

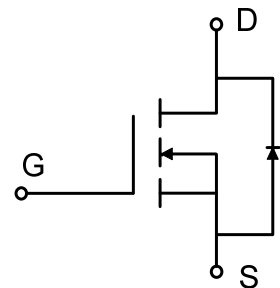
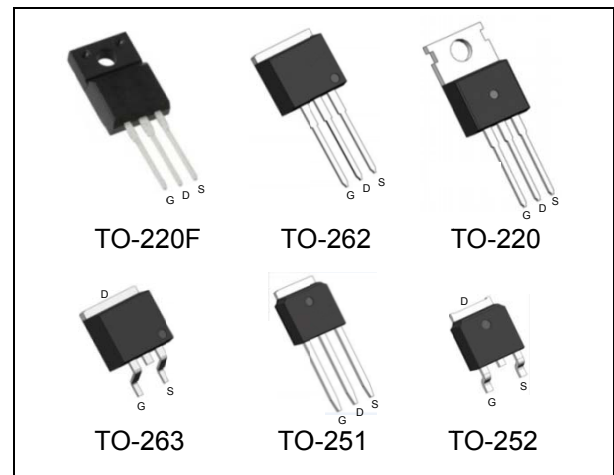
## 650V 0.35Ω Super Junction Power MOSFET

### Description

WMOS™ EM is Wayon's 3<sup>rd</sup> generation super junction MOSFET family that is utilizing charge balance technology for extremely low on-resistance and low gate charge performance. WMOS™ EM is suitable for applications which require superior power density and outstanding efficiency.

### Features

- $V_{DS} = 700V @ T_{j,max}$
- Typ.  $R_{DS(on)} = 0.35\Omega$
- 100% UIS tested
- Pb-free plating, Halogen free



### Applications

LED Lighting, Charger, Adapter, PC, LCD TV, Server

### Absolute Maximum Ratings

Parameter	Symbol	WMK/WMM/WMO/WMP/WMN	WML	Unit
Drain-source voltage	$V_{DSS}$	650		V
Continuous drain current <sup>1)</sup> ( $T_C = 25^\circ C$ )	$I_D$	11		A
		6.5		A
Pulsed drain current <sup>2)</sup>	$I_{DM}$	35		A
Gate-source voltage	$V_{GS}$	$\pm 30$		V
Avalanche energy, single pulse <sup>3)</sup>	$E_{AS}$	145		mJ
Avalanche energy, repetitive <sup>2)</sup>	$E_{AR}$	0.21		mJ
Avalanche current, repetitive <sup>2)</sup>	$I_{AR}$	2		A
Power dissipation ( $T_C = 25^\circ C$ ) - Derate above $25^\circ C$	$P_D$	85	31	W
		0.68	0.25	W/ $^\circ C$
Operating and storage temperature range	$T_i, T_{stg}$	-55 to +150		$^\circ C$
Continuous diode forward current	$I_S$	11		A
Diode pulse current	$I_{S,pulse}$	35		A
MOSFET dv/dt ruggedness	dv/dt	50		V/ns
Peak diode recovery voltage slope	dv/dt	15		V/ns

## Thermal Characteristics

Parameter	Symbol	WMK/WMM/WMO/WMP/WMN	WML	Unit
Thermal resistance, junction-to-case	$R_{\theta JC}$	1.47	4	$^{\circ}\text{C}/\text{W}$
Thermal resistance, junction-to-ambient	$R_{\theta JA}$	62	80	$^{\circ}\text{C}/\text{W}$

