

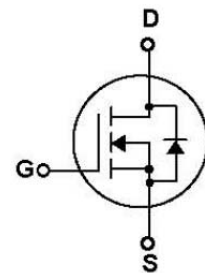
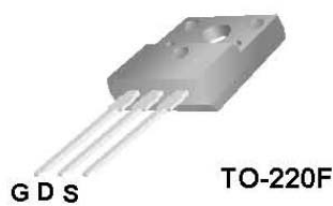
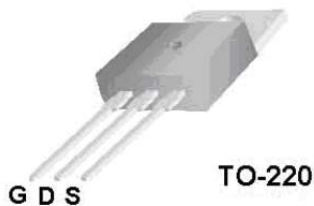
### 1 Description

These N-Channel enhancement mode power field effect transistors are produced using planar stripe, DMOS technology.

This advanced technology has been especially tailored to minimize on-state resistance, provide superior switching performance, and withstand high energy pulse in the avalanche and commutation mode. These devices are well suited for high efficiency switched mode power supplies, active power factor correction based on half bridge topology.

### 2 Features

- 650V / 4.5A
- $R_{DS(on)} = 2.4\Omega(\text{typ}) \cdot V_{GS} = 10V, I_D = 2.25A$
- Fast switching
- 100% avalanche tested
- Improved dv/dt capability..



### 3 Absolute Maximum Ratings $T_C = 25^\circ\text{C}$ unless otherwise noted

Symbol	Parameter	APQ4ESN65AH-XXM0	APQ4ESN65AF-XXM0	Units
		APQ4ESN65AH-XXJ0	APQ4ESN65AF-XXJ0	
		TO-220	TO-220F	
$V_{DSS}$	Drain-Source Voltage	650		V
$I_D$	Drain Current - Continuous ( $T_C = 25^\circ\text{C}$ ) - Continuous ( $T_C = 100^\circ\text{C}$ )	4.5		A
		2.8		A
$I_{DM}$	Drain Current – Pulsed ①	18		A
$V_{GS}$	Gate-Source Voltage	$\pm 30$		V
$E_{AS}$	Single Pulsed Avalanche Energy ②	210		mJ
$I_{AR}$	Avalanche Current	4.5		A
$E_{AR}$	Repetitive Avalanche Energy	10		mJ
dv/dt	Peak Diode Recovery dv/dt ③	4.5		V/ns
$P_D$	Power Dissipation ( $T_C = 25^\circ\text{C}$ ) - De-rate above $25^\circ\text{C}$	106	35	W
		1.03	0.27	W/ $^\circ\text{C}$
$T_J, T_{STG}$	Operating and Storage Temperature Range	-55 to +150		$^\circ\text{C}$
$T_L$	Maximum lead temperature for soldering purposes, 1/8" from case for 5 seconds	300		$^\circ\text{C}$

\* note :

- ① Repetitive Rating: Pulse width limited by maximum junction temperature.
- ②  $V_{DD} = 50V$ , starting  $T_J = 25^\circ\text{C}$ ,  $L = \text{TBD}$ ,  $R_G = 25\Omega$ ,  $I_{AS} = 4.5A$
- ③  $ISD \leq 4.5A$ ,  $di/dt \leq 100A/\mu s$ ,  $V_{DD} \leq V_{(BR)DSS}$ ,  $T_J \leq 150^\circ\text{C}$ .



