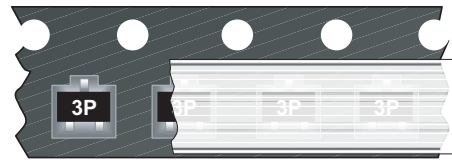


#### Packaging Description:

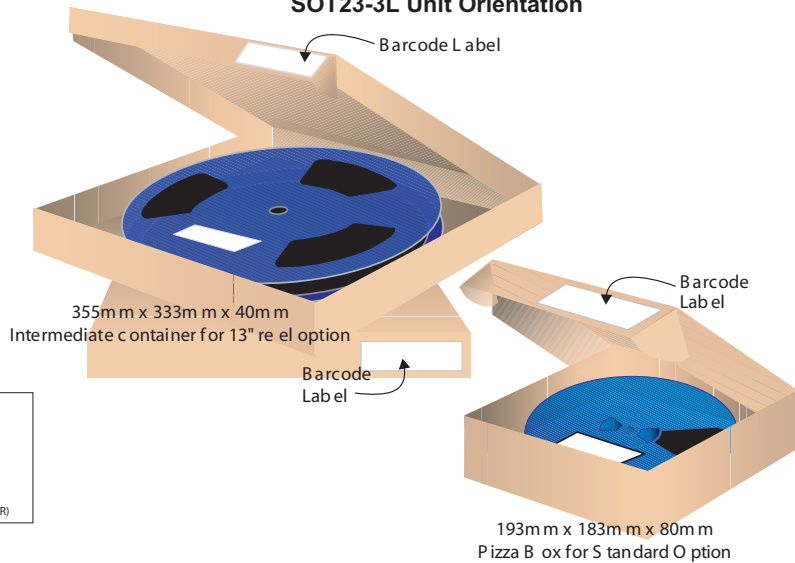
SOT23-3L parts are shipped in tape. The carrier tape is made from a dissipative (carbon filled) polycarbonate resin. The cover tape is a multilayer film (Heat Activated Adhesive in nature) primarily composed of polyester film, adhesive layer, sealant, and anti-static sprayed agent. These reeled parts in standard option are shipped with 3,000 units per 7" or 177mm diameter reel. The reels are dark blue in color and is made of polystyrene plastic (anti-static coated). Other option comes in 10,000 units per 13" or 330mm diameter reel. This and some other options are described in the Packaging Information table.

These full reels are individually labeled and placed inside a standard intermediate box made of recyclable corrugated brown paper with a ON Semiconductor logo printing. One box contains five reels maximum. And these intermediate boxes are placed inside a labeled shipping box which comes in different sizes depending on the number of parts shipped.

| SOT23-3L Packaging Information |                         |            |
|--------------------------------|-------------------------|------------|
| Packaging Option               | Standard (no flow code) | D87Z       |
| Packaging type                 | TNR                     | TNR        |
| Qty per Reel/Tube/Bag          | 3,000                   | 10,000     |
| Reel Size                      | 7" Dia                  | 13"        |
| Box Dimension (mm)             | 193x183x80              | 355x333x40 |
| Max qty per Box                | 15,000                  | 30,000     |
| Weight per unit (gm)           | 0.0082                  | 0.0082     |
| Weight per Reel (kg)           | 0.1175                  | 0.4006     |
| Note/Comments                  |                         |            |



