

# MMFTP3401-HAF

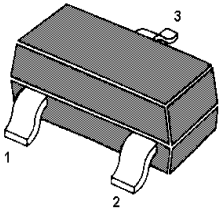
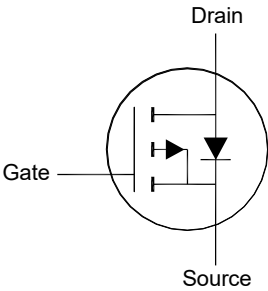
## P-Channel Enhancement Mode MOSFET

### Features

- Surface-mounted package
- Advanced trench cell design
- Halogen and Antimony Free(HAF),  
RoHS compliant

### Applications

- Portable appliances
- Battery management
- High speed switch
- Low power DC to DC Converter



1. Gate 2. Source 3. Drain  
SOT-23 Plastic Package

### Absolute Maximum Ratings (at $T_a = 25^{\circ}\text{C}$ unless otherwise specified)

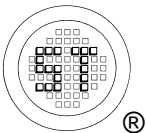
| Parameter                                        | Symbol         | Value         | Unit               |
|--------------------------------------------------|----------------|---------------|--------------------|
| Drain-Source Voltage                             | $-V_{DS}$      | 30            | V                  |
| Gate-Source Voltage                              | $V_{GS}$       | $\pm 12$      | V                  |
| Drain Current                                    | $-I_D$         | 4             | A                  |
| Peak Drain Current, Pulsed <sup>1)</sup>         | $-I_{DM}$      | 27            | A                  |
| Power Dissipation <sup>2)</sup>                  | $P_D$          | 1.4           | W                  |
| Operating Junction and Storage Temperature Range | $T_J, T_{stg}$ | - 55 to + 150 | $^{\circ}\text{C}$ |

### Thermal Resistance Ratings

| Parameter                                                 | Symbol          | Max. | Unit                 |
|-----------------------------------------------------------|-----------------|------|----------------------|
| Thermal Resistance from Junction to Ambient <sup>2)</sup> | $R_{\theta JA}$ | 90   | $^{\circ}\text{C/W}$ |

<sup>1)</sup> Pulse Test: Pulse Width  $\leq 100 \mu\text{s}$ , Duty Cycle  $\leq 2\%$ , Repetitive rating, pulse width limited by junction temperature  $T_{J(\text{MAX})}=150^{\circ}\text{C}$ .

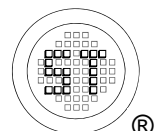
<sup>2)</sup> Device mounted on FR-4 substrate PC board, 2oz copper, with 1-inch square copper plate in still air,  $t \leq 10 \text{ s}$ .



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Characteristics at  $T_a = 25^\circ\text{C}$  unless otherwise specified