# DEVICE SPECIFICATION

APQ4ESN65AH  
APQ4ESN65AF

650V/4.5A N-Channel MOSFET

## 4 Thermal Characteristics

Symbol	Parameter	APQ4ESN65AH-XXM0	APQ4ESN65AF-XXM0	Units
		APQ4ESN65AH-XXJ0	APQ4ESN65AF-XXJ0	
		TO-220	TO-220F	
$R_{\theta JC}$	Thermal Resistance, Junction-to-Case	1.25	3.79	°C/W
$R_{\theta CS}$	Thermal Resistance, Case-to-Sink Typ.	0.5	--	°C/W
$R_{\theta JA}$	Thermal Resistance, Junction-to-Ambient	62.5	62.5	°C/W

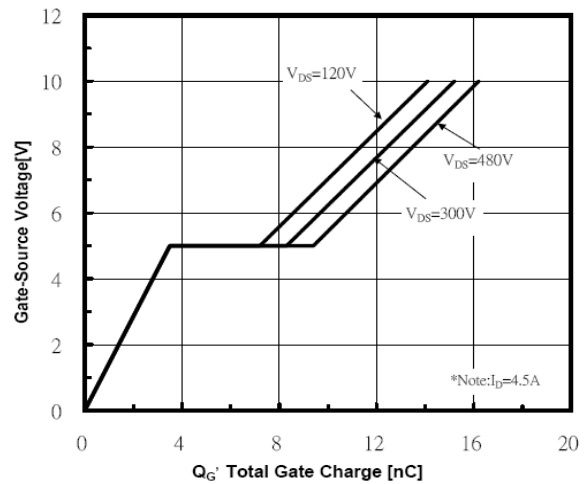
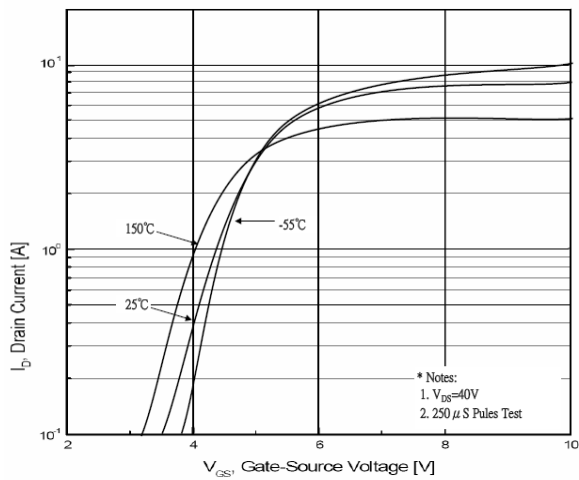
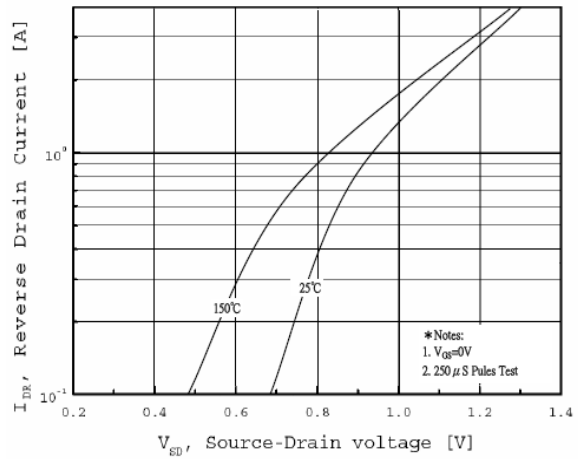
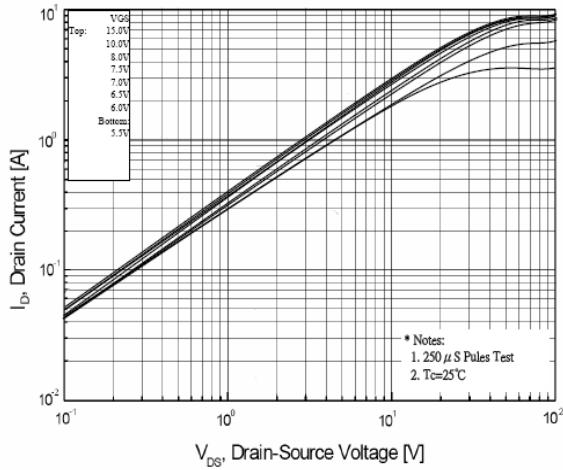
## 5 Electrical Characteristics $T_C = 25^\circ\text{C}$ unless otherwise noted

