

# JFET Switching Transistors

## N-Channel

### MMBF4391L, MMBF4392L, MMBF4393L

#### Features

- S Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q101 Qualified and PPAP Capable
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant

#### MAXIMUM RATINGS

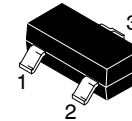
| Rating               | Symbol     | Value | Unit |
|----------------------|------------|-------|------|
| Drain-Source Voltage | $V_{DS}$   | 30    | Vdc  |
| Drain-Gate Voltage   | $V_{DG}$   | 30    | Vdc  |
| Gate-Source Voltage  | $V_{GS}$   | 30    | Vdc  |
| Forward Gate Current | $I_{G(f)}$ | 50    | mAdc |

#### THERMAL CHARACTERISTICS

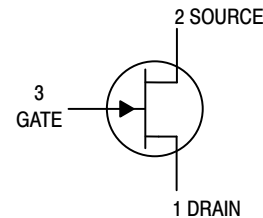
| Characteristic                                                                                              | Symbol          | Max         | Unit                       |
|-------------------------------------------------------------------------------------------------------------|-----------------|-------------|----------------------------|
| Total Device Dissipation FR-5 Board<br>(Note 1) $T_A = 25^\circ\text{C}$<br>Derate above $25^\circ\text{C}$ | $P_D$           | 225<br>1.8  | mW<br>mW/ $^\circ\text{C}$ |
| Thermal Resistance, Junction-to-Ambient                                                                     | $R_{\theta JA}$ | 556         | $^\circ\text{C}/\text{W}$  |
| Junction and Storage Temperature Range                                                                      | $T_J, T_{stg}$  | -55 to +150 | $^\circ\text{C}$           |

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.

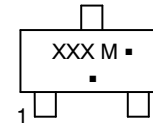
1. FR-5 =  $1.0 \times 0.75 \times 0.062$  in.



SOT-23  
CASE 318  
STYLE 10



#### MARKING DIAGRAM



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

(Note: Microdot may be in either location)

\*Date Code orientation and/or overbar may vary depending upon manufacturing location.

#### MARKING & ORDERING INFORMATION

See detailed ordering, marking and shipping information in the package dimensions section on page 2 of this data sheet.

# MMBF4391L, MMBF4392L, MMBF4393L

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

| Characteristic                                                                                                                                                            | Symbol               | Min                  | Max                 | Unit              |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|----------------------|---------------------|-------------------|
| <b>OFF CHARACTERISTICS</b>                                                                                                                                                |                      |                      |                     |                   |
| Gate–Source Breakdown Voltage<br>(I <sub>G</sub> = 1.0 $\mu$ Adc, V <sub>DS</sub> = 0)                                                                                    | V <sub>(BR)GSS</sub> | 30                   | –                   | Vdc               |
| Gate Reverse Current<br>(V <sub>GS</sub> = 15 Vdc, V <sub>DS</sub> = 0, T <sub>A</sub> = 25°C)<br>(V <sub>GS</sub> = 15 Vdc, V <sub>DS</sub> = 0, T <sub>A</sub> = 100°C) | I <sub>GSS</sub>     | –<br>–               | 1.0<br>0.20         | nAdc<br>$\mu$ Adc |
| Gate–Source Cutoff Voltage<br>(V <sub>DS</sub> = 15 Vdc, I <sub>D</sub> = 10 nAdc)<br>MMBF4391LT1<br>MMBF4392LT1<br>MMBF4393LT1                                           | V <sub>GS(off)</sub> | –4.0<br>–2.0<br>–0.5 | –10<br>–5.0<br>–3.0 | Vdc               |
| Off–State Drain Current<br>(V <sub>DS</sub> = 15 Vdc, V <sub>GS</sub> = –12 Vdc)<br>(V <sub>DS</sub> = 15 Vdc, V <sub>GS</sub> = –12 Vdc, T <sub>A</sub> = 100°C)         | I <sub>D(off)</sub>  | –<br>–               | 1.0<br>1.0          | nAdc<br>$\mu$ Adc |

