

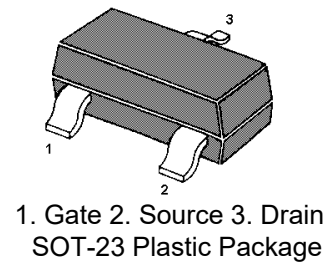
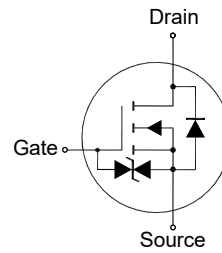
# MMFTN138AK

## N-Channel Enhancement Mode MOSFET

### Features

- Built-in G-S Protection Diode
- Typical ESD Protection HBM Class 2

Classification	Voltage Range(V)
0A	< 125
0B	125 to < 250
1A	250 to < 500
1B	500 to < 1000
1C	1000 to < 2000
2	2000 to < 4000
3A	4000 to < 8000
3B	≥ 8000



### Applications

- Portable appliances
- Battery management

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

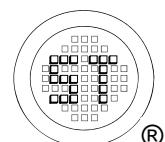
Parameter	Symbol	Value	Unit
Drain-Source Voltage	$V_{DS}$	50	V
Gate-Source Voltage	$V_{GS}$	$\pm 20$	V
Drain Current	$I_D$	500	mA
Peak Drain Current, Pulsed <sup>1)</sup>	$I_{DM}$	1.2	A
Power Dissipation <sup>2)</sup>	$P_D$	500	mW
Operating Junction Temperature Range	$T_j$	- 55 to + 150	$^\circ\text{C}$
Storage Temperature Range	$T_{stg}$	- 55 to + 150	$^\circ\text{C}$

### Thermal Characteristics

Parameter	Symbol	Max.	Unit
Thermal Resistance from Junction to Ambient <sup>2)</sup>	$R_{\theta JA}$	250	$^\circ\text{C/W}$

<sup>1)</sup> Pulse Test: Pulse Width  $\leq 100 \mu\text{s}$ , Duty Cycle  $\leq 2\%$ , limited by  $T_{J(MAX)}$ .

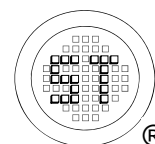
<sup>2)</sup> Device mounted on FR-4 substrate PC board, 2oz copper, with 1-inch square copper plate



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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 at $I_D = 250 \mu\text{A}$	$BV_{DSS}$	50	-	-	V
Zero Gate Voltage Drain Current at $V_{DS} = 50 \text{ V}$	$I_{DSS}$	-	-	1	$\mu\text{A}$
Gate Leakage Current at $V_{GS} = \pm 20 \text{ V}$	$I_{GSS}$	-	-	$\pm 10$	$\mu\text{A}$
Gate-Source Threshold Voltage at $V_{DS} = V_{GS}$ , $I_D = 250 \mu\text{A}$	$V_{GS(th)}$	0.8	-	1.5	V
Drain-Source On-State Resistance at $V_{GS} = 10 \text{ V}$ , $I_D = 500 \text{ mA}$ at $V_{GS} = 4.5 \text{ V}$ , $I_D = 200 \text{ mA}$ at $V_{GS} = 2.5 \text{ V}$ , $I_D = 100 \text{ mA}$	$R_{DS(on)}$	-	-	1.6 2.5 4.5	$\Omega$
<b>DYNAMIC PARAMETERS</b>					
Input Capacitance at $V_{DS} = 25 \text{ V}$ , $V_{GS} = 0 \text{ V}$ , $f = 1 \text{ MHz}$	$C_{iss}$	-	33	-	pF
Output Capacitance at $V_{DS} = 25 \text{ V}$ , $V_{GS} = 0 \text{ V}$ , $f = 1 \text{ MHz}$	$C_{oss}$	-	10	-	pF
Reverse Transfer Capacitance at $V_{DS} = 25 \text{ V}$ , $V_{GS} = 0 \text{ V}$ , $f = 1 \text{ MHz}$	$C_{rss}$	-	8	-	pF
Gate charge total at $V_{DS} = 25 \text{ V}$ , $I_D = 1 \text{ A}$ , $V_{GS} = 10 \text{ V}$ at $V_{DS} = 25 \text{ V}$ , $I_D = 1 \text{ A}$ , $V_{GS} = 4.5 \text{ V}$	$Q_g$	-	1.3 0.85	-	nC
Gate to Source Charge at $V_{DS} = 25 \text{ V}$ , $I_D = 1 \text{ A}$ , $V_{GS} = 10 \text{ V}$	$Q_{gs}$	-	0.45	-	nC
Gate to Drain Charge at $V_{DS} = 25 \text{ V}$ , $I_D = 1 \text{ A}$ , $V_{GS} = 10 \text{ V}$	$Q_{gd}$	-	0.3	-	nC
Turn-On Delay Time at $V_{DS} = 30 \text{ V}$ , $V_{GS} = 10 \text{ V}$ , $I_D = 500 \text{ mA}$ , $R_G = 25 \Omega$	$t_{d(on)}$	-	5.4	-	ns
Turn-On Rise Time at $V_{DS} = 30 \text{ V}$ , $V_{GS} = 10 \text{ V}$ , $I_D = 500 \text{ mA}$ , $R_G = 25 \Omega$	$t_r$	-	3	-	ns
Turn-Off Delay Time at $V_{DS} = 30 \text{ V}$ , $V_{GS} = 10 \text{ V}$ , $I_D = 500 \text{ mA}$ , $R_G = 25 \Omega$	$t_{d(off)}$	-	6	-	ns
Turn-Off Fall Time at $V_{DS} = 30 \text{ V}$ , $V_{GS} = 10 \text{ V}$ , $I_D = 500 \text{ mA}$ , $R_G = 25 \Omega$	$t_f$	-	30	-	ns
<b>Body-Diode PARAMETERS</b>					
Drain-Source Diode Forward Voltage at $V_{GS} = 0 \text{ V}$ , $I_S = 500 \text{ mA}$	$V_{SD}$	-	-	1.5	V
Body-Diode Continuous Current	$I_S$	-	-	500	mA