## Electrical Characteristics $T_c = 25^{\circ}\text{C}$ , unless otherwise noted

Parameter	Symbol	Test Condition	Min.	Typ.	Max.	Unit
<b>Static characteristics</b>						
Drain-source breakdown voltage	$BV_{DSS}$	$V_{GS}=0\text{ V}, I_D=0.25\text{ mA}$	650	-	-	V
Gate threshold voltage	$V_{GS(th)}$	$V_{DS}=V_{GS}, I_D=0.25\text{ mA}$	2	3	4	V
Drain cut-off current	$I_{DSS}$	$V_{DS}=650\text{ V}, V_{GS}=0\text{ V},$ $T_j = 25^{\circ}\text{C}$ $T_j = 125^{\circ}\text{C}$	-	-	1	$\mu\text{A}$
Gate leakage current, forward	$I_{GSSF}$	$V_{GS}=20\text{ V}, V_{DS}=0\text{ V}$	-	-	100	nA
Gate leakage current, reverse	$I_{GSSR}$	$V_{GS}=-20\text{ V}, V_{DS}=0\text{ V}$	-	-	-100	nA
Drain-source on-state resistance	$R_{DS(on)}$	$V_{GS}=10\text{ V}, I_D=2\text{ A}$	--	0.35	0.39	$\Omega$
<b>Dynamic characteristics</b>						
Input capacitance	$C_{iss}$	$V_{DS}=100\text{ V}, V_{GS}=0\text{ V},$	-	710	-	pF
Output capacitance	$C_{oss}$	$f = 1\text{ MHz}$	-	25	-	
Reverse transfer capacitance	$C_{rss}$		-	2	-	
Turn-on delay time	$t_{d(on)}$	$V_{DD} = 300\text{ V}, I_D = 5\text{ A}$ $R_G = 25\Omega, V_{GS}=10\text{ V}$	-	20	-	ns
Rise time	$t_r$		-	16	-	
Turn-off delay time	$t_{d(off)}$		-	61	-	
Fall time	$t_f$		-	17	-	
<b>Gate charge characteristics</b>						
Gate to source charge	$Q_{gs}$	$V_{DD}=480\text{ V}, I_D=5\text{ A},$ $V_{GS}=0\text{ to }10\text{ V}$	-	3.4	-	nC
Gate to drain charge	$Q_{gd}$		-	10.1	-	
Gate charge total	$Q_g$		-	20.3	-	
Gate plateau voltage	$V_{plateau}$		-	4.7	-	V
<b>Reverse diode characteristics</b>						
Diode forward voltage	$V_{SD}$	$V_{GS}=0\text{ V}, I_F=2\text{ A}$	-	-	1.2	V
Reverse recovery time	$t_{rr}$	$V_R=50\text{ V}, I_F=5\text{ A},$ $di_F/dt=100\text{ A}/\mu\text{s}$	-	213	-	ns
Reverse recovery charge	$Q_{rr}$		-	2.1	-	$\mu\text{C}$
Peak reverse recovery current	$I_{rrm}$		-	20	-	A

Notes:

- Limited by  $T_{j\text{max}}$ . Maximum duty cycle  $D=0.5$ .
- Repetitive rating: pulse width limited by maximum junction temperature.
- $I_{AS} = 2\text{ A}, V_{DD} = 50\text{ V}, R_G = 25\Omega$ , starting  $T_j = 25^{\circ}\text{C}$ .

