

# Field Effect Transistor - N-Channel, Enhancement Mode

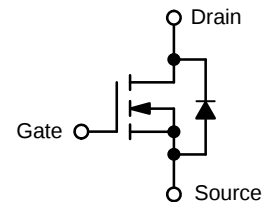
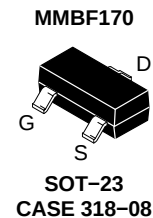
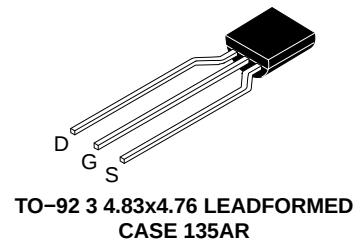
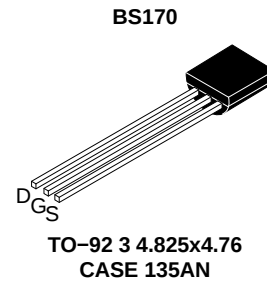
## BS170, MMBF170

### General Description

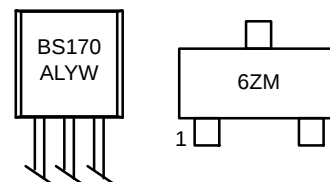
These N-Channel enhancement mode field effect transistors are produced using onsemi's proprietary, high cell density, DMOS technology. These products have been designed to minimize on-state resistance while provide rugged, reliable, and fast switching performance. They can be used in most applications requiring up to 500 mA 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
- These are Pb-Free Devices



### MARKING DIAGRAM



BS170, 6Z = Device Code  
 A = Assembly Plant Code  
 L = Wafer Lot Number  
 YW = Assembly Start Week  
 M = Date Code

### ORDERING INFORMATION

See detailed ordering and shipping information on page 6 of this data sheet.

NOTE: Some of the devices on this data sheet have been **DISCONTINUED**. Please refer to the table on page 6.

# BS170, MMBF170

## ABSOLUTE MAXIMUM RATINGS (T<sub>A</sub> = 25°C unless otherwise noted)

| Symbol                            | Parameter                                                                       |              | BS170       | MMBF170 | Unit |
|-----------------------------------|---------------------------------------------------------------------------------|--------------|-------------|---------|------|
| V <sub>DSS</sub>                  | Drain–Source Voltage                                                            |              | 60          |         | V    |
| V <sub>DGR</sub>                  | Drain–Gate Voltage (R <sub>GS</sub> ≤ 1 MΩ)                                     |              | 60          |         | V    |
| V <sub>GSS</sub>                  | Gate–Source Voltage                                                             |              | ±20         |         | V    |
| I <sub>D</sub>                    | Drain Current                                                                   | – Continuous | 500         | 500     | mA   |
|                                   |                                                                                 | – Pulsed     | 1200        | 800     |      |
| T <sub>J</sub> , T <sub>STG</sub> | Operating and Storage Temperature Range                                         |              | – 55 to 150 |         | °C   |
| T <sub>L</sub>                    | Maximum Lead Temperature for Soldering Purposes, 1/16" from Case for 10 Seconds |              | 300         |         | °C   |

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

## THERMAL CHARACTERISTICS (T<sub>A</sub> = 25°C unless otherwise noted)

| Symbol           | Parameter                                      | BS170      | MMBF170    | Unit        |
|------------------|------------------------------------------------|------------|------------|-------------|
| P <sub>D</sub>   | Maximum Power Dissipation<br>Derate above 25°C | 830<br>6.6 | 300<br>2.4 | mW<br>mW/°C |
| R <sub>θJA</sub> | Thermal Resistance, Junction to Ambient        | 150        | 417        | °C/W        |

## ELECTRICAL CHARACTERISTICS (T<sub>A</sub> = 25°C unless otherwise noted)

| Symbol | Parameter | Test Condition | Type | Min | Typ | Max | Unit |
|--------|-----------|----------------|------|-----|-----|-----|------|
|--------|-----------|----------------|------|-----|-----|-----|------|