## ON CHARACTERISTICS

|                                                                                                                                                                                                                                 |                     |                 |                   |          |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|-----------------|-------------------|----------|
| Zero–Gate–Voltage Drain Current<br>(V <sub>DS</sub> = 15 Vdc, V <sub>GS</sub> = 0)<br>MMBF4391LT1<br>MMBF4392LT1<br>MMBF4393LT1                                                                                                 | I <sub>DSS</sub>    | 50<br>25<br>5.0 | 150<br>75<br>30   | mAdc     |
| Drain–Source On–Voltage<br>(I <sub>D</sub> = 12 mAdc, V <sub>GS</sub> = 0)<br>MMBF4391LT1<br>(I <sub>D</sub> = 6.0 mAdc, V <sub>GS</sub> = 0)<br>MMBF4392LT1<br>(I <sub>D</sub> = 3.0 mAdc, V <sub>GS</sub> = 0)<br>MMBF4393LT1 | V <sub>DS(on)</sub> | –<br>–<br>–     | 0.4<br>0.4<br>0.4 | Vdc      |
| Static Drain–Source On–Resistance<br>(I <sub>D</sub> = 1.0 mAdc, V <sub>GS</sub> = 0)<br>MMBF4391LT1<br>MMBF4392LT1<br>MMBF4393LT1                                                                                              | r <sub>DS(on)</sub> | –<br>–<br>–     | 30<br>60<br>100   | $\Omega$ |

## SMALL– SIGNAL CHARACTERISTICS

|                                                                                                   |                  |   |     |    |
|---------------------------------------------------------------------------------------------------|------------------|---|-----|----|
| Input Capacitance<br>(V <sub>DS</sub> = 0 Vdc, V <sub>GS</sub> = –15 Vdc, f = 1.0 MHz)            | C <sub>iss</sub> | – | 14  | pF |
| Reverse Transfer Capacitance<br>(V <sub>DS</sub> = 0 Vdc, V <sub>GS</sub> = –12 Vdc, f = 1.0 MHz) | C <sub>rss</sub> | – | 3.5 | pF |

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.

## ORDERING INFORMATION

| Device         | Marking | Package             | Shipping <sup>†</sup> |
|----------------|---------|---------------------|-----------------------|
| MMBF4391LT1G   | 6J      | SOT–23<br>(Pb–Free) | 3,000 / Tape & Reel   |
| SMMBF4391LT1G* | 6J      |                     |                       |
| MMBF4392LT1G   | 6K      |                     |                       |
| MMBF4393LT1G   | M6G     |                     |                       |
| SMMBF4393LT1G* | M6G     |                     |                       |

<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.