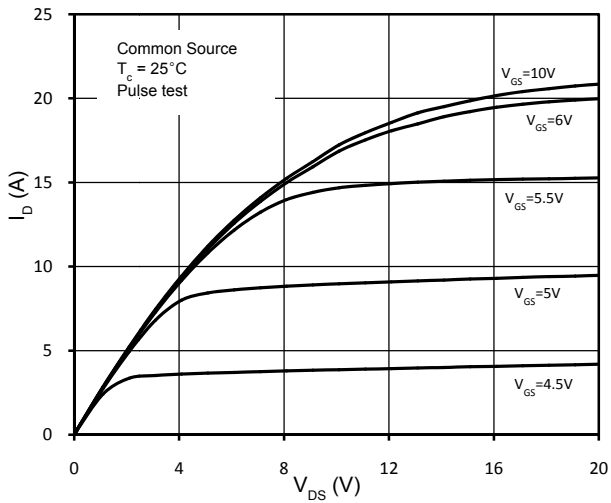


Figure 1. On-Region Characteristics

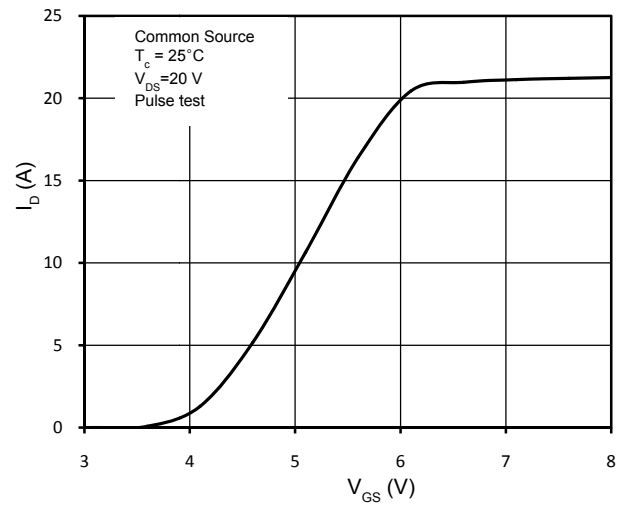


Figure 2. Transfer Characteristics

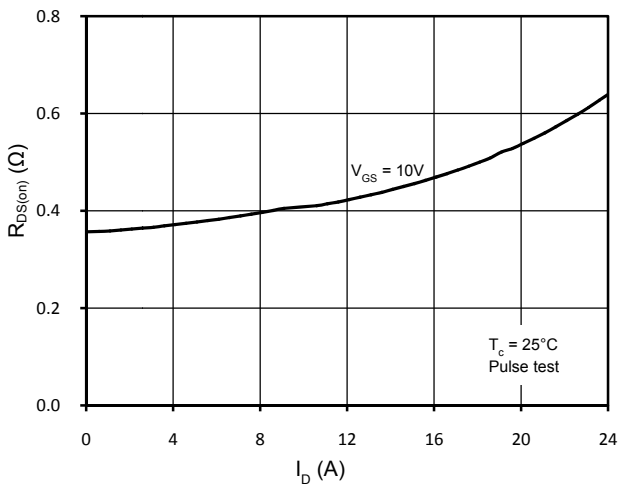


Figure 3. Static Drain-Source On Resistance

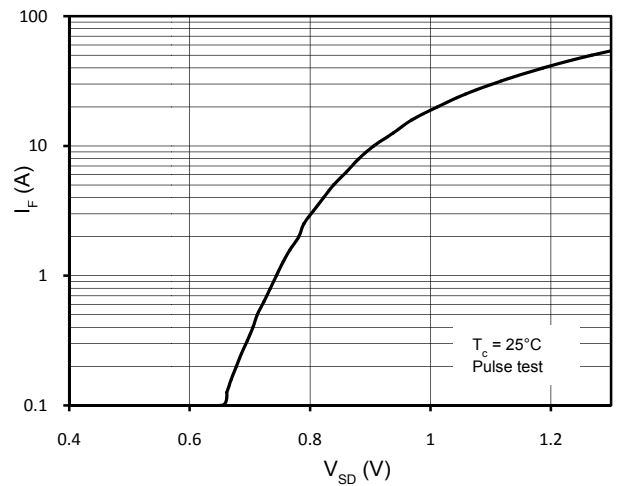


Figure 4. Body-Diode Forward Characteristics

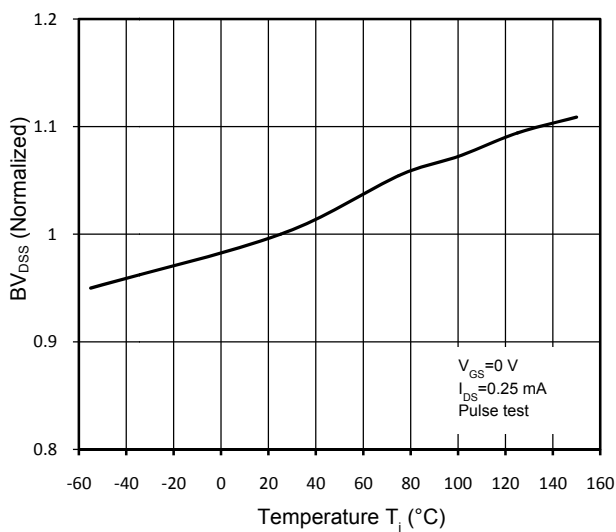


Figure 5. Normalized  $BV_{DS(sat)}$  vs. Temperature