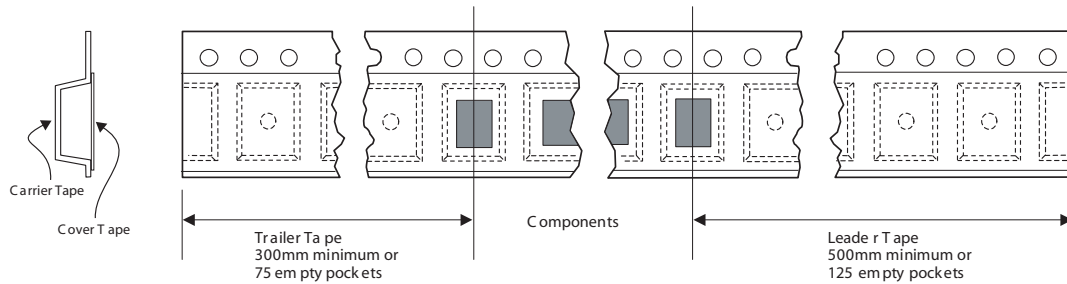
#### SOT23-3L Unit Orientation



#### Barcode Label sample

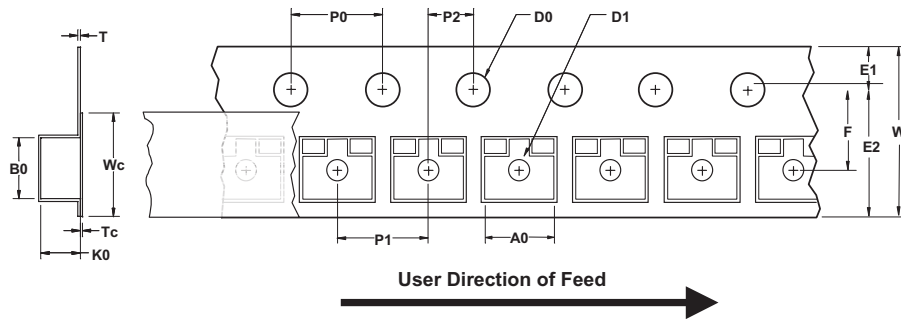


### SOT23-3L Tape Leader and Trailer Configuration: Figure 2.0



## SOT-23 Std Tape and Reel Data, continued

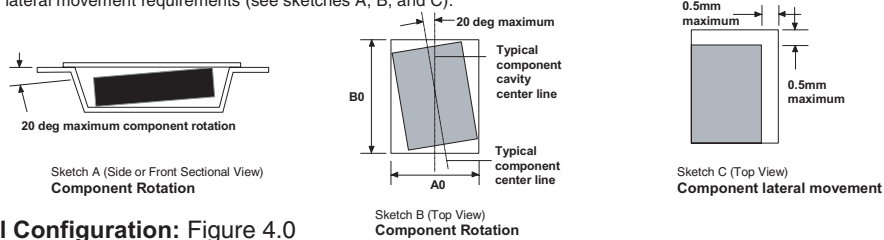
### SOT23-3L Embossed Carrier Tape Configuration: Figure 3.0



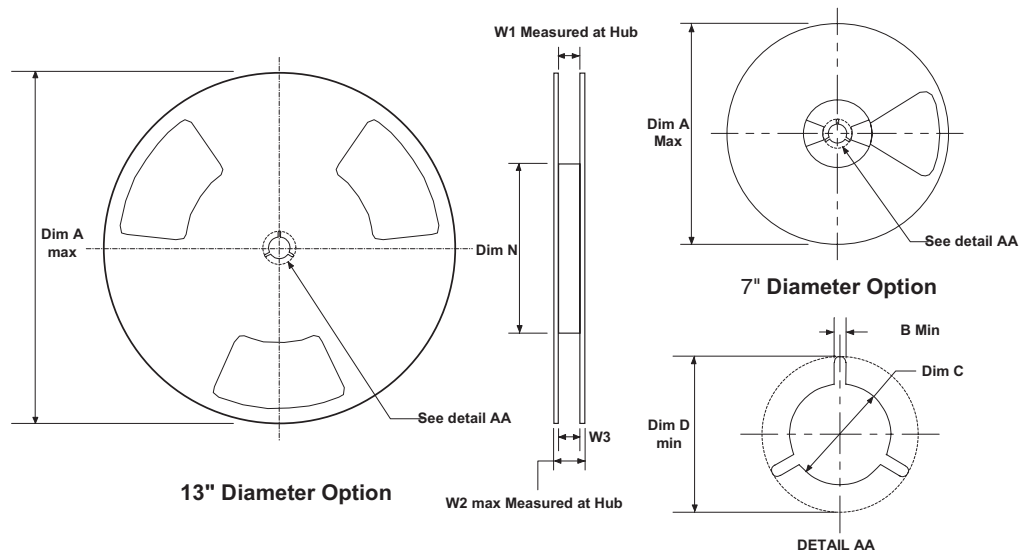
Dimensions are in millimeter

| Pkg type     | A0              | B0              | W             | D0              | D1                | E1              | E2          | F               | P1            | P0            | K0              | T                 | Wc            | Tc              |
|--------------|-----------------|-----------------|---------------|-----------------|-------------------|-----------------|-------------|-----------------|---------------|---------------|-----------------|-------------------|---------------|-----------------|
| SOT-23 (8mm) | 3.15<br>+/-0.10 | 2.77<br>+/-0.10 | 8.0<br>+/-0.3 | 1.55<br>+/-0.05 | 1.125<br>+/-0.125 | 1.75<br>+/-0.10 | 6.25<br>min | 3.50<br>+/-0.05 | 4.0<br>+/-0.1 | 4.0<br>+/-0.1 | 1.30<br>+/-0.10 | 0.228<br>+/-0.013 | 5.2<br>+/-0.3 | 0.06<br>+/-0.02 |

Notes: A0, B0, and K0 dimensions are determined with respect to the EIA/Jedec RS-481 rotational and lateral movement requirements (see sketches A, B, and C).