## Electrical Characteristics Curves

Fig. 1 Typical Output Characteristics

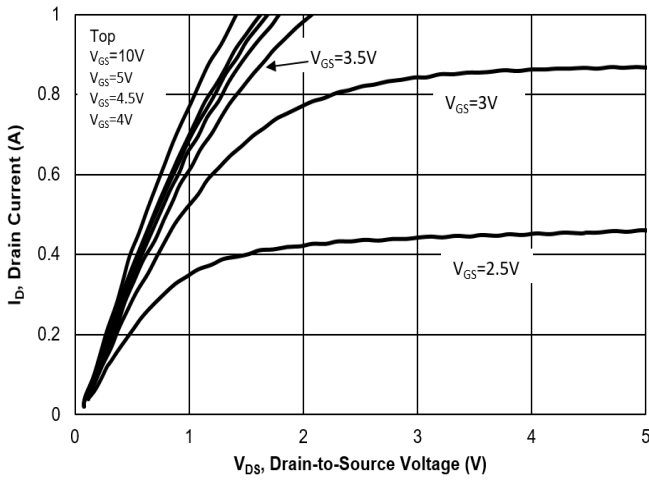


Fig. 2 Typical Transfer Characteristics

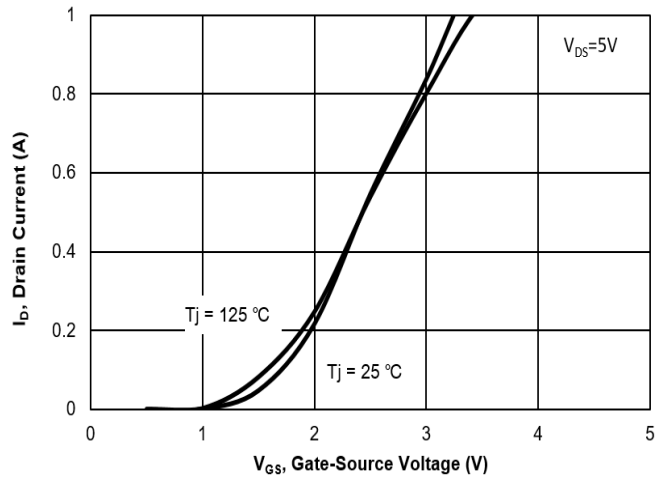


Fig. 3 On-Resistance vs. Drain Current

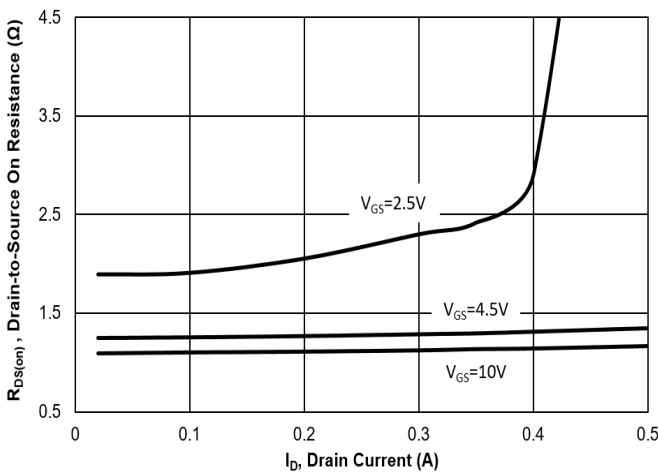