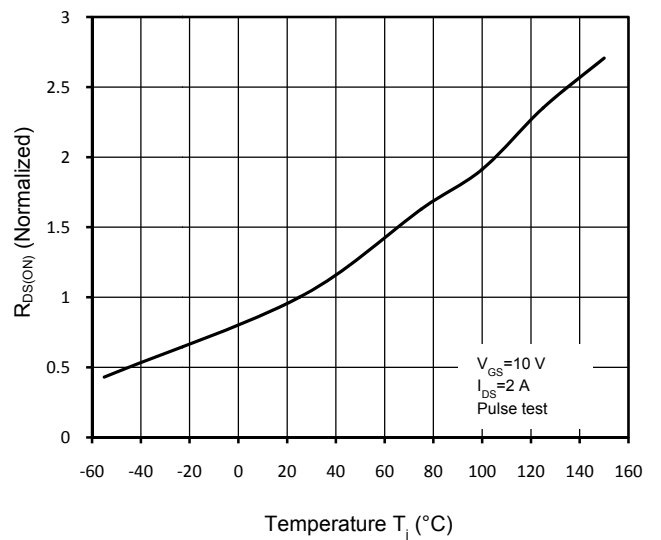


Figure 6. Normalized  $R_{DS(on)}$  vs. Temperature

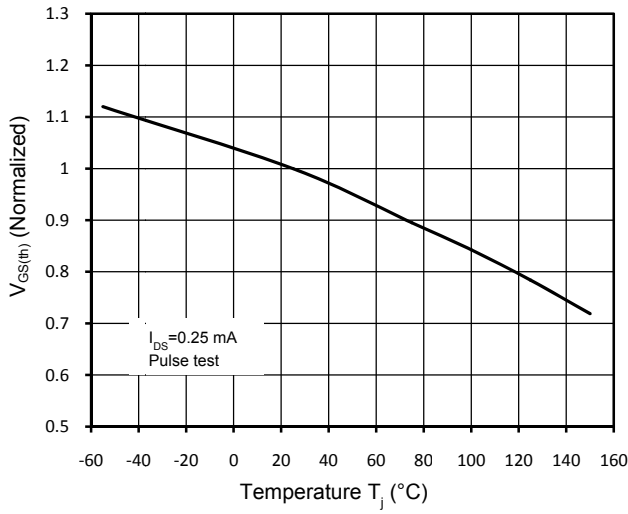


Figure 7. Threshold Voltage vs. Temperature

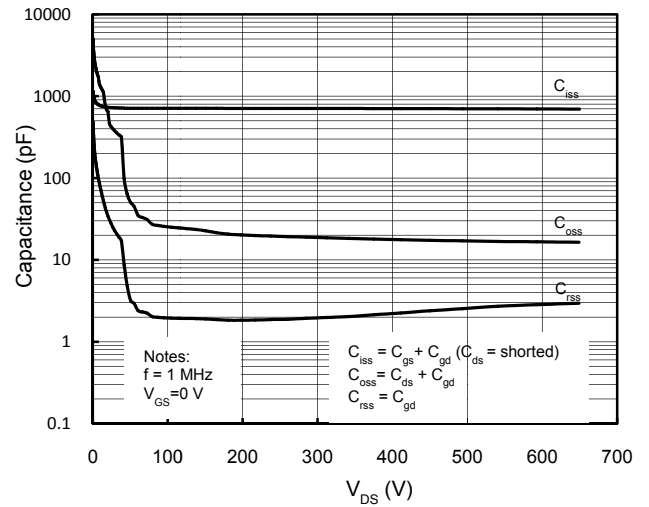


Figure 8. Capacitance Characteristics

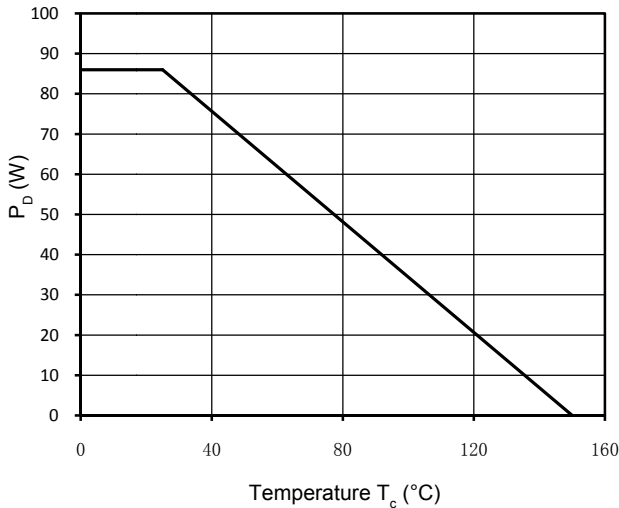


Figure 9. Power Dissipation

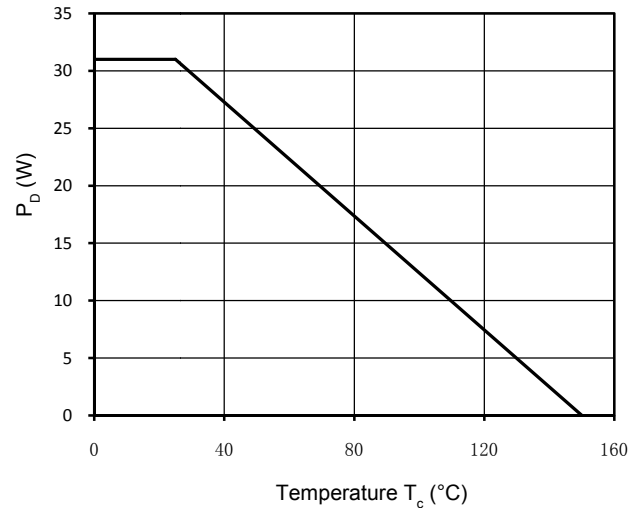


Figure 10. Power Dissipation (TO-220F)