### OFF CHARACTERISTICS

|                   |                                 |                                                |     |    |   |     |    |
|-------------------|---------------------------------|------------------------------------------------|-----|----|---|-----|----|
| BV <sub>DSS</sub> | Drain–Source Breakdown Voltage  | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 100 μA | All | 60 | – | –   | V  |
| I <sub>DSS</sub>  | Zero Gate Voltage Drain Current | V <sub>DS</sub> = 25 V, V <sub>GS</sub> = 0 V  | All | –  | – | 0.5 | μA |
| I <sub>GSSF</sub> | Gate – Body Leakage, Forward    | V <sub>GS</sub> = 15 V, V <sub>DS</sub> = 0 V  | All | –  | – | 10  | nA |

### ON CHARACTERISTICS (Note 1)

|                     |                                   |                                                                   |         |     |     |   |    |
|---------------------|-----------------------------------|-------------------------------------------------------------------|---------|-----|-----|---|----|
| V <sub>GS(th)</sub> | Gate Threshold Voltage            | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 1 mA         | All     | 0.8 | 2.1 | 3 | V  |
| R <sub>DS(on)</sub> | Static Drain–Source On–Resistance | V <sub>GS</sub> = 10 V, I <sub>D</sub> = 200 mA                   | All     | –   | 1.2 | 5 | Ω  |
| g <sub>FS</sub>     | Forward Transconductance          | V <sub>DS</sub> = 10 V, I <sub>D</sub> = 200 mA                   | BS170   | –   | 320 | – | mS |
|                     |                                   | V <sub>DS</sub> ≥ 2 V <sub>DS(on)</sub> , I <sub>D</sub> = 200 mA | MMBF170 | –   | 320 | – |    |

### DYNAMIC CHARACTERISTICS

|                  |                              |                                                               |     |   |    |    |    |
|------------------|------------------------------|---------------------------------------------------------------|-----|---|----|----|----|
| C <sub>iss</sub> | Input Capacitance            | V <sub>DS</sub> = 10 V, V <sub>GS</sub> = 0 V,<br>f = 1.0 MHz | All | – | 24 | 40 | pF |
| C <sub>oss</sub> | Output Capacitance           |                                                               | All | – | 17 | 30 | pF |
| C <sub>rss</sub> | Reverse Transfer Capacitance |                                                               | All | – | 7  | 10 | pF |

### SWITCHING CHARACTERISTICS (Note 1)

|                  |               |                                                                                                     |         |   |   |    |    |
|------------------|---------------|-----------------------------------------------------------------------------------------------------|---------|---|---|----|----|
| t <sub>on</sub>  | Turn–On Time  | V <sub>DD</sub> = 25 V, I <sub>D</sub> = 200 mA,<br>V <sub>GS</sub> = 10 V, R <sub>GEN</sub> = 25 Ω | BS170   | – | – | 10 | ns |
|                  |               | V <sub>DD</sub> = 25 V, I <sub>D</sub> = 500 mA,<br>V <sub>GS</sub> = 10 V, R <sub>GEN</sub> = 50 Ω | MMBF170 | – | – | 10 |    |
| t <sub>off</sub> | Turn–Off Time | V <sub>DD</sub> = 25 V, I <sub>D</sub> = 200 mA,<br>V <sub>GS</sub> = 10 V, R <sub>GEN</sub> = 25 Ω | BS170   | – | – | 10 | ns |
|                  |               | V <sub>DD</sub> = 25 V, I <sub>D</sub> = 500 mA,<br>V <sub>GS</sub> = 10 V, R <sub>GEN</sub> = 50 Ω | MMBF170 | – | – | 10 |    |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