Fig. 4 On-Resistance vs. Gate-Source Voltage

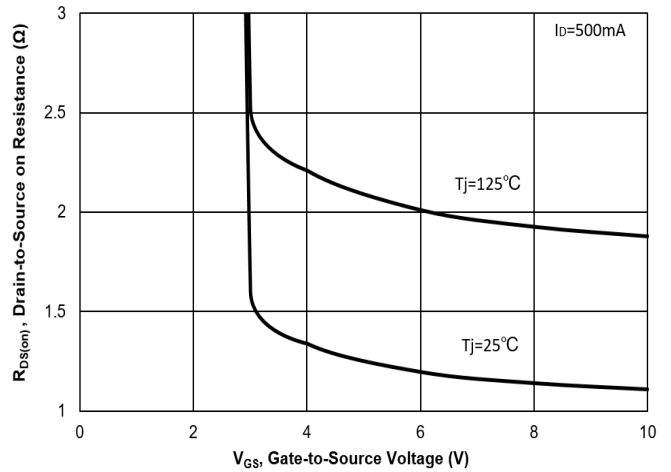


Fig. 5 On-Resistance vs.  $T_j$

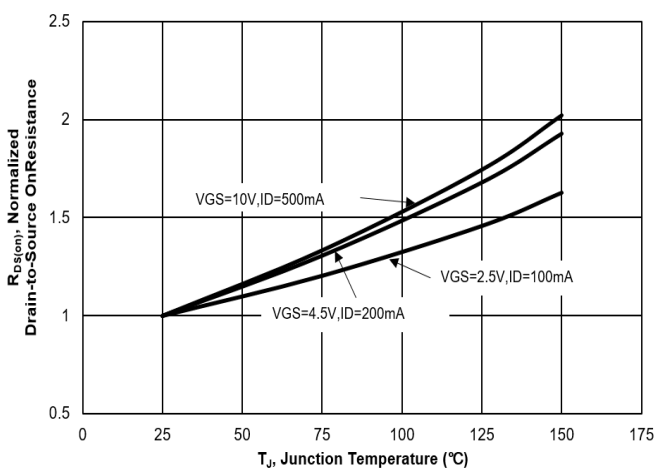
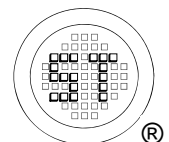
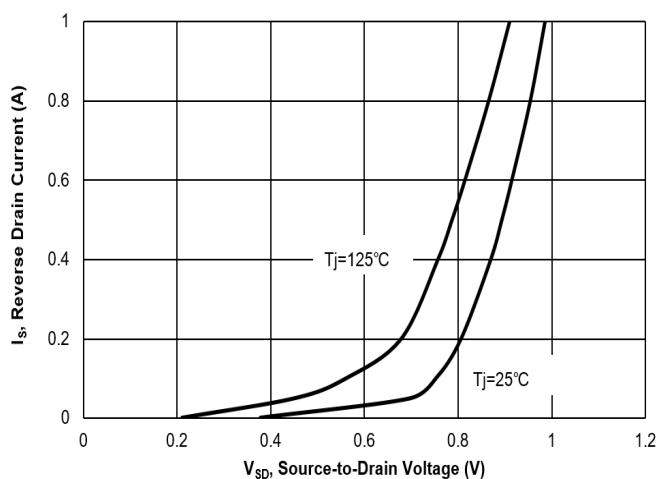