## TYPICAL CHARACTERISTICS

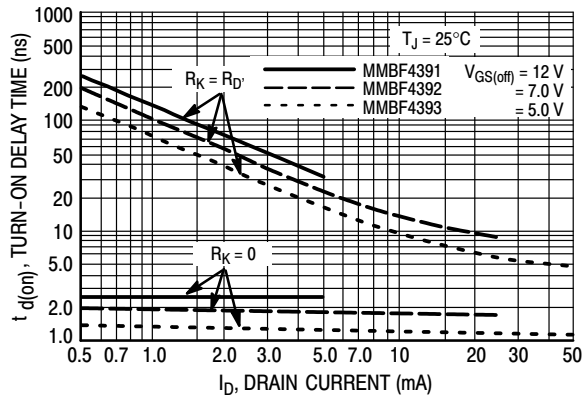


Figure 1. Turn-On Delay Time

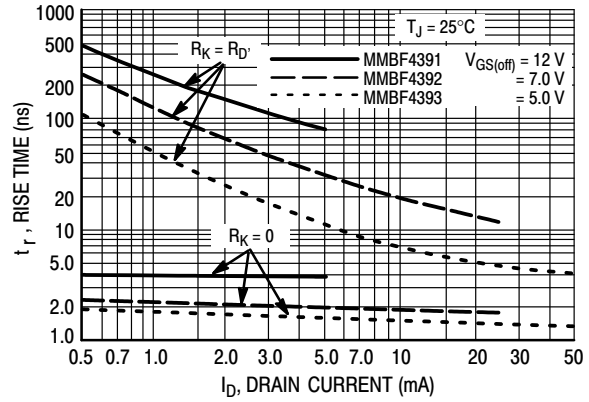


Figure 2. Rise Time

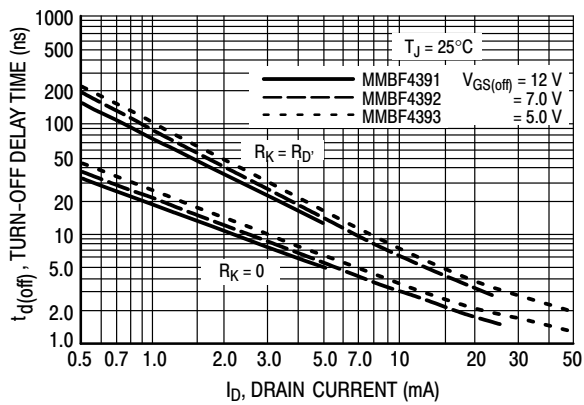


Figure 3. Turn-Off Delay Time

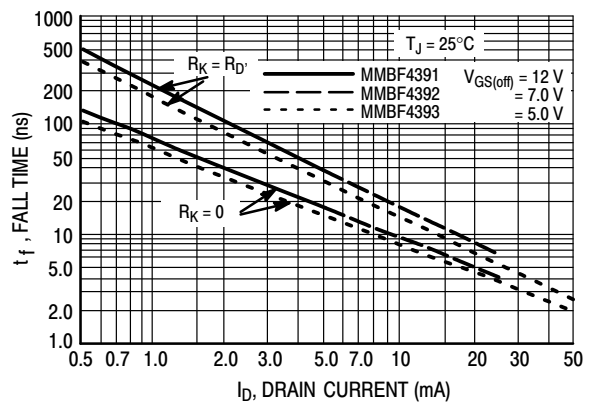


Figure 4. Fall Time

NOTE 1

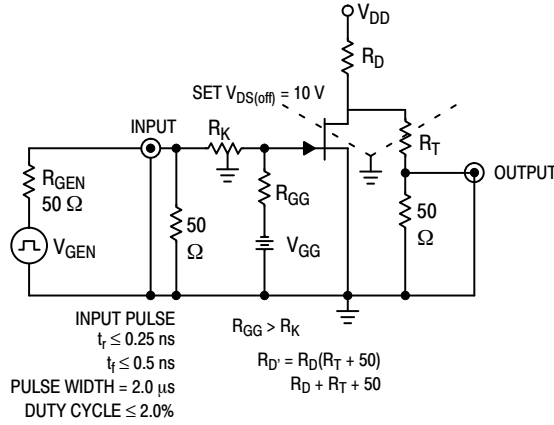


Figure 5. Switching Time Test Circuit

The switching characteristics shown above were measured using a test circuit similar to Figure 5. At the beginning of the switching interval, the gate voltage is at Gate Supply Voltage ( $-V_{GG}$ ). The Drain-Source Voltage ( $V_{DS}$ ) is slightly lower than Drain Supply Voltage ( $V_{DD}$ ) due to the voltage divider. Thus Reverse Transfer Capacitance ( $C_{rss}$ ) of Gate-Drain Capacitance ( $C_{gd}$ ) is charged to  $V_{GG} + V_{DS}$ .

During the turn-on interval, Gate-Source Capacitance ( $C_{gs}$ ) discharges through the series combination of  $R_{Gen}$  and  $R_K$ .  $C_{gd}$  must discharge to  $V_{DS(on)}$  through  $R_G$  and  $R_K$  in series with the parallel combination of effective load impedance ( $R'_D$ ) and Drain-Source Resistance ( $r_{DS}$ ). During the turn-off, this charge flow is reversed.

Predicting turn-on time is somewhat difficult as the channel resistance  $r_{DS}$  is a function of the gate-source voltage. While  $C_{gs}$  discharges,  $V_{GS}$  approaches zero and  $r_{DS}$  decreases. Since  $C_{gd}$  discharges through  $r_{DS}$ , turn-on time is non-linear. During turn-off, the situation is reversed with  $r_{DS}$  increasing as  $C_{gd}$  charges.

The above switching curves show two impedance conditions; 1)  $R_K$  is equal to  $R_D$ , which simulates the switching behavior of cascaded stages where the driving source impedance is normally the load impedance of the previous stage, and 2)  $R_K = 0$  (low impedance) the driving source impedance is that of the generator.