TYPICAL ELECTRICAL CHARACTERISTICS

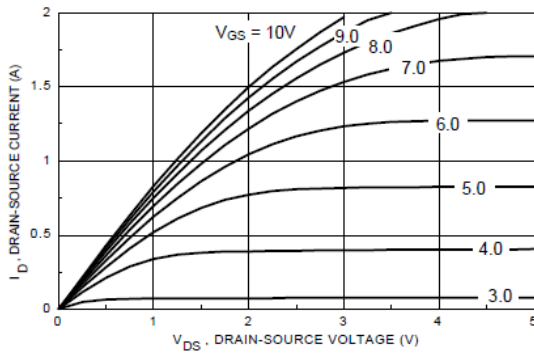


Figure 1. On-Region Characteristics

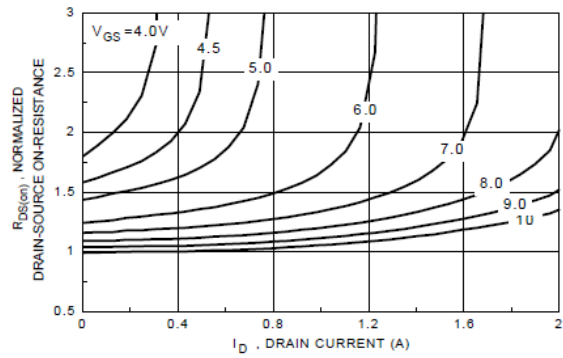


Figure 2. On-Resistance Variation with Gate Voltage and Drain Current

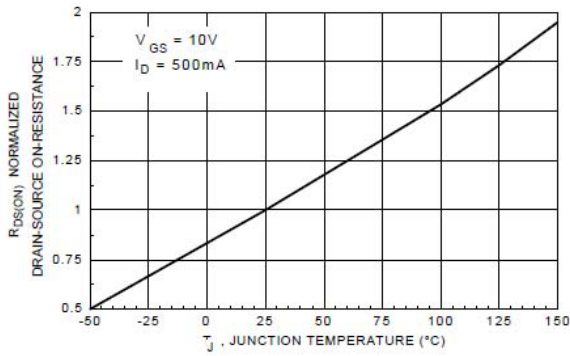


Figure 3. On-Resistance Variation with Temperature

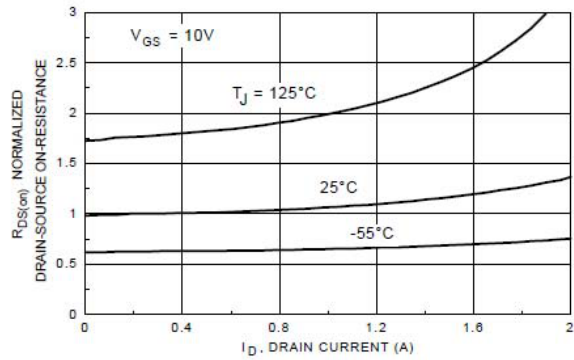


Figure 4. On-Resistance Variation with Drain Current and Temperature

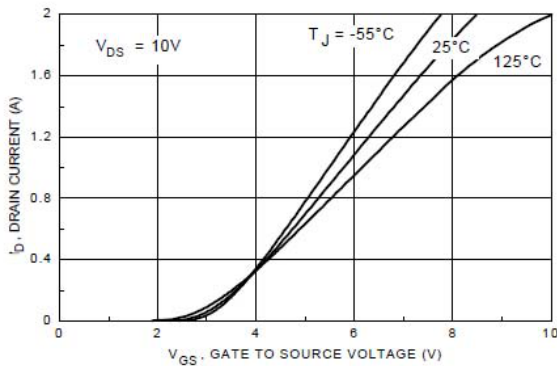


Figure 5. Transfer Characteristics

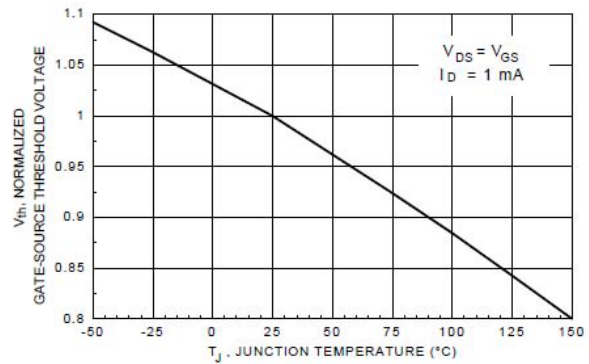


Figure 6. Gate Threshold Variation with Temperature

TYPICAL ELECTRICAL CHARACTERISTICS (continued)