Fig. 6 Typical Body-Diode Forward Characteristics



## Electrical Characteristics Curves

Fig. 7 Typical Junction Capacitance

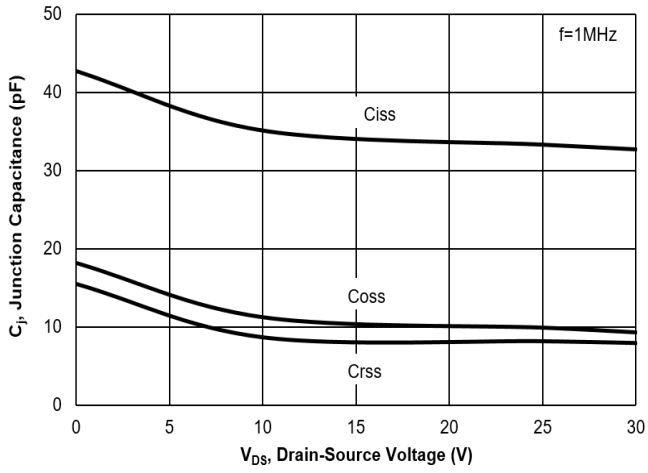


Fig. 8 Gate Charge

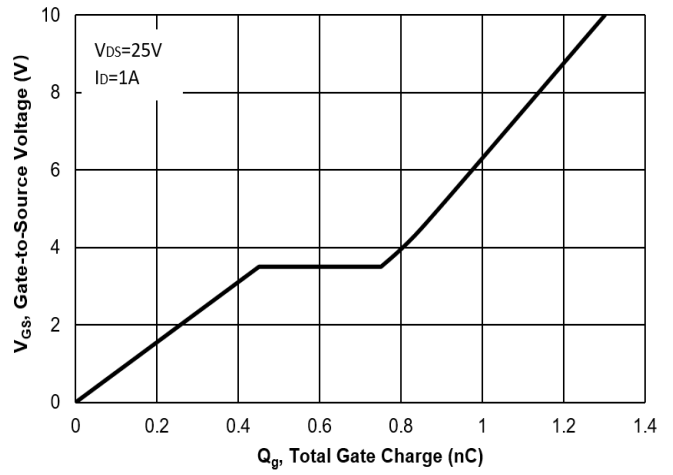


Fig. 9  $V_{(BR)DSS}$  vs. Junction Temperature

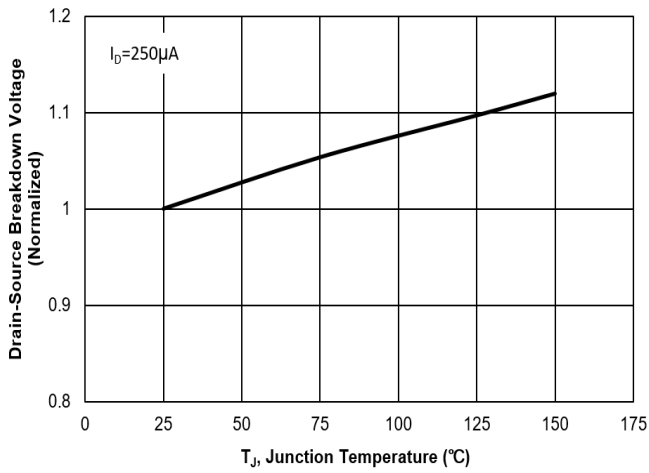
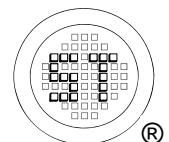
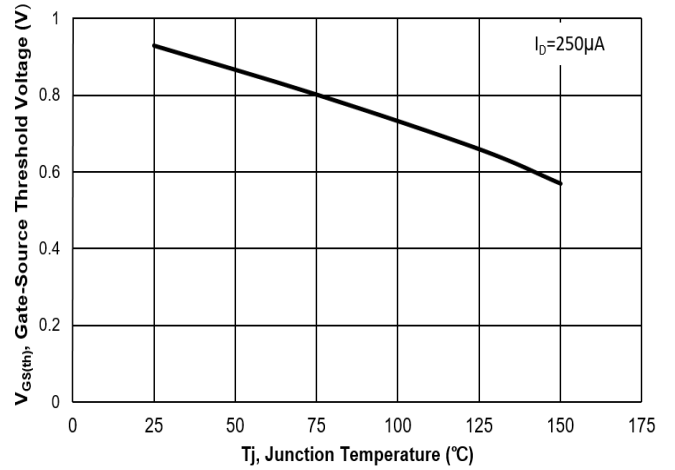


