

**SuperMOS – TO-220F -60V BV<sub>DSS</sub>,27mΩ R<sub>DS(on)</sub>, -24A I<sub>D</sub> P-channel MOSFET**

**1. Description**

The ESTF409 is P-Channel enhancement MOS Field Effect Transistor. Uses advanced trench technology and design to provide excellent R<sub>DS(ON)</sub> with low gate charge. Device is suitable for use in DC-DC conversion, power switch and charging circuit. Standard Product ESTF409 is Pb-free.

**2. Features**

- -60V, R<sub>DS(ON)</sub>=27mΩ(Typ), V<sub>GS</sub>=-10V  
R<sub>DS(ON)</sub>=31mΩ(Typ), V<sub>GS</sub>=-4.5V
- Fast Switching
- High density cell design for low R<sub>DS(on)</sub>
- Material: Halogen free
- Reliable and rugged
- Avalanche Rated
- Low leakage current

**3. Applications**

- PWM applications
- Load switch
- Power management in portable/desktop PCs
- DC/DC conversion

**100% UIS TESTED**

**4. Ordering Information**

Part Number	Package	Marking	Material	Packing	Quantity per Tube	Flammability Rating
ESTF409	TO-220F	ESTF409/lot	Halogen free	Tube	50 PCS	UL 94V-0

Table-1 Ordering information

**5. Pin Configuration and Functions**

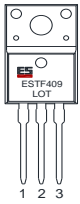
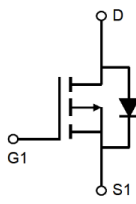
Pin	Function	Outline	Circuit Diagram
3	Source		
1	Gate		
2	Drain		

Table-2 Pin configuration

## 6. Specification

### Absolute Maximum Rating & Thermal Characteristics

Ratings at 25 °C ambient temperature unless otherwise specified.

Parameter	Symbol	Limit	Unit
Drain-Source Voltage	$BV_{DSS}$	-60	V
Gate-Source Voltage	$V_{GS}$	$\pm 20$	V
Continuous Drain Current	$I_D$	$T_C=25^\circ C$	-24
		$T_C=75^\circ C$	-18
Maximum Power Dissipation	$P_D$	$T_C=25^\circ C$	36
		$T_C=75^\circ C$	21
Pulsed Drain Current	$I_{DM}$	-96	A
Operating Junction Temperature	$T_J$	150	$^\circ C$
Storage Temperature Range	$T_{stg}$	-55 to +150	$^\circ C$

### Thermal resistance ratings

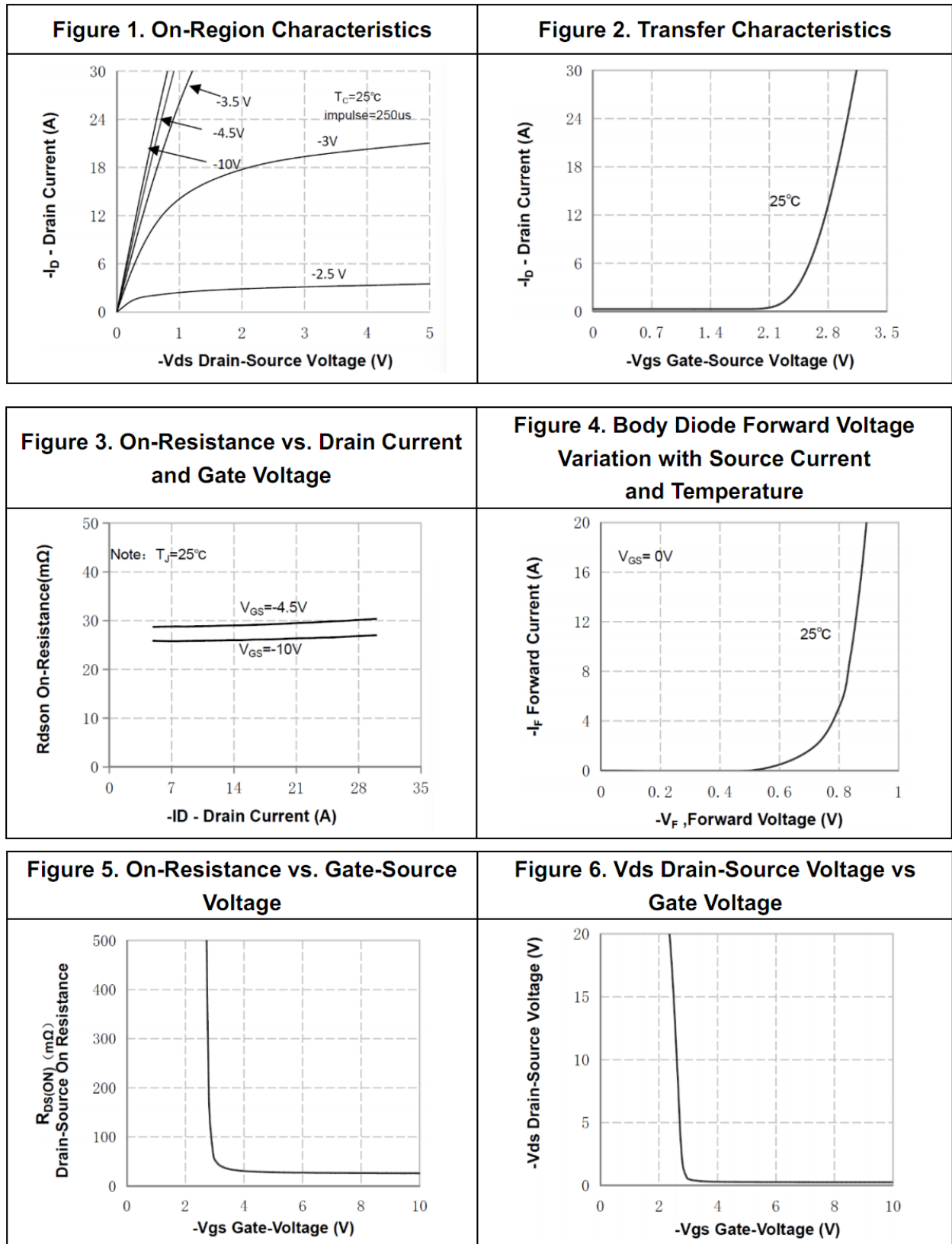
Single Operation				
Parameter	Symbol	Typical	Maximum	Unit
Junction-to- Case Thermal Resistance( $t \leq 10s$ )	$R_{\theta JC}$	2.9	3.5	$^\circ C/W$