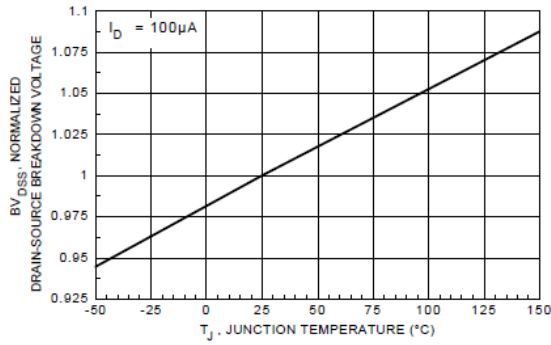


Figure 7. Breakdown Voltage Variation with Temperature

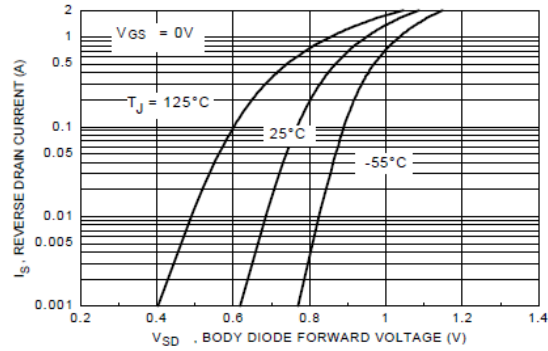


Figure 8. Body Diode Forward Voltage Variation with Current and Temperature

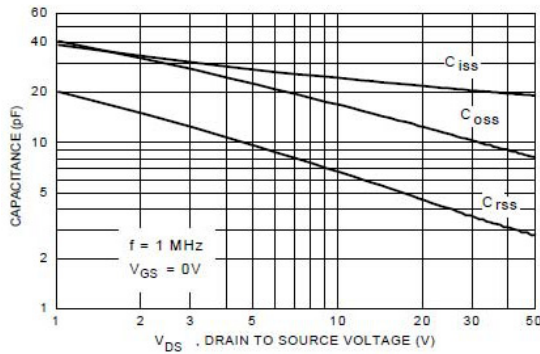


Figure 9. Capacitance Characteristics

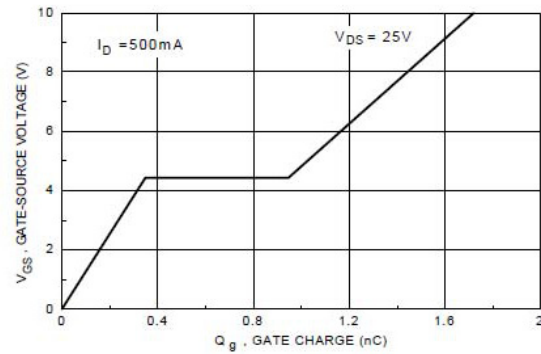


Figure 10. Gate Charge Characteristics

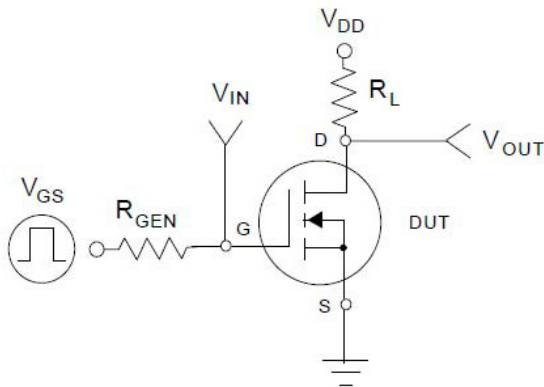


Figure 11. Switching Test Circuit

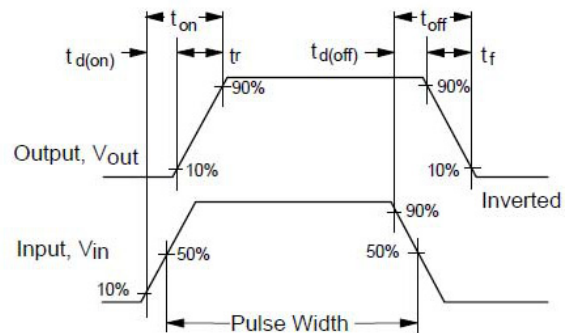


Figure 12. Switching Waveforms

# BS170, MMBF170

## TYPICAL ELECTRICAL CHARACTERISTICS (continued)

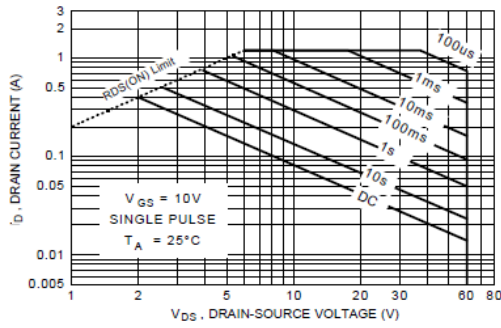


Figure 13. BS170 Maximum Safe Operating Area

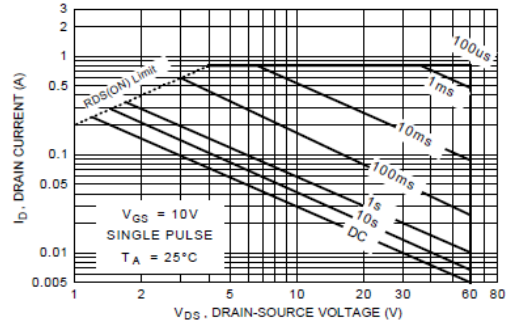


Figure 14. MMBF170 Maximum Safe Operating Area

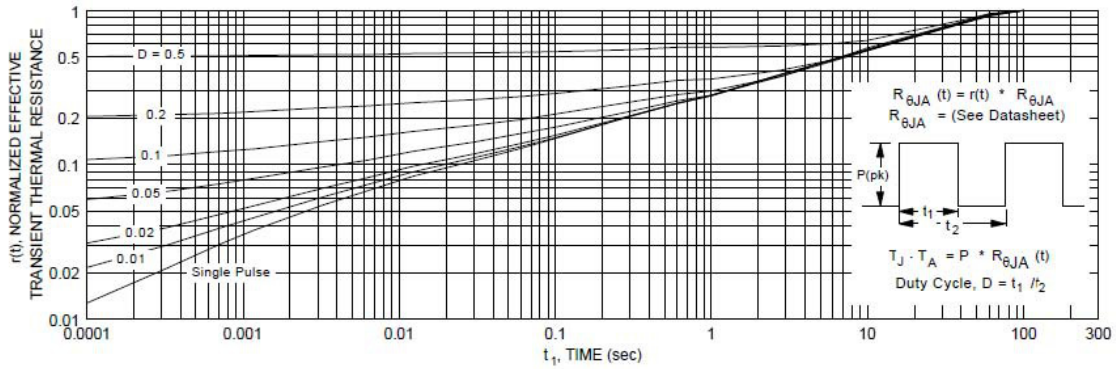