| Parameter                                                                                                                                                                                              | Symbol        | Min.        | Typ.        | Max.           | Unit          |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|-------------|-------------|----------------|---------------|
| <b>STATIC PARAMETERS</b>                                                                                                                                                                               |               |             |             |                |               |
| Drain-Source Breakdown Voltage<br>at $-I_D = 250\ \mu\text{A}$                                                                                                                                         | $-BV_{DSS}$   | 30          | -           | -              | V             |
| Drain-Source Leakage Current<br>at $-V_{DS} = 30\ \text{V}$                                                                                                                                            | $-I_{DSS}$    | -           | -           | 1              | $\mu\text{A}$ |
| Gate-Source Leakage Current<br>at $V_{GS} = \pm 12\ \text{V}$                                                                                                                                          | $I_{GSS}$     | -           | -           | $\pm 100$      | nA            |
| Gate-Source Threshold Voltage<br>at $V_{DS} = V_{GS}$ , $-I_D = 250\ \mu\text{A}$                                                                                                                      | $-V_{GS(th)}$ | 0.7         | -           | 1.4            | V             |
| Drain-Source On-State Resistance<br>at $-V_{GS} = 10\ \text{V}$ , $-I_D = 4\ \text{A}$<br>at $-V_{GS} = 4.5\ \text{V}$ , $-I_D = 3.7\ \text{A}$<br>at $-V_{GS} = 2.5\ \text{V}$ , $-I_D = 2\ \text{A}$ | $R_{DS(on)}$  | -<br>-<br>- | -<br>-<br>- | 50<br>60<br>85 | m $\Omega$    |
| <b>DYNAMIC PARAMETERS</b>                                                                                                                                                                              |               |             |             |                |               |
| Forward Transconductance<br>at $-V_{DS} = 5\ \text{V}$ , $-I_D = 4\ \text{A}$                                                                                                                          | $g_{fs}$      | -           | 11.3        | -              | S             |
| Gate resistance<br>at $V_{DS} = 0\ \text{V}$ , $V_{GS} = 0\ \text{V}$ , $f = 1\ \text{MHz}$                                                                                                            | $R_g$         | -           | 10.4        | -              | $\Omega$      |
| Input Capacitance<br>at $-V_{DS} = 15\ \text{V}$ , $V_{GS} = 0\ \text{V}$ , $f = 1\ \text{MHz}$                                                                                                        | $C_{iss}$     | -           | 824         | -              | pF            |
| Output Capacitance<br>at $-V_{DS} = 15\ \text{V}$ , $V_{GS} = 0\ \text{V}$ , $f = 1\ \text{MHz}$                                                                                                       | $C_{oss}$     | -           | 69          | -              | pF            |
| Reverse Transfer Capacitance<br>at $-V_{DS} = 15\ \text{V}$ , $V_{GS} = 0\ \text{V}$ , $f = 1\ \text{MHz}$                                                                                             | $C_{rss}$     | -           | 37          | -              | pF            |
| Total Gate Charge<br>at $-V_{DS} = 15\ \text{V}$ , $-I_D = 4\ \text{A}$ , $-V_{GS} = 10\ \text{V}$<br>at $-V_{DS} = 15\ \text{V}$ , $-I_D = 4\ \text{A}$ , $-V_{GS} = 4.5\ \text{V}$                   | $Q_g$         | -<br>-      | 19<br>8.4   | -<br>-         | nC            |
| Gate-Source Charge<br>at $-V_{DS} = 15\ \text{V}$ , $-I_D = 4\ \text{A}$ , $-V_{GS} = 10\ \text{V}$                                                                                                    | $Q_{gs}$      | -           | 2.1         | -              | nC            |
| Gate-Drain Charge<br>at $-V_{DS} = 15\ \text{V}$ , $-I_D = 4\ \text{A}$ , $-V_{GS} = 10\ \text{V}$                                                                                                     | $Q_{gd}$      | -           | 2           | -              | nC            |
| Turn-On Delay Time<br>at $-V_{DS} = 15\ \text{V}$ , $-I_D = 4\ \text{A}$ , $-V_{GS} = 10\ \text{V}$ , $R_G = 6\ \Omega$                                                                                | $t_{d(on)}$   | -           | 9.6         | -              | ns            |
| Turn-On Rise Time<br>at $-V_{DS} = 15\ \text{V}$ , $-I_D = 4\ \text{A}$ , $-V_{GS} = 10\ \text{V}$ , $R_G = 6\ \Omega$                                                                                 | $t_r$         | -           | 23          | -              | ns            |
| Turn-Off Delay Time<br>at $-V_{DS} = 15\ \text{V}$ , $-I_D = 4\ \text{A}$ , $-V_{GS} = 10\ \text{V}$ , $R_G = 6\ \Omega$                                                                               | $t_{d(off)}$  | -           | 31          | -              | ns            |
| Turn-Off Fall Time<br>at $-V_{DS} = 15\ \text{V}$ , $-I_D = 4\ \text{A}$ , $-V_{GS} = 10\ \text{V}$ , $R_G = 6\ \Omega$                                                                                | $t_f$         | -           | 4.6         | -              | ns            |
| <b>Body-Diode PARAMETERS</b>                                                                                                                                                                           |               |             |             |                |               |
| Drain-Source Diode Forward Voltage<br>at $-I_S = 4\ \text{A}$ , $V_{GS} = 0\ \text{V}$                                                                                                                 | $-V_{SD}$     | -           | -           | 1.3            | V             |
| Body-Diode Continuous Current                                                                                                                                                                          | $-I_S$        | -           | -           | 4              | A             |
| Body Diode Reverse Recovery Time<br>at $-I_S = 4\ \text{A}$ , $di/dt = 100\ \text{A} / \mu\text{s}$                                                                                                    | $t_{rr}$      | -           | 9.5         | -              | ns            |
| Body Diode Reverse Recovery Charge<br>at $-I_S = 4\ \text{A}$ , $di/dt = 100\ \text{A} / \mu\text{s}$                                                                                                  | $Q_{rr}$      | -           | 5           | -              | nC            |



