

## N-Ch and P-Ch Fast Switching MOSFET

$V_{DS}=60V, I_D=23A, R_{DS(ON)}=32m\Omega$

$V_{DS}=-60V, I_D=-18A, R_{DS(ON)}=70m\Omega$

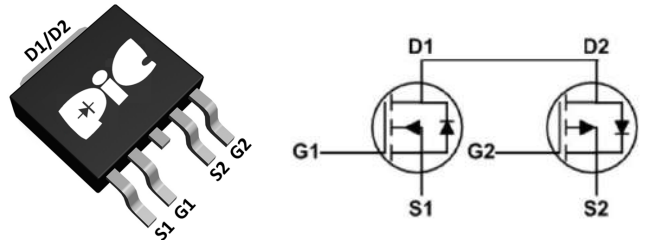
### ➤ General Description

This PAC69TX01X N&P Channel enhancement mode power field effect transistor is the high density trench technology and this advanced technology can provide excellent  $R_{ds(On)}$  performance and efficiency for power switching and load switching application., this device also comply with the RoHS and Green Product requirement with full function reliability approved.

### ➤ Feature

- Super Low Gate Charge
- 100% EAS Guaranteed
- Green Device Available
- Excellent  $CdV/dt$  effect decline
- Advanced high cell density Trench technology

### ➤ TO-252-4L



### ➤ Application

- Inverter
- H-Bridge

### ➤ Absolute Maximum Ratings

Parameter	Symbol	Rating		Units
		N-Channel	P-Channel	
Drain-Source Voltage	$V_{DS}$	60	-60	V
Gate-Source Voltage	$V_{GS}$	$\pm 20$	$\pm 20$	V
Continuous Drain Current, $V_{GS} @ 10V_1$	$I_D @ T_C=25^\circ C$	23	-18	A
Continuous Drain Current, $V_{GS} @ 10V_1$	$I_D @ T_C=100^\circ C$	15	-11	A
Continuous Drain Current, $V_{GS} @ 10V_1$	$I_D @ T_A=25^\circ C$	5.6	-4.3	A
Continuous Drain Current, $V_{GS} @ 10V_1$	$I_D @ T_A=70^\circ C$	4.5	-3.5	A
Pulsed Drain Current <sup>2</sup>	$I_{DM}$	46	-36	A
Single Pulse Avalanche Energy <sup>3</sup>	EAS	34.5	51.2	mJ
Avalanche Current	$I_{AS}$	22.6	-26.6	A
Total Power Dissipation <sup>4</sup>	$P_D @ T_C=25^\circ C$	34.7	34.7	W
Total Power Dissipation <sup>4</sup>	$P_D @ T_A=25^\circ C$	2	2	W
Storage Temperature Range	$T_{STG}$	-55 to 150	-55 to 150	$^\circ C$
Operating Junction Temperature Range	$T_J$	-55 to 150	-55 to 150	$^\circ C$
Thermal Resistance Junction-Ambient <sup>1</sup>	$R_{\theta JA}$	62		$^\circ C/W$
Thermal Resistance Junction-Case <sup>1</sup>	$R_{\theta JC}$	3.6		$^\circ C/W$

### ➤ N-Channel Electrical Characteristics (T<sub>J</sub>=25°C Unless otherwise noted)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Drain-Source Breakdown Voltage	$BV_{DSS}$	$V_{GS}=0V, I_D=250\mu A$	60	---	---	V
$BV_{DSS}$ Temperature Coefficient	$\Delta BV_{DSS}/\Delta T_J$	Reference to 25°C, $I_D=1mA$	---	0.063	---	V/°C
Static Drain-Source On-Resistance <sup>2</sup>	$R_{DS(ON)}$	$V_{GS}=10V, I_D=15A$	---	---	32	mΩ
		$V_{GS}=4.5V, I_D=10A$	---	---	38	
Gate Threshold Voltage	$V_{GS(th)}$	$V_{GS}=V_{DS}, I_D=250\mu A$	1.2	---	2.5	V
$V_{GS(th)}$ Temperature Coefficient	$\Delta V_{GS(th)}$		---	-5.24	---	mV/°C
Drain-Source Leakage Current	$I_{DSS}$	$V_{DS}=48V, V_{GS}=0V, T_J=25^\circ C$	---	---	1	μA
		$V_{DS}=48V, V_{GS}=0V, T_J=55^\circ C$	---	---	5	
Gate-Source Leakage Current	$I_{GSS}$	$V_{GS}=\pm 20V, V_{DS}=0V$	---	---	±100	nA
Forward Transconductance	$g_{fs}$	$V_{DS}=5V, I_D=15A$	---	17	---	S
Gate Resistance	$R_g$	$V_{DS}=0V, V_{GS}=0V, f=1MHz$	---	3.2	---	Ω
Total Gate Charge (4.5V)	$Q_g$	$V_{DS}=48V, V_{GS}=4.5V, I_D=12A$	---	12.56	---	nC
Gate-Source Charge	$Q_{gs}$		---	3.24	---	
Gate-Drain Charge	$Q_{gd}$		---	6.31	---	
Turn-On Delay Time	$T_{d(on)}$	$V_{DD}=30V, V_{GS}=10V, R_G=3.3\Omega, I_D=10A$	---	8	---	ns
Rise Time	$T_r$		---	14.2	---	
Turn-Off Delay Time	$T_{d(off)}$		---	24.4	---	
Fall Time	$T_f$		---	4.6	---	
Input Capacitance	$C_{iss}$	$V_{DS}=15V, V_{GS}=0V, f=1MHz$	---	1378	---	pF
Output Capacitance	$C_{oss}$		---	86	---	
Reverse Transfer Capacitance	$C_{rss}$		---	64	---	