Figure 15. TO-92, BS170 Transient Thermal Response Curve

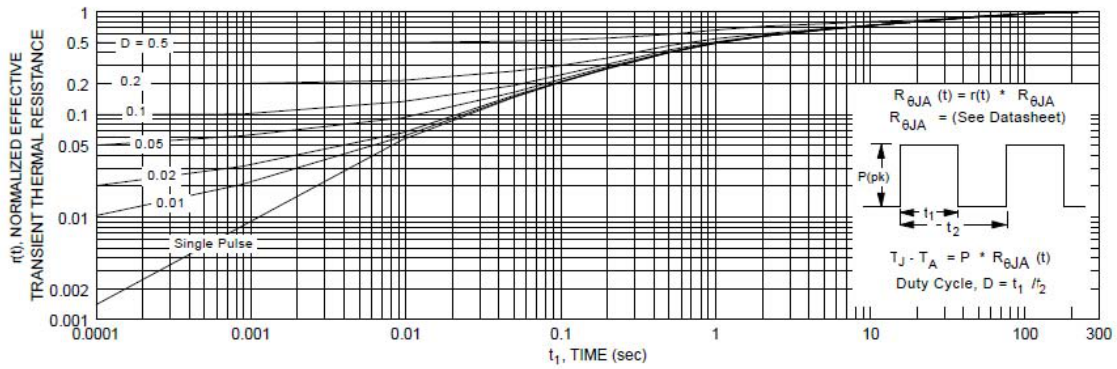


Figure 16. SOT-23, MMBF170 Transient Thermal Response Curve

## BS170, MMBF170

### ORDERING INFORMATION

| Part Number | Package             | Lead Frame | Pin Array | Shipping <sup>†</sup> |
|-------------|---------------------|------------|-----------|-----------------------|
| BS170       | TO-92<br>(Pb-Free)  | Straight   | D G S     | 10000 Units / Bulk    |
| BS170-D26Z  | TO-92<br>(Pb-Free)  | Forming    | D G S     | 2000 / Tape & Reel    |
| BS170-D27Z  | TO-92<br>(Pb-Free)  | Forming    | D G S     | 2000 / Tape & Reel    |
| BS170-D75Z  | TO-92<br>(Pb-Free)  | Forming    | D G S     | 2000 / Ammo           |
| MMBF170     | SOT-23<br>(Pb-Free) |            |           | 3000 / Tape & Reel    |