Fig. 10 Gate Threshold Variation vs.  $T_j$



## Test Circuits

Fig.1-1 Switching times test circuit

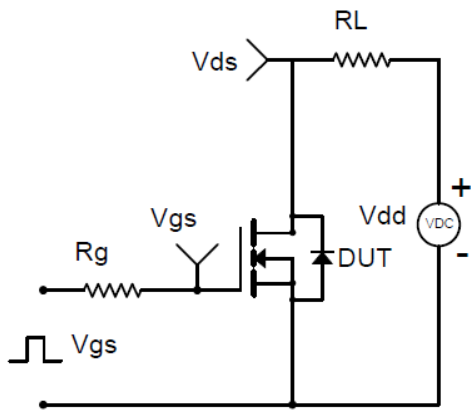


Fig.1-2 Switching Waveform

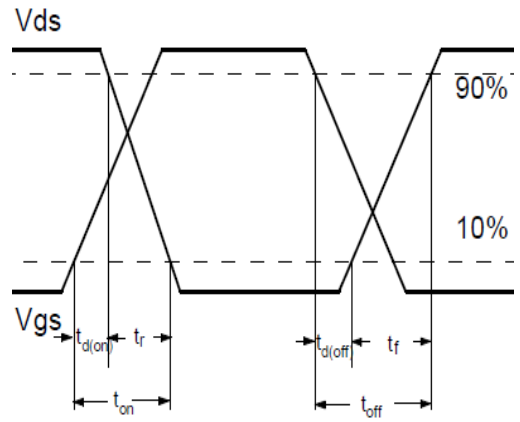


Fig.2-1 Gate charge test circuit

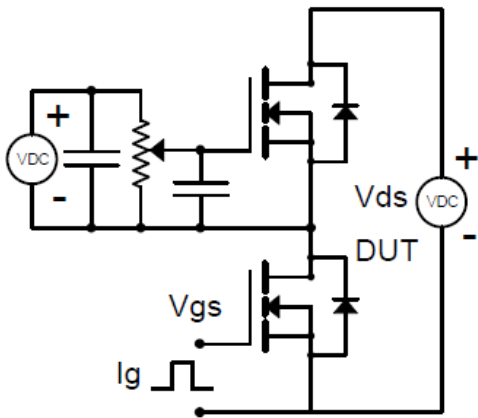
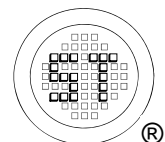
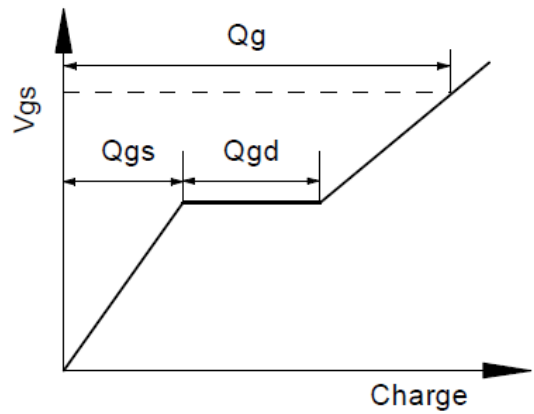


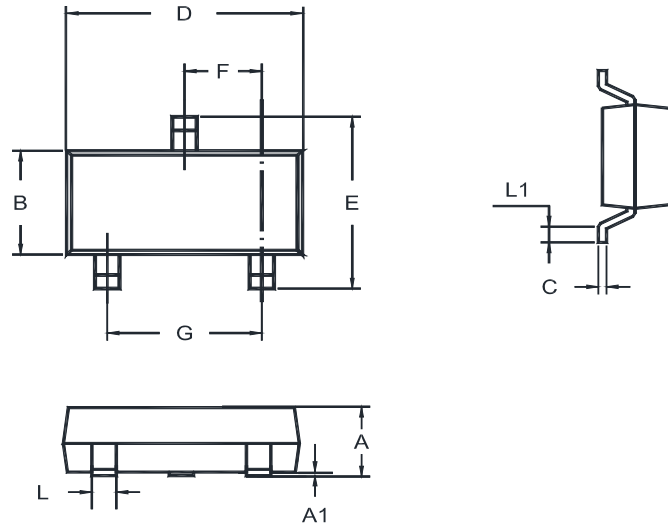
Fig.2-2 Gate charge waveform



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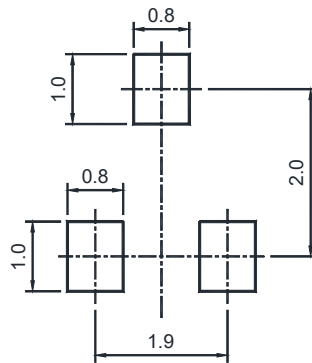
## Package Outline (Dimensions in mm)

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

- "VD" = Part No.
  - "YM" = Date Code Marking
  - "Y" = Year
  - "M" = Month
- Font type: Arial