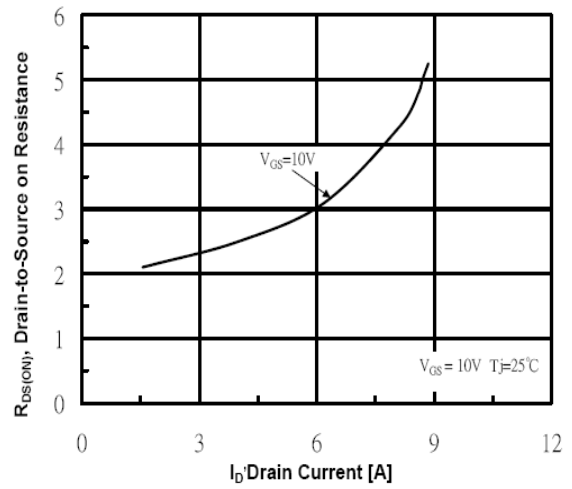
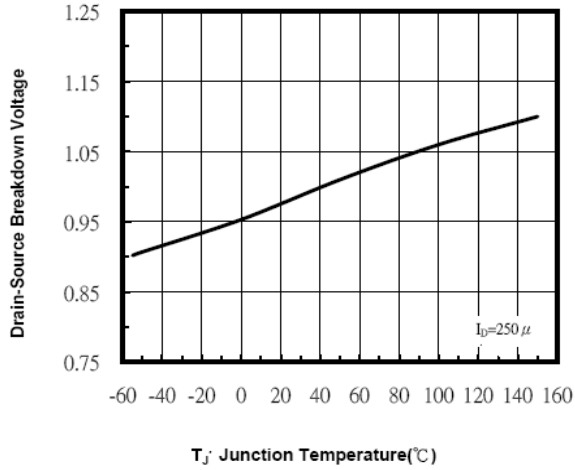
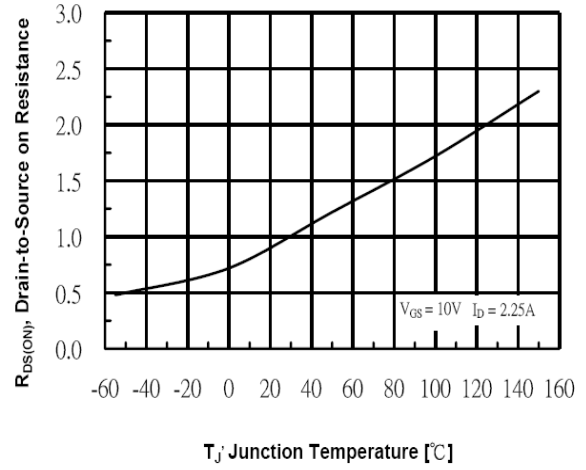
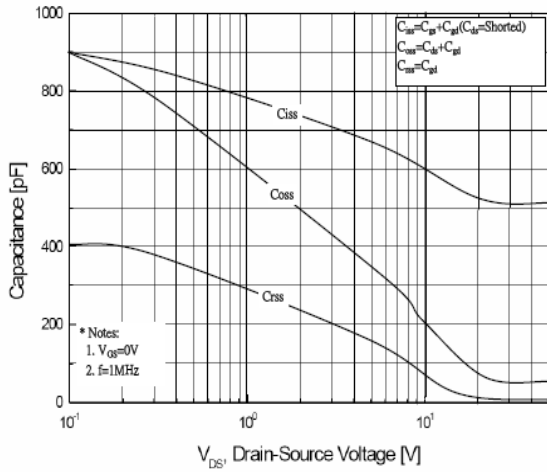
Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
<b>Off Characteristics</b>						
$BV_{DSS}$	Drain-Source Breakdown Voltage	$V_{GS} = 0\text{ V}, I_D = 250\ \mu\text{A}$	650	--	--	V
$\Delta BV_{DSS} / \Delta T_J$	Breakdown Voltage Temperature Coefficient	$I_D = 250\ \mu\text{A}$ , Referenced to $25^\circ\text{C}$	--	0.76	--	V/°C
$I_{DSS}$	Gate to Source leakage current	$V_{DS} = 650\text{ V}, V_{GS} = 0\text{ V}$	--	--	20	$\mu\text{A}$
$I_{GSSF}$	Gate-Body Leakage Current, Forward	$V_{GS} = 30\text{ V}, V_{DS} = 0\text{ V}$	--	--	100	nA
$I_{GSSR}$	Gate-Body Leakage Current, Reverse	$V_{GS} = -30\text{ V}, V_{DS} = 0\text{ V}$	--	--	-100	nA
<b>On Characteristics</b>						
$V_{GS(th)}$	Gate Threshold Voltage	$V_{DS} = V_{GS}, I_D = 250\ \mu\text{A}$	2.0	--	4.0	V