### DISCONTINUED (Note 2)

|            |                    |         |       |             |
|------------|--------------------|---------|-------|-------------|
| BS170-D74Z | TO-92<br>(Pb-Free) | Forming | D G S | 2000 / Ammo |
|------------|--------------------|---------|-------|-------------|

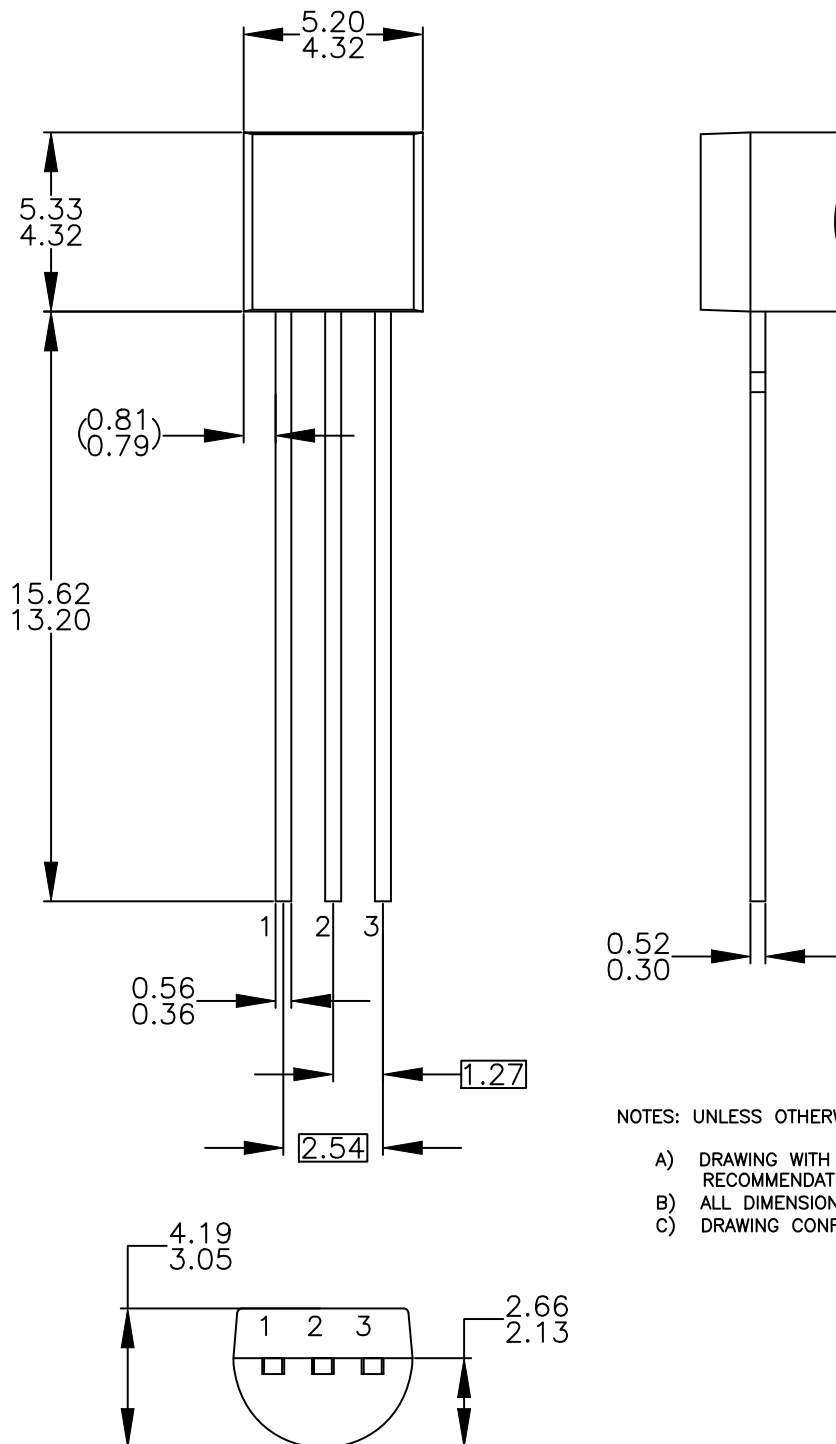
<sup>†</sup>For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