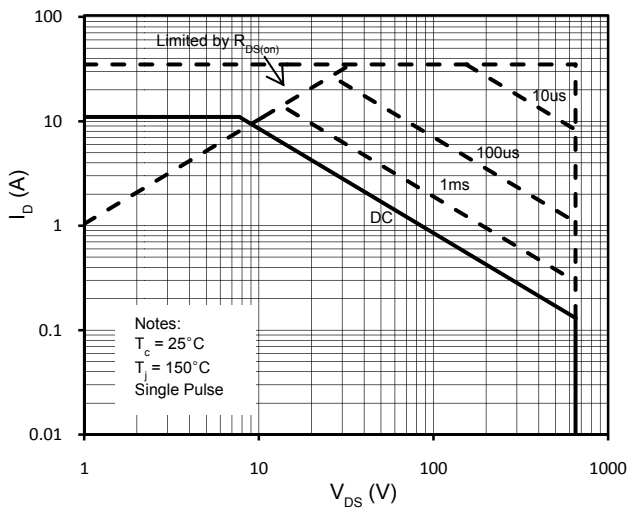


Figure 11. Maximum Safe Operating Area

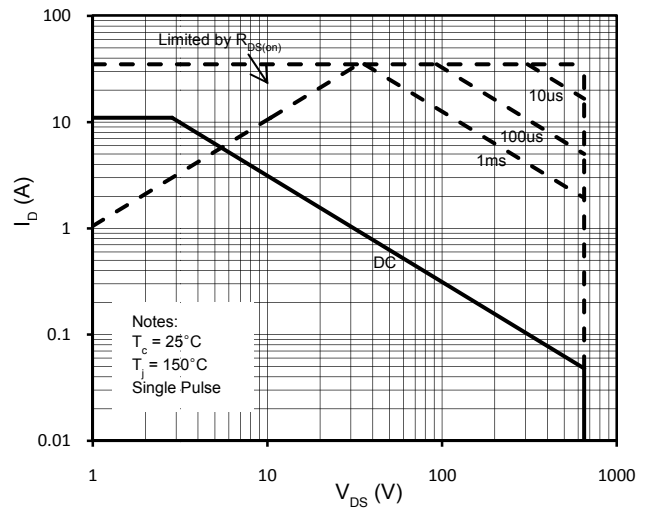


Figure 12. Maximum Safe Operating Area (TO-220F)

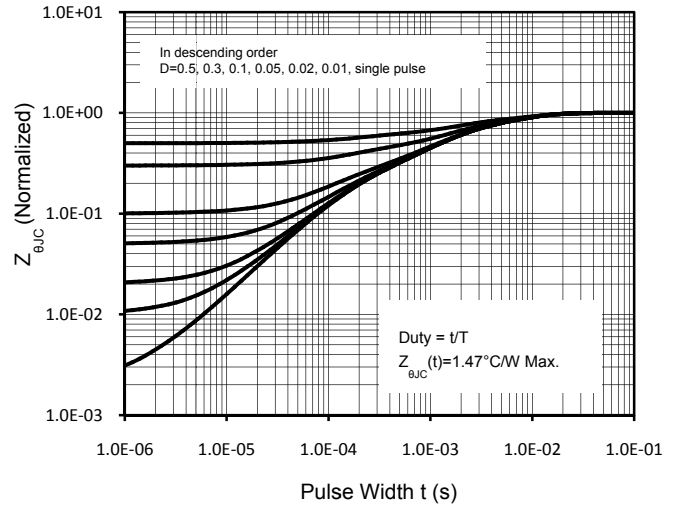
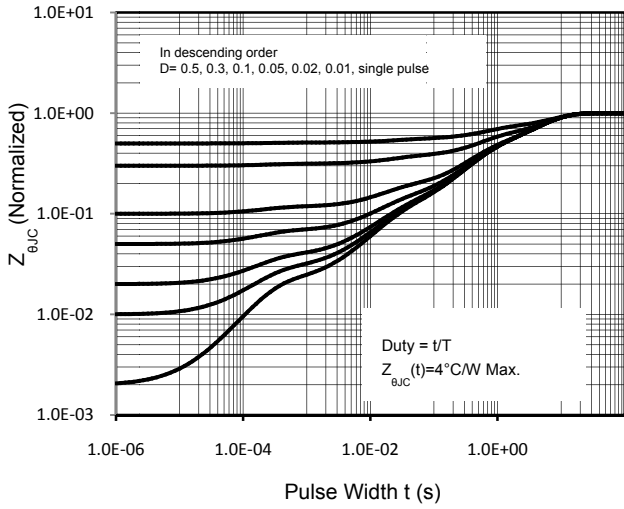