$R_{DS(on)}$	Static Drain-Source On-Resistance	$V_{GS} = 10\text{ V}, I_D = 2.25\text{ A}$ ④	--	2.4	2.8	$\Omega$
$g_{FS}$	Forward Transconductance	$V_{DS} = 15\text{ V}, I_D = 2.25\text{ A}$ ①	--	--	15	S
<b>Dynamic Characteristics</b>						
$C_{iss}$	Input Capacitance	$V_{DS} = 25\text{ V}, V_{GS} = 0\text{ V}, f = 1.0\text{ MHz}$	--	490	--	pF
$C_{oss}$	Output Capacitance		--	50	--	pF
$C_{rss}$	Reverse Transfer Capacitance		--	6.1	--	pF
<b>Switching Characteristics</b>						
$t_{d(on)}$	Turn-On Delay Time	$V_{DD} = 300\text{ V}, I_D = 4.5\text{ A}, R_G = 25\ \Omega$ ④	--	10	--	ns
$t_r$	Turn-On Rise Time		--	42	--	ns
$t_{d(off)}$	Turn-Off Delay Time		--	36	--	ns
$t_f$	Turn-Off Fall Time		--	43	--	ns
$Q_g$	Total Gate Charge	$V_{DS} = 480\text{ V}, I_D = 4.5\text{ A}, V_{GS} = 10\text{ V}$ ④	--	14	--	nC
$Q_{gs}$	Gate-Source Charge		--	2.2	--	nC
$Q_{gd}$	Gate-Drain Charge		--	6.4	--	nC
<b>Drain-Source Diode Characteristics and Maximum Ratings</b>						
$I_S$	Maximum Continuous Drain-Source Diode Forward Current		--	--	4.5	A