2. **DISCONTINUED:** This device is not recommended for new design. Please contact your **onsemi** representative for information. The most current information on this device may be available on [www.onsemi.com](http://www.onsemi.com).



**TO-92 3 4.825x4.76**  
**CASE 135AN**  
**ISSUE O**

DATE 31 JUL 2016



NOTES: UNLESS OTHERWISE SPECIFIED

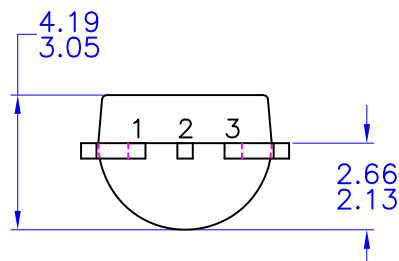
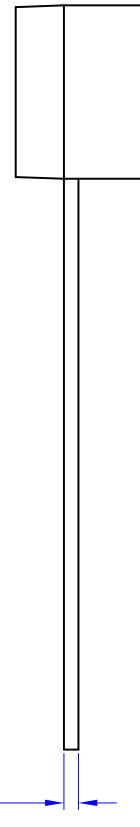
- A) DRAWING WITH REFERENCE TO JEDEC TO-92 RECOMMENDATIONS.
- B) ALL DIMENSIONS ARE IN MILLIMETERS.
- C) DRAWING CONFORMS TO ASME Y14.5M-2009.

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**TO-92 3 4.83x4.76 LEADFORMED**  
CASE 135AR  
ISSUE O

DATE 30 SEP 2016

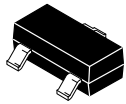


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- B) ALL DIMENSIONS ARE IN MILLIMETERS.
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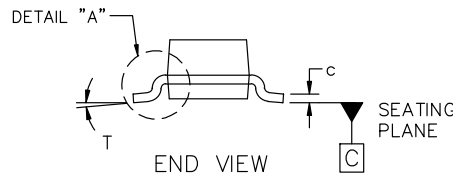
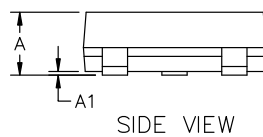
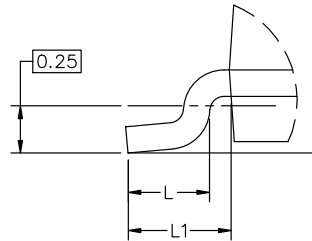
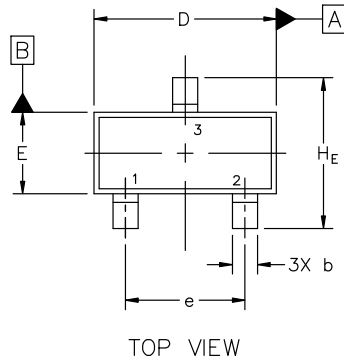
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SCALE 4:1

SOT-23 (TO-236) 2.90x1.30x1.00 1.90P  
CASE 318  
ISSUE AU

DATE 14 AUG 2024

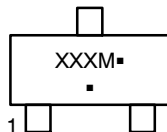


| MILLIMETERS |      |      |      |
|-------------|------|------|------|
| DIM         | MIN  | NOM  | MAX  |
| A           | 0.89 | 1.00 | 1.11 |
| A1          | 0.01 | 0.06 | 0.10 |
| b           | 0.37 | 0.44 | 0.50 |
| c           | 0.08 | 0.14 | 0.20 |
| D           | 2.80 | 2.90 | 3.04 |
| E           | 1.20 | 1.30 | 1.40 |
| e           | 1.78 | 1.90 | 2.04 |
| L           | 0.30 | 0.43 | 0.55 |
| L1          | 0.35 | 0.54 | 0.69 |
| HE          | 2.10 | 2.40 | 2.64 |
| T           | 0°   | ---  | 10°  |