## Electrical Characteristics Curves

Fig. 1 Typical Output Characteristics

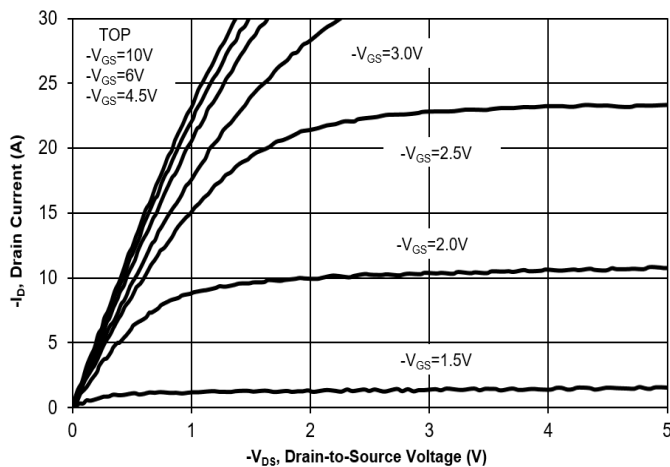


Fig. 2 Typical Transfer Characteristics

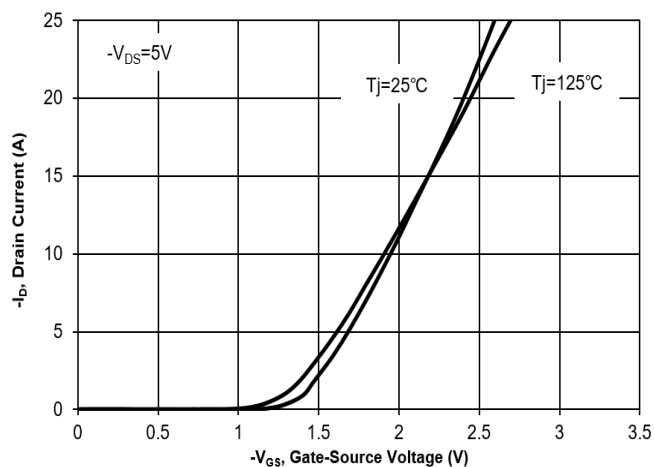


Fig. 3 On-Resistance vs. Drain Current

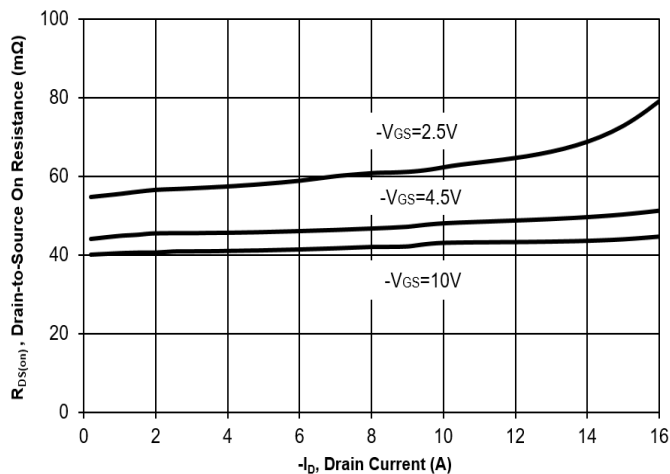