## Electrical Characteristics

At TA = 25°C unless otherwise specified

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
<b>OFF CHARACTERISTICS</b>						
Drain-to-Source Breakdown Voltage	$BV_{DSS}$	$V_{GS}=0V, I_D=-250\mu A$	-60			V
Zero Gate Voltage Drain Current	$I_{DSS}$	$V_{DS}=-60V, V_{GS}=0V$			-1	$\mu A$
Gate-to-source Leakage Current	$I_{GSS}$	$V_{DS}=0V, V_{GS}=\pm 20V$			$\pm 100$	nA
<b>ON CHARACTERISTICS</b>						
Gate Threshold Voltage	$V_{GS(TH)}$	$V_{GS}=V_{DS}, I_D=-250\mu A$	-1.1	-1.6	-2.1	V
Drain-to-source On-resistance	$R_{DS(on)}$	$V_{GS}=-10V, I_D=-20A$		27	34	m $\Omega$
		$V_{GS}=-4.5V, I_D=-20A$		31	38	
Forward Transconductance	$g_{FS}$	$V_{DS}=-5V, I_D=-20A$			60	S
<b>CHARGES, CAPACITANCES AND GATE RESISTANCE</b>						
Input Capacitance	$C_{ISS}$	$V_{GS}=0V$ $V_{DS}=-20V$ $f=1MHz$		3020		pF
Output Capacitance	$C_{OSS}$			180		
Reverse Transfer Capacitance	$C_{RSS}$			160		
Total Gate Charge	$Q_{G(TOT)}$	$V_{GS}=-10V$ $V_{DS}=-20V$ $I_D=-10A$		46.6		nC
Gate-to-Source Charge	$Q_{GS}$			9.1		
Gate-to-Drain Charge	$Q_{GD}$			6.2		
<b>SWITCHING CHARACTERISTICS</b>						
Turn-On Delay Time	$t_{d(ON)}$	$V_{GS}=-10V, V_{DS}=-15V,$ $I_D=-1A, R_G=3\Omega$		45		ns
Rise Time	$t_r$			28		
Turn-Off Delay Time	$t_{d(OFF)}$			80		
Fall Time	$t_f$			6.6		
<b>BODY DIODE CHARACTERISTICS</b>						
Forward Voltage	$V_{SD}$	$V_{GS}=0V, I_S=-1.0A$			-1.2	V