### SOT23-3L Reel Configuration: Figure 4.0

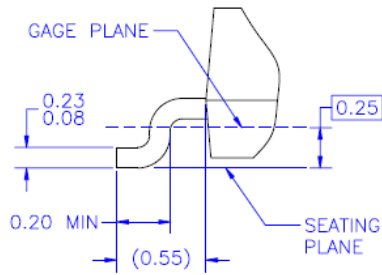
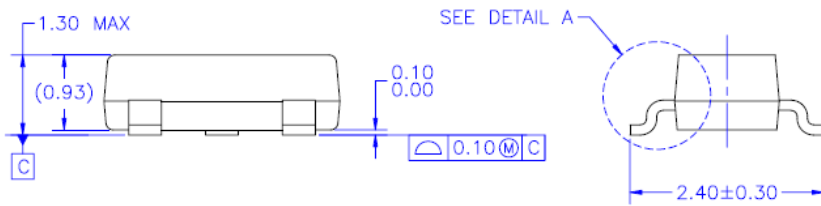
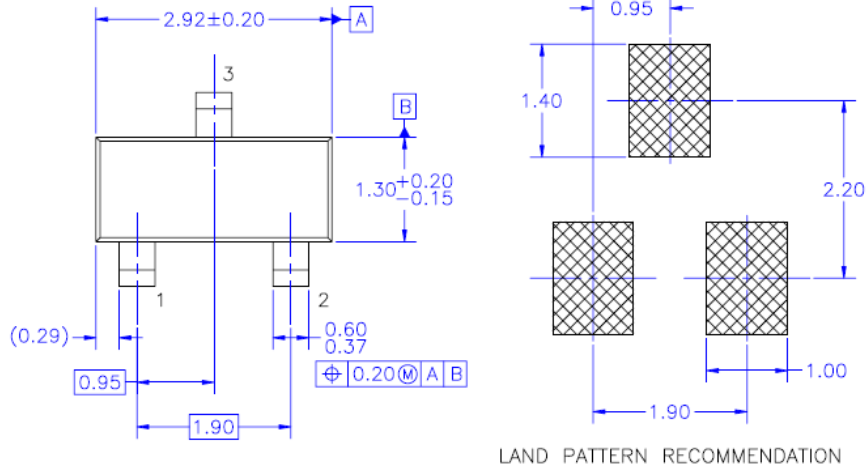


Dimensions are in inches and millimeters

| Tape Size | Reel Option | Dim A         | Dim B        | Dim C                             | Dim D         | Dim N       | Dim W1                            | Dim W2        | Dim W3 (LSL-USL)            |
|-----------|-------------|---------------|--------------|-----------------------------------|---------------|-------------|-----------------------------------|---------------|-----------------------------|
| 8mm       | 7" Dia      | 7.00<br>177.8 | 0.059<br>1.5 | 512 +0.020/-0.008<br>13 +0.5/-0.2 | 0.795<br>20.2 | 2.165<br>55 | 0.331 +0.059/-0.000<br>8.4 +1.5/0 | 0.567<br>14.4 | 0.311 - 0.429<br>7.9 - 10.9 |
| 8mm       | 13" Dia     | 13.00<br>330  | 0.059<br>1.5 | 512 +0.020/-0.008<br>13 +0.5/-0.2 | 0.795<br>20.2 | 4.00<br>100 | 0.331 +0.059/-0.000<br>8.4 +1.5/0 | 0.567<br>14.4 | 0.311 - 0.429<br>7.9 - 10.9 |

Mechanical Dimensions ( SOT-23 )

SOT-23



DETAIL A  
SCALE: 2X

NOTES: UNLESS OTHERWISE SPECIFIED

- A) REFERENCE JEDEC REGISTRATION TO-236, VARIATION AB, ISSUE H.
- B) ALL DIMENSIONS ARE IN MILLIMETERS.
- C) DIMENSIONS ARE INCLUSIVE OF BURRS, MOLD FLASH AND TIE BAR EXTRUSIONS.
- D) DIMENSIONING AND TOLERANCING PER ASME Y14.5M — 1994.
- E) DRAWING FILE NAME: MA03DREV9

Dimensions in Millimeters

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