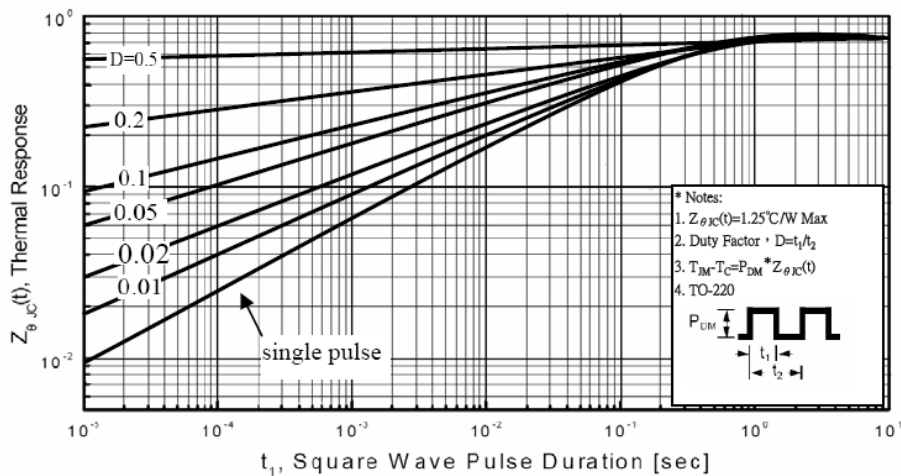
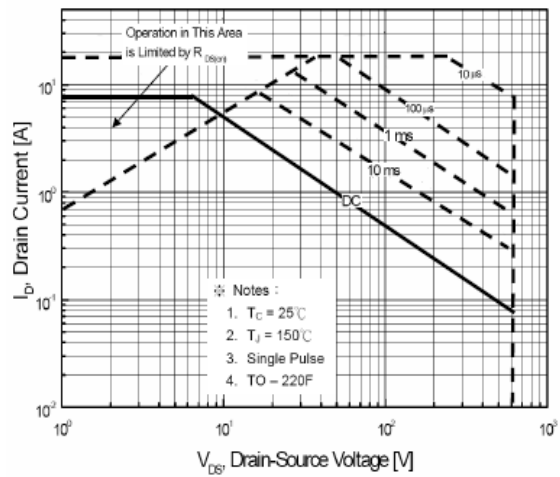
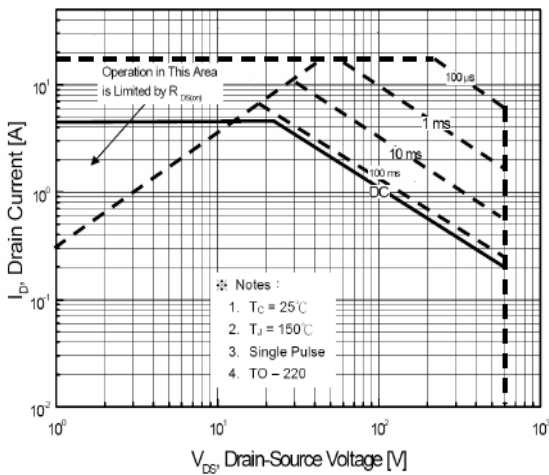
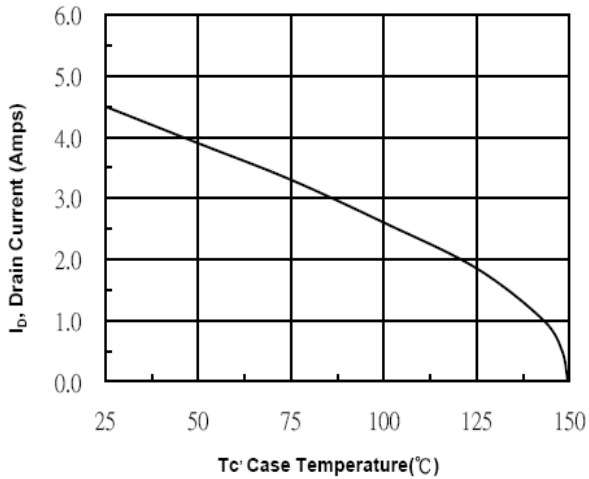
$I_{SM}$	Maximum Pulsed Drain-Source Diode Forward Current	--	--	18	A	
$V_{SD}$	Drain-Source Diode Forward Voltage	$V_{GS} = 0\text{ V}, I_S = 2.25\text{ A}$	--	--	1.5	V
$t_{rr}$	Reverse Recovery Time	$V_{GS} = 0\text{ V}, I_S = 4.5\text{ A},$ $di_F/dt = 100\text{ A}/\mu\text{s}$ ④	--	290	--	ns
$Q_{rr}$	Reverse Recovery Charge		--	2.1	--	$\mu\text{C}$