7. Typical Characteristic



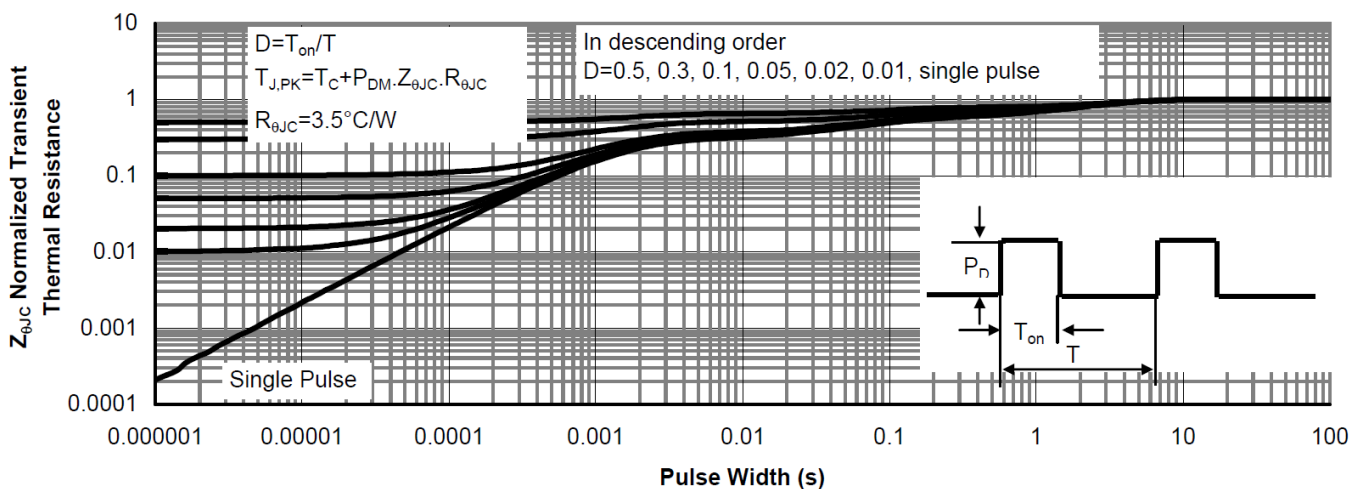
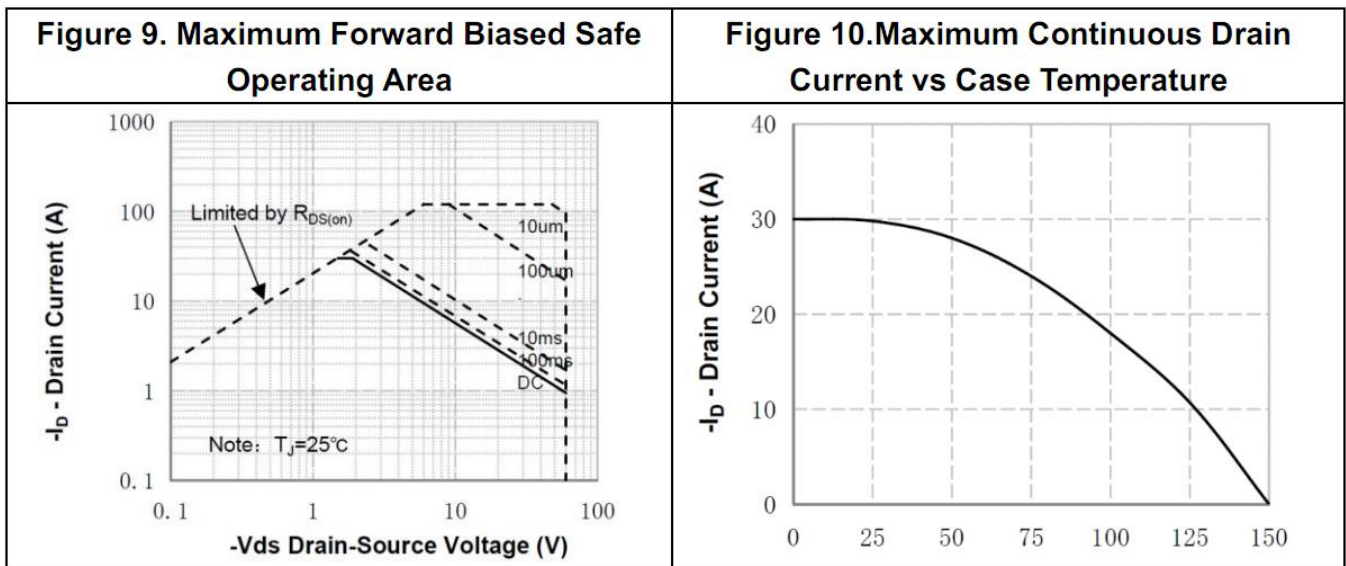
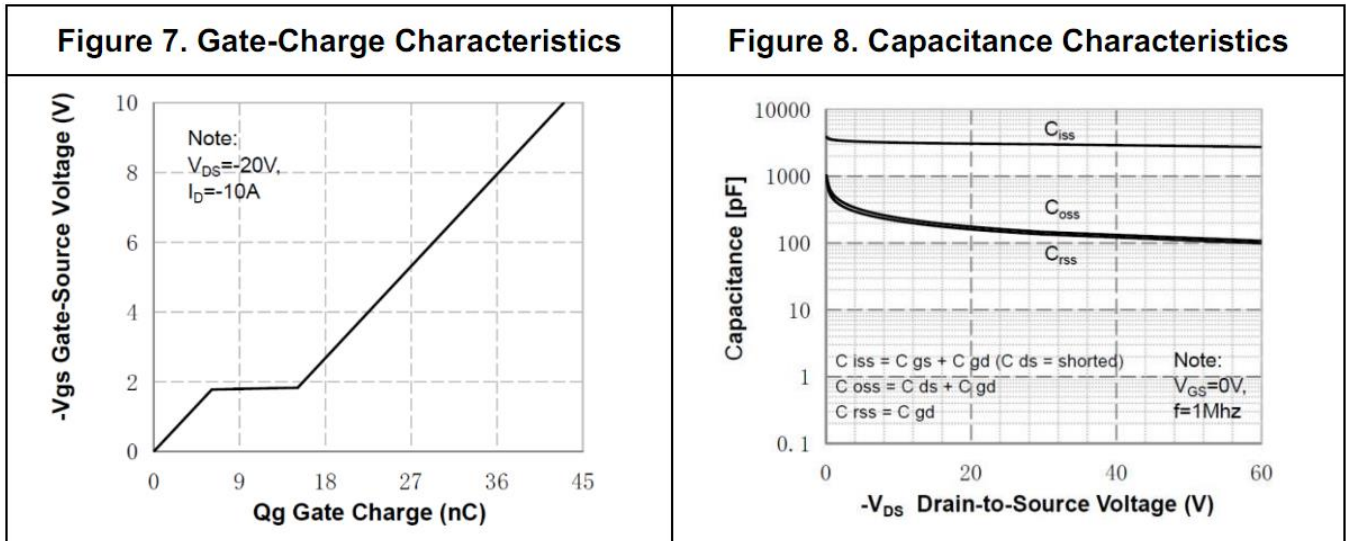
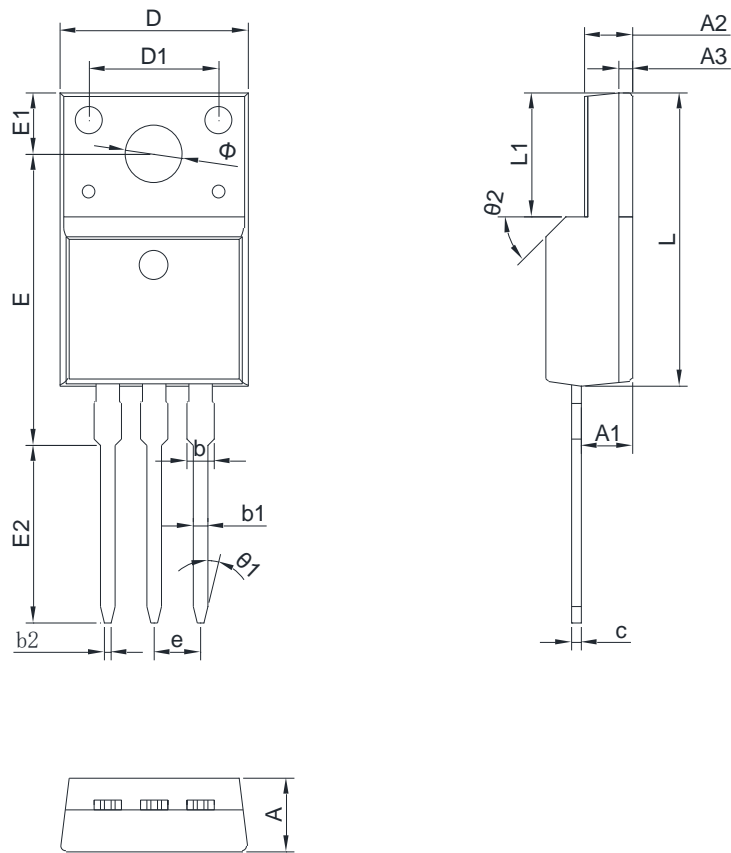


Figure 11: Normalized Maximum Transient Thermal Impedance (Note F)

**8. Dimension (TO-220F)**



REF	Millimeters		REF	Millimeters	
	Min	Max		Min	Max
A	4.50	4.90	E	15.6	16.00
A1	2.56	2.96	E1	3.20	3.40
A2	2.34	2.74	E2	9.45	10.05
A3	0.70 REF		e	2.54 REF	
b		1.45	L	15.67	16.07
b1	0.70	0.90	L1	6.48	6.88
b2	0.25	0.45	$\phi$	3.10	3.30
c	0.45	0.60	$\theta 1$	30° REF	
D	10.06	10.26	$\theta 2$	45° REF	
D1	7.0 REF				

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