Fig. 4 On-Resistance vs. Gate-Source Voltage

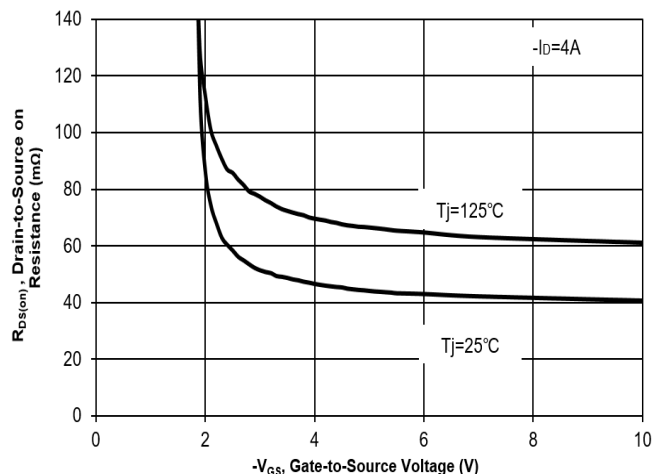


Fig. 5 On-Resistance vs. T\_J

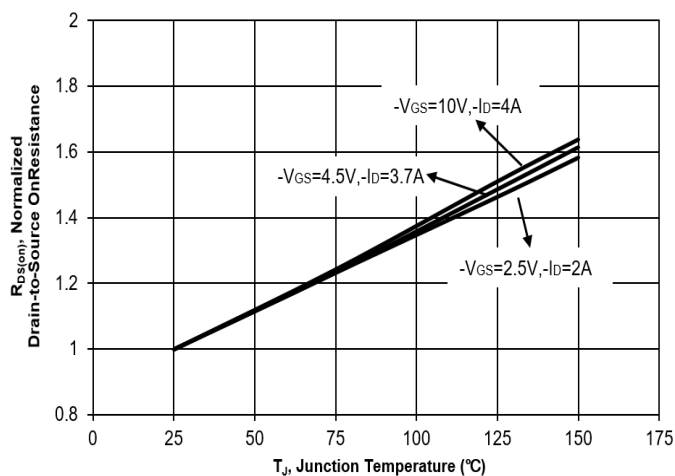
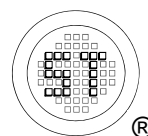
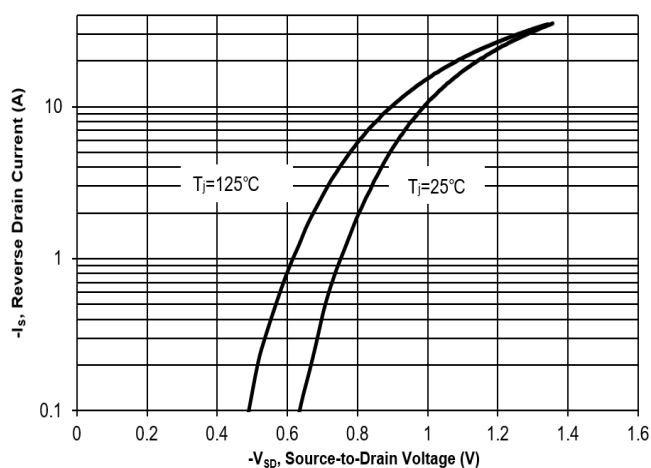