Figure 13. Transient Thermal Response Curve (TO-220F) Figure 14. Transient Thermal Response Curve

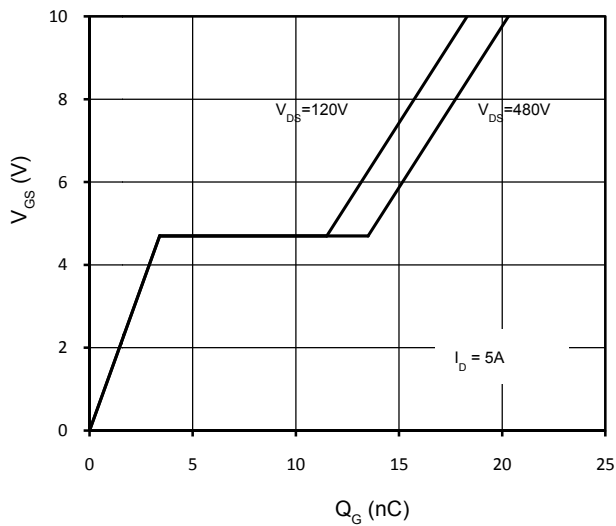


Figure 15. Gate Charge Characteristics

### Gate Charge Test Circuit & Waveform



### Switching Test Circuit & Waveforms

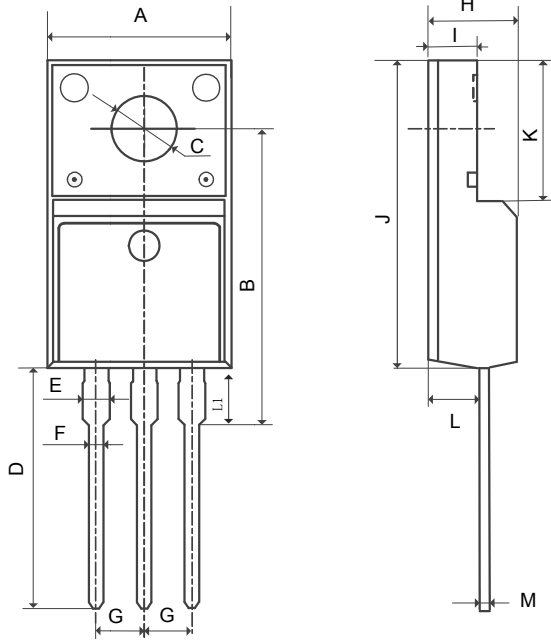


### Unclamped Inductive Switching Test Circuit & Waveforms



Mechanical Dimensions for TO-220F

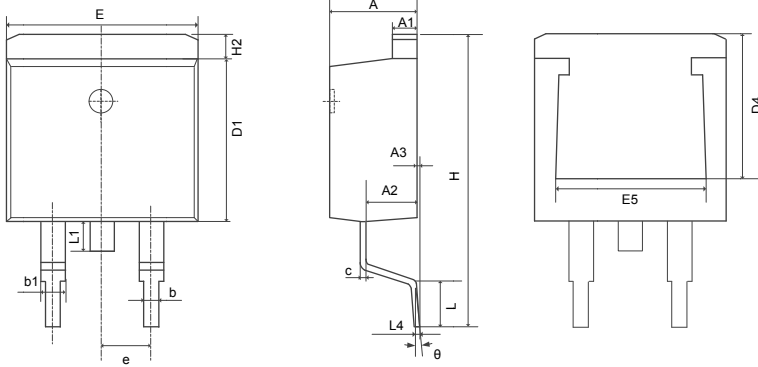
COMMON DIMENSIONS



SYMBOL	MM		
	MIN	NOM	MAX
A	9.96	10.16	10.36
B	15.10	15.60	16.10
C	3.03	3.20	3.38
D	12.64	12.96	13.28
E	1.18	1.38	1.58
F	0.70	0.81	0.95
G	2.54REF		
H	4.50	4.70	4.90
I	2.34	2.54	2.74
J	15.57	15.87	16.17
K	6.70REF		
L	2.56	2.76	2.96
M	0.40	0.52	0.65
L1	2.85	3.10	3.45