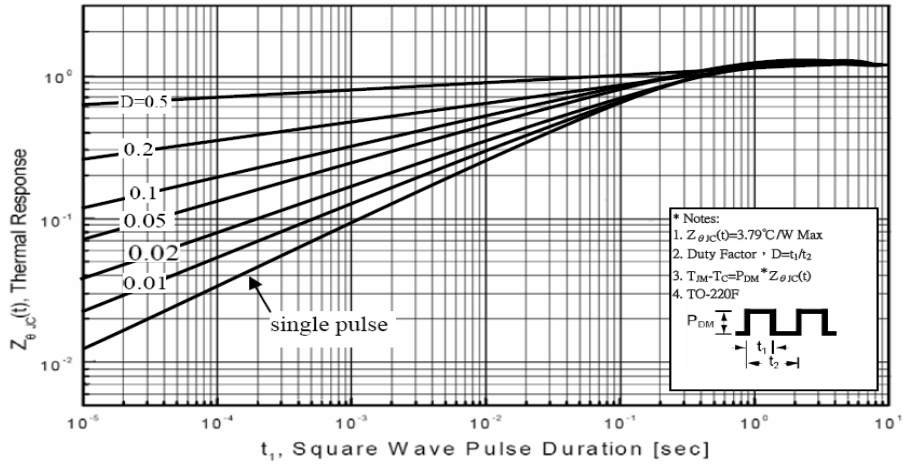
**Notes:**

- ① Repetitive Rating: Pulse width limited by maximum junction temperature.
- ② VDD=50V, starting T<sub>J</sub>=25°C, L=TBD, R<sub>G</sub>=25Ω, I<sub>AS</sub>=4.5A
- ③ I<sub>SD</sub> ≤ 4.5A, di/dt ≤ 100A/μs, VDD ≤ V(BR)DSS, T<sub>J</sub> ≤ 150°C
- ④ Pulse Test: Pulse width ≤ 300μs, Duty cycle ≤ 2%. Depend on FT Test.
- ⑤ CP Test