Fig. 6 Typical Body-Diode Forward Characteristics



## Electrical Characteristics Curves

Fig. 7 Typical Junction Capacitance

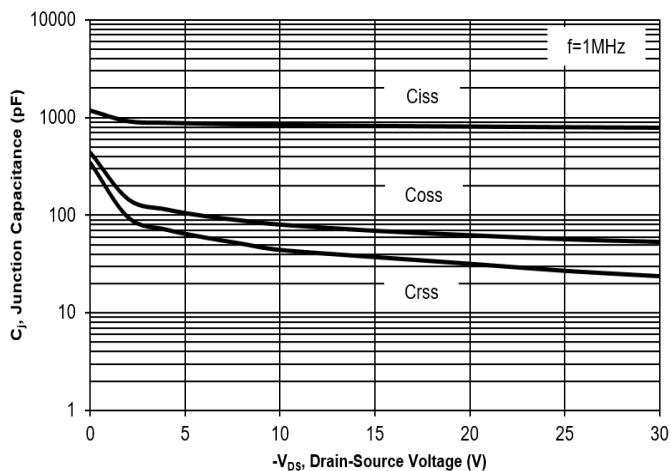


Fig. 8 Drain-Source Leakage Current vs.  $T_j$

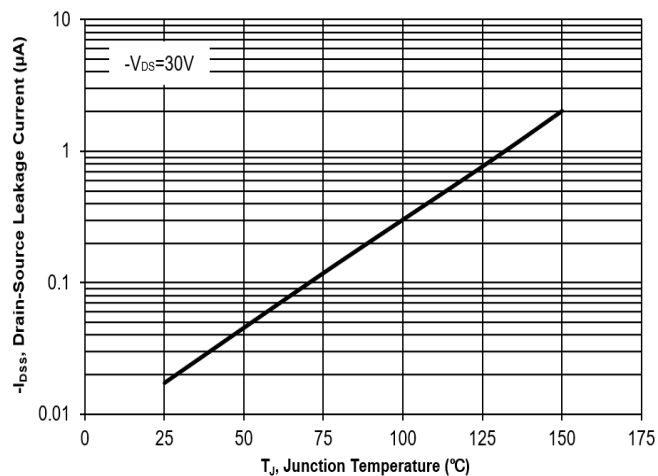


Fig. 9  $V_{(BR)DSS}$  vs. Junction Temperature

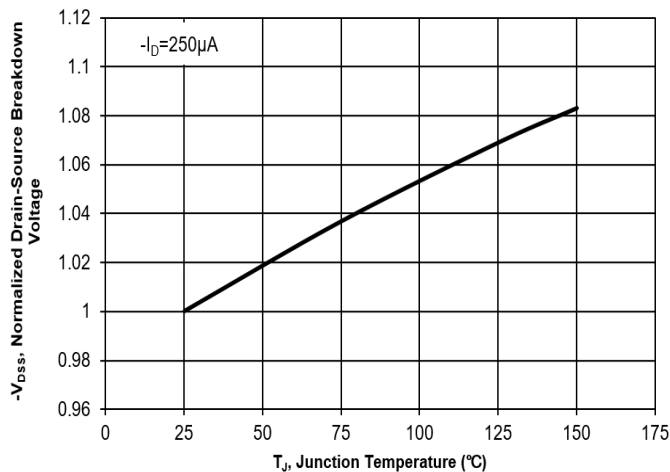


Fig. 10 Gate Threshold Variation vs.  $T_j$

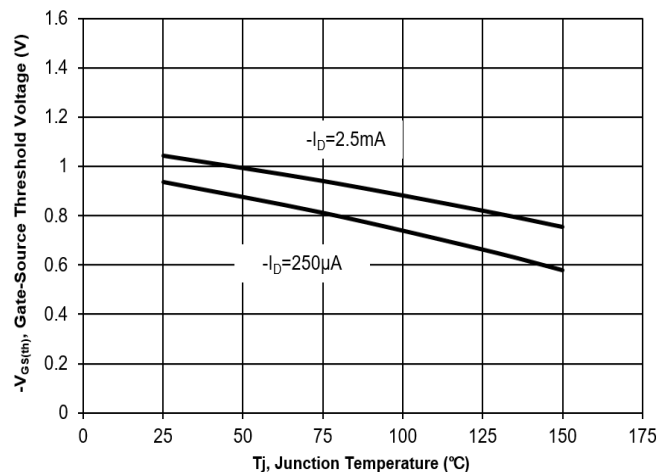
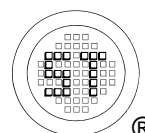
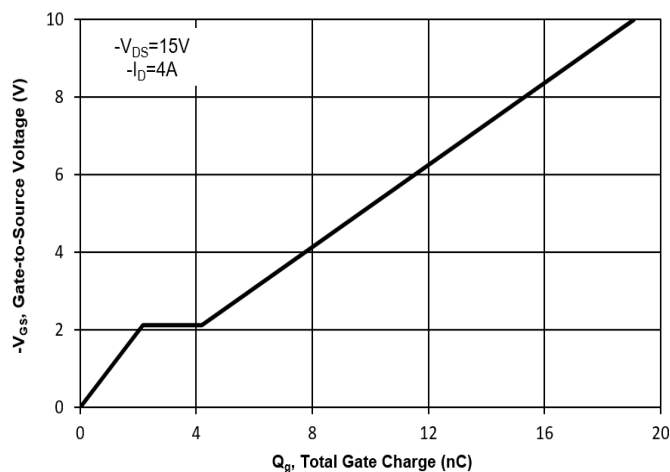