Mechanical Dimensions for TO-263

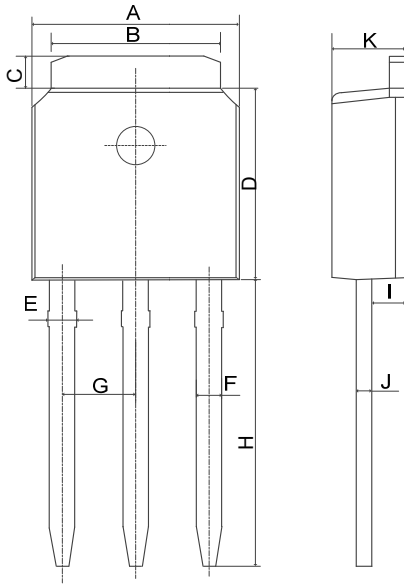
COMMON DIMENSIONS



SYMBOL	MM		
	MIN	NOM	MAX
A	4.37	4.57	4.77
A1	1.22	1.27	1.42
A2	2.49	2.69	2.89
b	0.70	0.81	0.96
b1	1.17	1.27	1.47
c	0.30	0.38	0.53
D1	8.50	8.70	8.90
D4	6.60	—	—
E	9.86	10.16	10.36
E5	7.06	—	—
e	2.54BSC		
H	14.70	15.10	15.50
H2	1.07	1.27	1.47
L	2.00	2.3	2.60
L1	1.40	1.55	1.70
L4	0.25BSC		
θ	0°	5°	9°



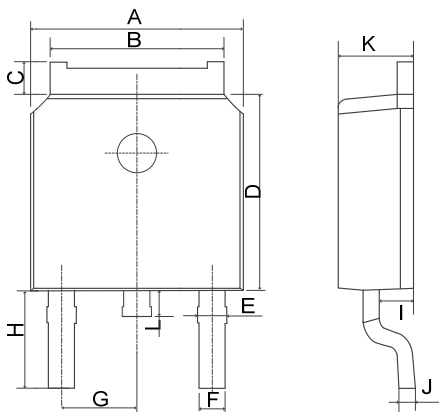
**Mechanical Dimensions for TO-251**



**COMMON DIMENSIONS**

SYMBOL	MM		
	MIN	NOM	MAX
A	6.40	6.60	6.80
B	5.13	5.30	5.46
C	0.88	1.02	1.28
D	5.90	6.06	6.22
E	0.68	0.89	1.10
F	0.68	0.78	0.91
G	2.29REF		
H	9.00	9.40	9.65
I	0.90	1.04	1.17
J	0.40	0.51	0.61
K	2.10	2.30	2.50