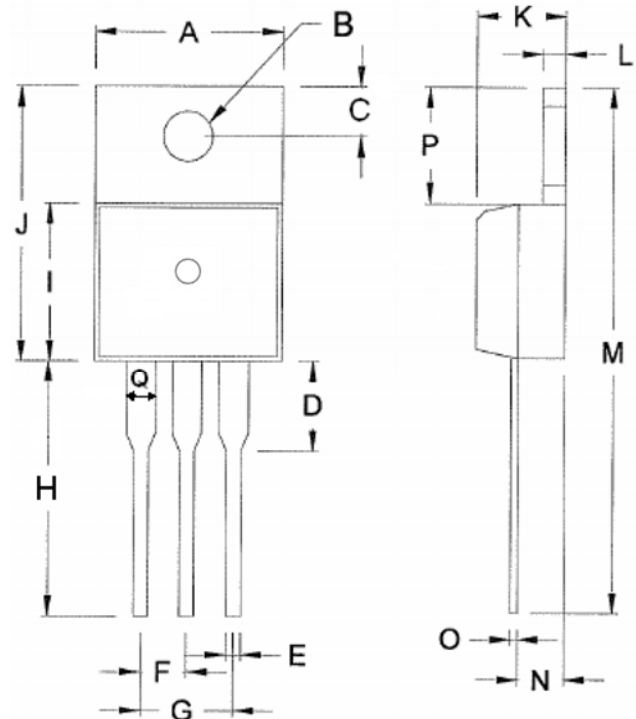




6 Package Dimensions

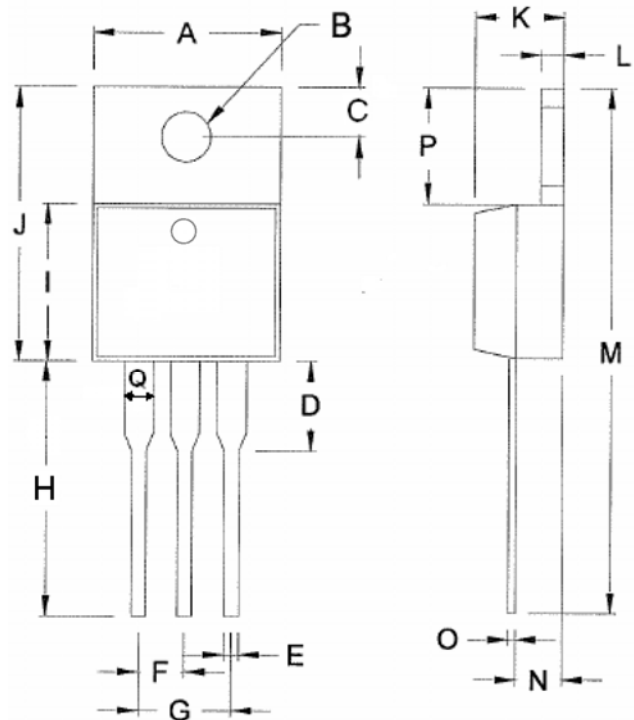
APQ4ESN65AH-XXM0  
TO-220

TO-220 DIMENSION			
DIM	MILLIMETERS		
	MIN	MAX	TYP.
A	10.04	10.41	10.23
B	3.66	3.88	3.77
C	2.50	2.84	2.67
D	3.31	4.50	3.91
E	0.70	0.91	0.81
F	2.54(typ.)		2.54
G	5.08(typ.)		5.08
H	13.47	14.20	13.84
I	8.50	9.00	8.80
J	14.80	15.49	15.15
K	4.32	4.57	4.45
L	1.22	1.42	1.30
M	28.27	29.69	28.98
N	2.40	2.90	2.65
O	0.36	0.53	0.45
P	5.97	6.47	6.22
Q	1.15	1.45	1.30



APQ4ESN65AH-XXJ0  
TO-220

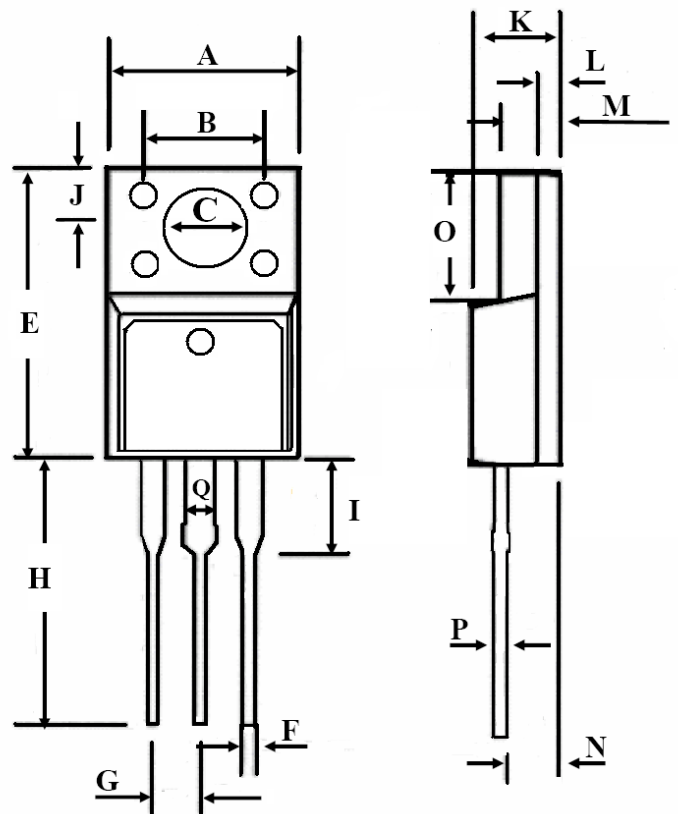
TO-220 DIMENSION			
DIM	MILLIMETERS		
	MIN	MAX	TYP.
A	10.01	10.31	10.16
B	3.66	3.94	3.80
C	2.59	2.89	2.74
D	3.5	3.96	3.73
E	0.70	0.90	0.80
F	2.54 TYP.		
G	4.98	5.18	5.08
H	13.4	13.8	13.6
I	8.5	8.9	8.70
J	14.65	15.35	15.05
K	4.47	4.67	4.57
L	1.22	1.42	1.32
M	28.05	29.15	28.60
N	2.52	2.82	2.67
O	0.31	0.53	0.42
P	6.10	6.50	6.30
Q	1.17	1.37	1.27