NOTES:

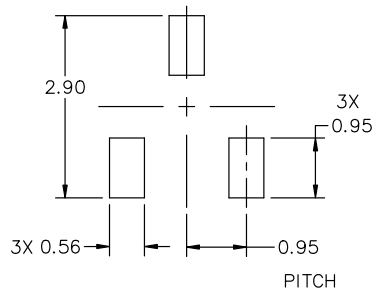
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 2018.
2. CONTROLLING DIMENSIONS: MILLIMETERS.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF THE BASE MATERIAL.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS.

GENERIC  
MARKING DIAGRAM\*



XXX = Specific Device Code  
M = Date Code  
▪ = Pb-Free Package

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "▪", may or may not be present. Some products may not follow the Generic Marking.



RECOMMENDED  
MOUNTING FOOTPRINT

\* For additional information on our Pb-Free strategy and soldering details, please download the onsemi Soldering and Mounting Techniques Reference Manual, SOLDERM/D.

STYLES ON PAGE 2

|                  |                                      |                                                                                                                                                                                     |
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**SOT-23 (TO-236) 2.90x1.30x1.00 1.90P**  
**CASE 318**  
**ISSUE AU**

DATE 14 AUG 2024

|                                                         |                                                       |                                                             |                                                             |                                                             |                                                             |
|---------------------------------------------------------|-------------------------------------------------------|-------------------------------------------------------------|-------------------------------------------------------------|-------------------------------------------------------------|-------------------------------------------------------------|
| STYLE 1 THRU 5:<br>CANCELLED                            | STYLE 6:<br>PIN 1. BASE<br>2. EMITTER<br>3. COLLECTOR | STYLE 7:<br>PIN 1. EMITTER<br>2. BASE<br>3. COLLECTOR       | STYLE 8:<br>PIN 1. ANODE<br>2. NO CONNECTION<br>3. CATHODE  |                                                             |                                                             |
| STYLE 9:<br>PIN 1. ANODE<br>2. ANODE<br>3. CATHODE      | STYLE 10:<br>PIN 1. DRAIN<br>2. SOURCE<br>3. GATE     | STYLE 11:<br>PIN 1. ANODE<br>2. CATHODE<br>3. CATHODE-ANODE | STYLE 12:<br>PIN 1. CATHODE<br>2. CATHODE<br>3. ANODE       | STYLE 13:<br>PIN 1. SOURCE<br>2. DRAIN<br>3. GATE           | STYLE 14:<br>PIN 1. CATHODE<br>2. GATE<br>3. ANODE          |
| STYLE 15:<br>PIN 1. GATE<br>2. CATHODE<br>3. ANODE      | STYLE 16:<br>PIN 1. ANODE<br>2. CATHODE<br>3. CATHODE | STYLE 17:<br>PIN 1. NO CONNECTION<br>2. ANODE<br>3. CATHODE | STYLE 18:<br>PIN 1. NO CONNECTION<br>2. CATHODE<br>3. ANODE | STYLE 19:<br>PIN 1. CATHODE<br>2. ANODE<br>3. CATHODE-ANODE | STYLE 20:<br>PIN 1. CATHODE<br>2. ANODE<br>3. GATE          |
| STYLE 21:<br>PIN 1. GATE<br>2. SOURCE<br>3. DRAIN       | STYLE 22:<br>PIN 1. RETURN<br>2. OUTPUT<br>3. INPUT   | STYLE 23:<br>PIN 1. ANODE<br>2. ANODE<br>3. CATHODE         | STYLE 24:<br>PIN 1. GATE<br>2. DRAIN<br>3. SOURCE           | STYLE 25:<br>PIN 1. ANODE<br>2. CATHODE<br>3. GATE          | STYLE 26:<br>PIN 1. CATHODE<br>2. ANODE<br>3. NO CONNECTION |
| STYLE 27:<br>PIN 1. CATHODE<br>2. CATHODE<br>3. CATHODE | STYLE 28:<br>PIN 1. ANODE<br>2. ANODE<br>3. ANODE     |                                                             |                                                             |                                                             |                                                             |

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