Fig. 11 Gate Charge



Test Circuits

Fig.1-1 Switching times test circuit

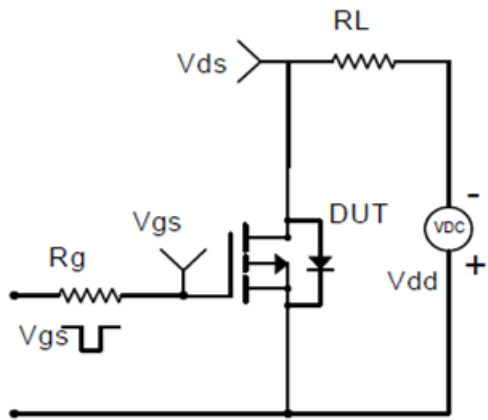


Fig.1-2 Switching Waveform

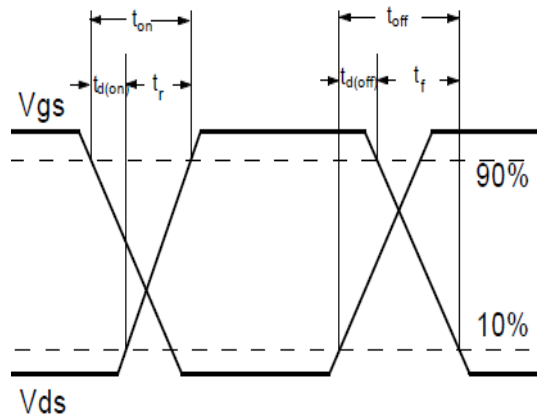


Fig.2-1 Gate charge test circuit

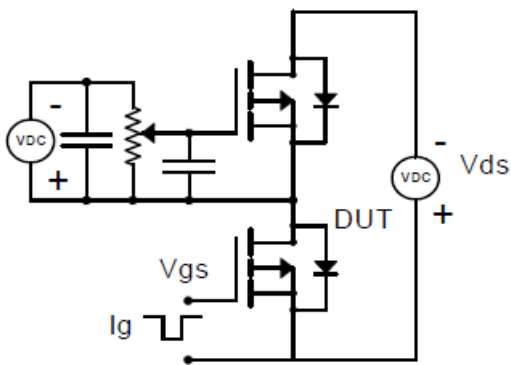
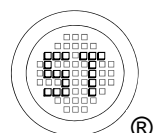
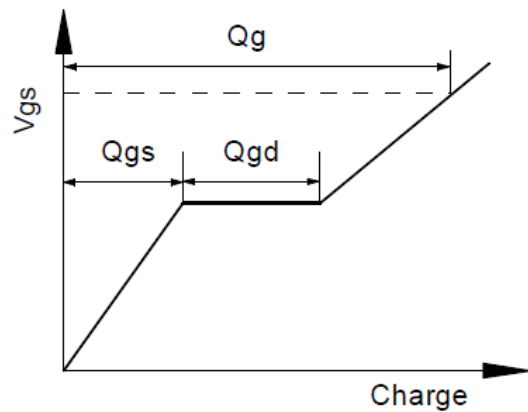


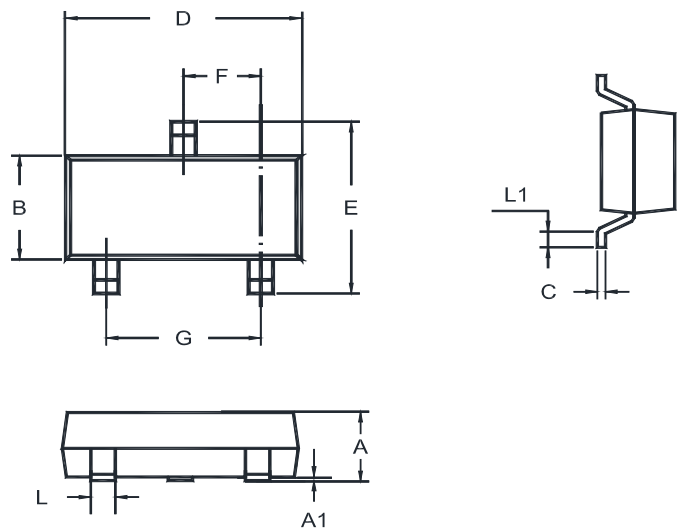
Fig.2-2 Gate charge waveform



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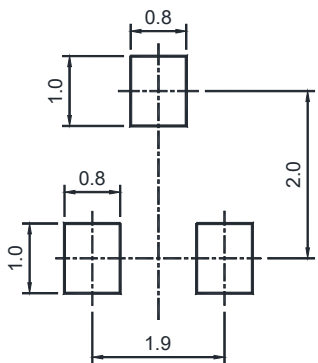
## Package Outline (Dimensions in mm)

SOT-23



| Unit | A    | A1    | B    | C    | D    | E   | F    | G    | L    | L1  |
|------|------|-------|------|------|------|-----|------|------|------|-----|
| mm   | 1.20 | 0.100 | 1.40 | 0.19 | 3.04 | 2.6 | 1.02 | 2.04 | 0.51 | 0.2 |
|      | 0.89 | 0.013 | 1.20 | 0.08 | 2.80 | 2.2 | 0.89 | 1.78 | 0.37 | MIN |

## Recommended Soldering Footprint



## Packing information

| Package | Tape Width (mm) | Pitch   |               | Reel Size |      | Per Reel Packing Quantity |
|---------|-----------------|---------|---------------|-----------|------|---------------------------|
|         |                 | mm      | inch          | mm        | inch |                           |
| SOT-23  | 8               | 4 ± 0.1 | 0.157 ± 0.004 | 178       | 7    | 3,000                     |

## Marking information

" P4 " = Part No.  
" • " = HAF (Halogen and Antimony Free)  
" YM " = Date Code Marking  
" Y " = Year  
" M " = Month  
Font type: Arial