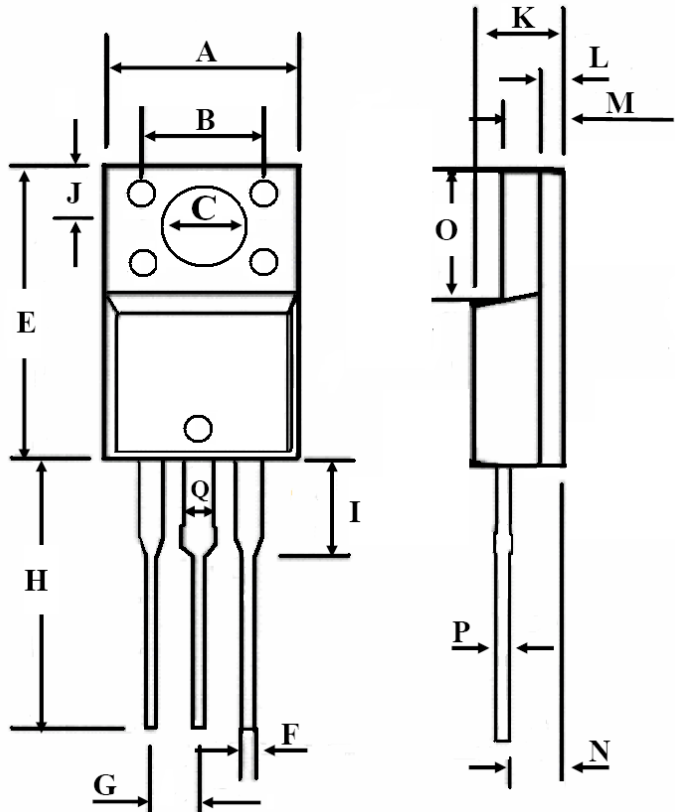
APQ4ESN65AF-XXM0  
TO-220F

TO-220F DIMENSION			
DIM	MILLIMETERS		
	MIN	MAX	TYP.
A	9.96	10.36	10.16
B	6.50 TYP.		6.50
C	3.00	3.20	3.10
E	15.10	16.07	15.59
F	0.55	1.39	0.97
G	2.54 TYP.		
H	12.37	13.5	12.94
I	2.23	3.90	3.07
J	2.90	3.50	3.2
K	4.45	4.93	4.69
L	1.15 TYP.		
M	2.34	2.74	2.54
N	2.56	2.96	2.76
O	6.50	7.10	6.8
P	0.36	0.68	0.52
Q	1.15	1.66	1.41



APQ4ESN65AF-XXJ0  
TO-220F

TO-220F DIMENSION			
DIM	MILLIMETERS		
	MIN	MAX	TYP.
A	9.96	10.36	10.16
B	6.50 TYP.		
C	3.5 REF.		
E	14.8	15.2	15.0
F	0.45	0.75	0.55
G	2.54 TYP.		
H	13.23	14.33	13.78
I	3.60	4.00	3.80
J	2.70 TYP.		
K	4.30	4.70	4.50
L	1.30 TYP.		
M	2.80	3.20	3.00
N	2.50	2.90	2.70
O	6.50	7.10	6.8
P	0.45	0.75	0.55
Q	1.05	1.75	1.40





## DEVICE SPECIFICATION

APQ4ESN65AH  
APQ4ESN65AF

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**650V/4.5A N-Channel MOSFET**

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### Note

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