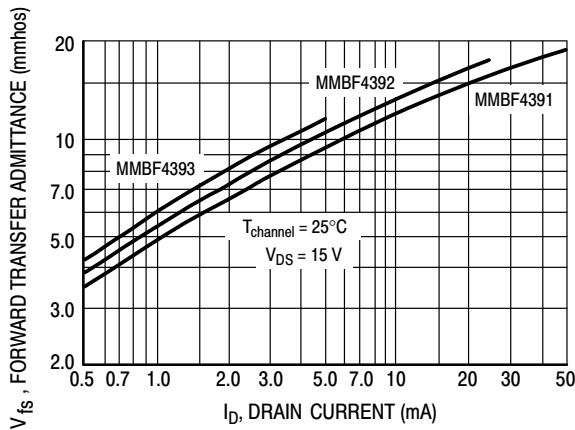


Figure 6. Typical Forward Transfer Admittance

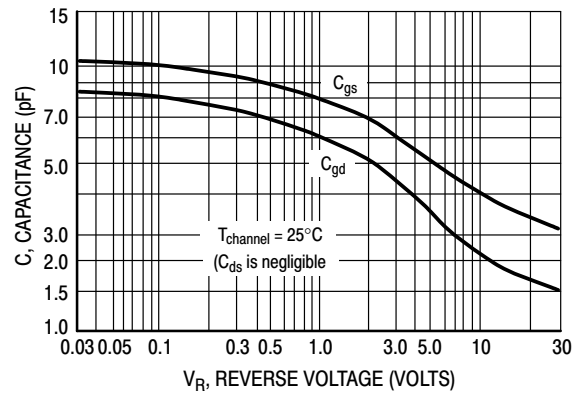


Figure 7. Typical Capacitance

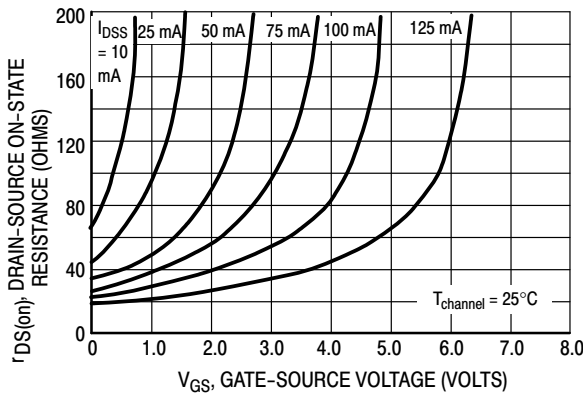


Figure 8. Effect of Gate-Source Voltage on Drain-Source Resistance

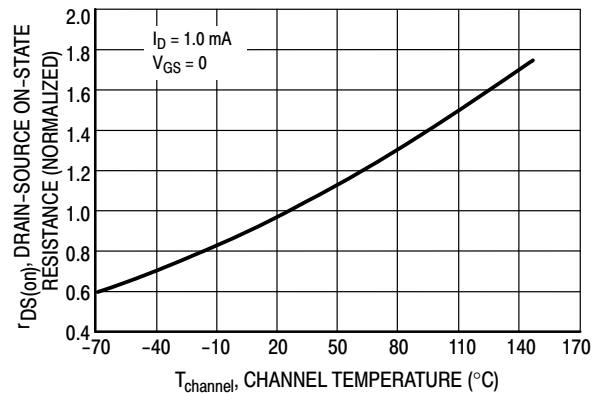
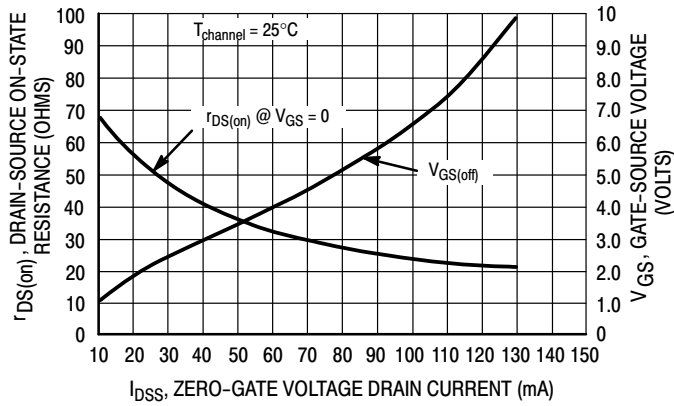


Figure 9. Effect of Temperature on Drain-Source On-State Resistance



**Figure 10. Effect of  $I_{DSS}$  on Drain-Source Resistance and Gate-Source Voltage**

#### NOTE 2

The Zero-Gate-Voltage Drain Current ( $I_{DSS}$ ) is the principle determinant of other J-FET characteristics. Figure 10 shows the relationship of Gate-Source Off Voltage ( $V_{GS(off)}$ ) and Drain-Source On Resistance ( $r_{DS(on)}$ ) to  $I_{DSS}$ . Most of the devices will be within  $\pm 10\%$  of the values shown in Figure 10. This data will be useful in predicting the characteristic variations for a given part number.

For example:

Unknown

$r_{DS(on)}$  and  $V_{GS}$  range for an MMBF4392

The electrical characteristics table indicates that an MMBF4392 has an  $I_{DSS}$  range of 25 to 75 mA. Figure 10 shows  $r_{DS(on)} = 52 \Omega$  for  $I_{DSS} = 25$  mA and  $30 \Omega$  for  $I_{DSS} = 75$  mA. The corresponding  $V_{GS}$  values are 2.2 V and 4.8 V.



SCALE 4:1

SOT-23 (TO-236) 2.90x1.30x1.00 1.90P  
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| 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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|                                                         |                                                       |                                                             |                                                             |                                                             |                                                             |
|---------------------------------------------------------|-------------------------------------------------------|-------------------------------------------------------------|-------------------------------------------------------------|-------------------------------------------------------------|-------------------------------------------------------------|
| 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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