**Mechanical Dimensions for TO-252**

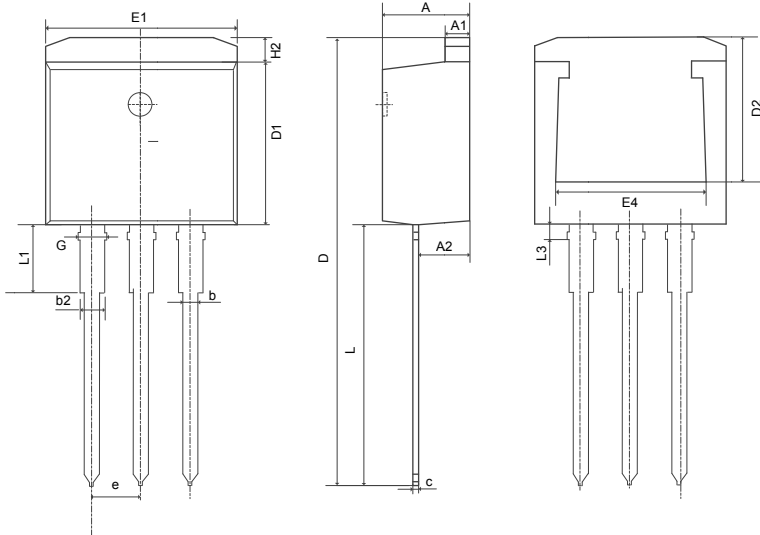


**COMMON DIMENSIONS**

SYMBOL	MM		
	MIN	NOM	MAX
A	6.40	6.60	6.80
B	5.13	5.33	5.50
C	0.88	—	1.28
D	5.90	6.10	6.22
E	0.68	0.89	1.10
F	0.68	0.78	0.91
G	2.29REF		
H	2.90REF		
I	0.85	1.07	1.17
J	0.51REF		
K	2.10	2.30	2.50
L	0.40	—	1.00

Mechanical Dimensions for TO-262

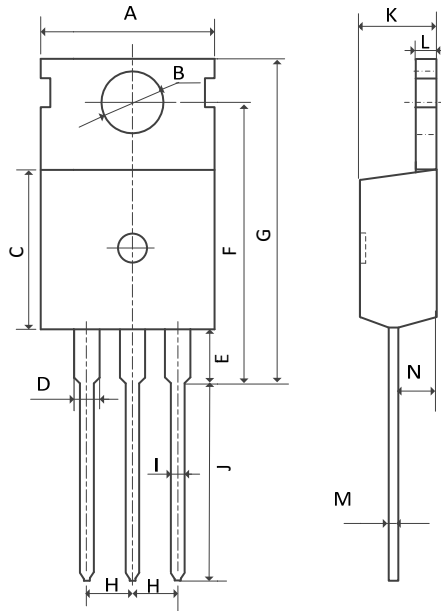
COMMON DIMENSIONS



SYMBOL	MM		
	MIN	NOM	MAX
A	4.37	4.57	4.77
A1	1.22	1.27	1.42
A2	2.49	2.69	2.89
b	0.71	0.81	0.96
b2	1.17	1.27	1.42
c	0.28	0.38	0.53
D	23.20	23.70	24.02
D1	8.50	8.7	8.90
D2	6.00	—	—
E1	9.86	10.16	10.36
E4	7.06	—	—
e	2.54BSC		
G	1.25	1.35	1.50
H2	—	—	1.50
L	13.33	13.73	14.13
L1	3.50	3.75	4.00
L3	1.28	1.43	1.58

Mechanical Dimensions for TO-220

COMMON DIMENSIONS

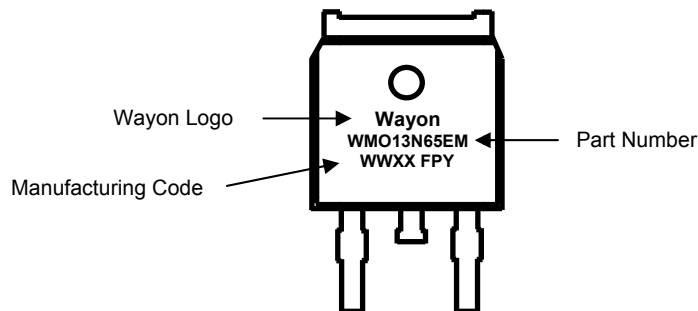


SYMBOL	MM		
	MIN	NOM	MAX
A	9.70	10.00	10.20
B	3.40	3.60	3.80
C	8.90	9.10	9.40
D	1.17	1.27	1.47
E	2.60	3.10	3.40
F	15.10	15.80	16.70
G	19.55MAX		
H	2.54REF		
I	0.70	0.80	0.95
J	9.35	10.30	11.00
K	4.30	4.57	4.77
L	1.20	1.30	1.45
M	0.40	0.50	0.65
N	2.20	2.40	2.60

## Ordering Information

Part	Package	Marking	Packing method
WML13N65EM	TO-220F	WML13N65EM	Tube
WMK13N65EM	TO-220	WMK13N65EM	Tube
WMN13N65EM	TO-262	WMN13N65EM	Tube
WMM13N65EM	TO-263	WMM13N65EM	Tape and Reel
WMO13N65EM	TO-252	WMO13N65EM	Tape and Reel
WMP13N65EM	TO-251	WMP13N65EM	Tube

## Marking Information



## Contact Information

No.1001, Shiwan(7) Road, Pudong District, Shanghai, P.R.China.201202

Tel: 86-21-50310888 Fax: 86-21-50757680 Email: market@way-on.com

WAYON website: <http://www.way-on.com>

For additional information, please contact your local Sales Representative.

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