### ➤ Diode Characteristics

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Continuous Source Current <sup>1,5</sup>	$I_S$	$V_G=V_D=0V, \text{Force Current}$	---	---	23	A
Pulsed Source Current <sup>2,5</sup>	$I_{SM}$		---	---	46	A
Diode Forward Voltage <sup>2</sup>	$V_{SD}$	$V_{GS}=0V, I_S=1A, T_J=25^\circ C$	---	---	1.2	V

Note :

1. Pulse width limited by maximum junction temperature.
2. The data tested by pulsed, pulse width  $\leq 300\mu s$ , duty cycle  $\leq 2\%$
3. The EAS data shows Max. rating The test condition is  $V_{GS}=25V, V_{GS}=10V, L=0.1mH, I_{AS}=22.6A$
4. Ensure that the channel temperature does not exceed 150°C.
5. The data is theoretically the same as  $I_D$  and  $I_{DM}$ , in real applications, should be limited by total power dissipation.

### ➤ P-Channel Electrical Characteristics (T<sub>J</sub>=25° C Unless otherwise noted)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Drain-Source Breakdown Voltage	$BV_{DSS}$	$V_{GS}=0V, I_D=-250\mu A$	-60	---	---	V
$BV_{DSS}$ Temperature Coefficient	$\Delta BV_{DSS}/\Delta T_J$	Reference to 25°C , $I_D=-1mA$	---	-0.03	---	V/°C
Static Drain-Source On-Resistance <sup>2</sup>	$R_{DS(ON)}$	$V_{GS}=-10V, I_D=-12A$	---	---	70	mΩ
		$V_{GS}=-4.5V, I_D=-8A$	---	---	105	
Gate Threshold Voltage	$V_{GS(th)}$	$V_{GS}=V_{DS}, I_D=-250\mu A$	-1.2	---	-2.5	V
$V_{GS(th)}$ Temperature Coefficient	$\Delta V_{GS(th)}$		---	4.56	---	mV/°C
Drain-Source Leakage Current	$I_{DSS}$	$V_{DS}=-48V, V_{GS}=0V, T_J=25^\circ C$	---	---	1	μA
		$V_{DS}=-48V, V_{GS}=0V, T_J=55^\circ C$	---	---	5	
Gate-Source Leakage Current	$I_{GSS}$	$V_{GS}=\pm 20V, V_{DS}=0V$	---	---	±100	nA
Forward Transconductance	$g_{fs}$	$V_{DS}=-5V, I_D=-12A$	---	15	---	S
Gate Resistance	$R_g$	$V_{DS}=0V, V_{GS}=0V, f=1MHz$	---	13.5	---	Ω
Total Gate Charge (-4.5V)	$Q_g$	$V_{DS}=-48V, V_{GS}=-4.5V, I_D=-12A$	---	9.86	---	nC
Gate-Source Charge	$Q_{gs}$		---	3.08	---	
Gate-Drain Charge	$Q_{gd}$		---	2.95	---	
Turn-On Delay Time	$T_{d(on)}$	$V_{DD}=-15V, V_{GS}=-10V, R_G=3.3\Omega, I_D=-1A$	---	28.8	---	ns
Rise Time	$T_r$		---	19.8	---	
Turn-Off Delay Time	$T_{d(off)}$		---	60.8	---	
Fall Time	$T_f$		---	7.2	---	
Input Capacitance	$C_{iss}$	$V_{DS}=-15V, V_{GS}=0V, f=1MHz$	---	1447	---	pF
Output Capacitance	$C_{oss}$		---	97	---	
Reverse Transfer Capacitance	$C_{rss}$		---	70	---	

### ➤ Diode Characteristics

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Continuous Source Current <sup>1,5</sup>	$I_S$	$V_G=V_D=0V, \text{ Force Current}$	---	---	-18	A
Pulsed Source Current <sup>2,5</sup>	$I_{SM}$		---	---	-36	A
Diode Forward Voltage <sup>2</sup>	$V_{SD}$	$V_{GS}=0V, I_S=-1A, T_J=25^\circ C$	---	---	-1.2	V

Note :

1. Pulse width limited by maximum junction temperature.
2. The data tested by pulsed , pulse width  $\leq 300\mu s$  , duty cycle  $\leq 2\%$
3. The EAS data shows Max. rating . The test condition is  $V_{DD}=-25V, V_{GS}=-10V, L=0.1mH, I_{AS}=-26.6A$
4. Ensure that the channel temperature does not exceed 150°C.
5. The data is theoretically the same as ID and IDM , in real applications , should be limited by total power dissipation.

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## N-Channel Typical Characteristics

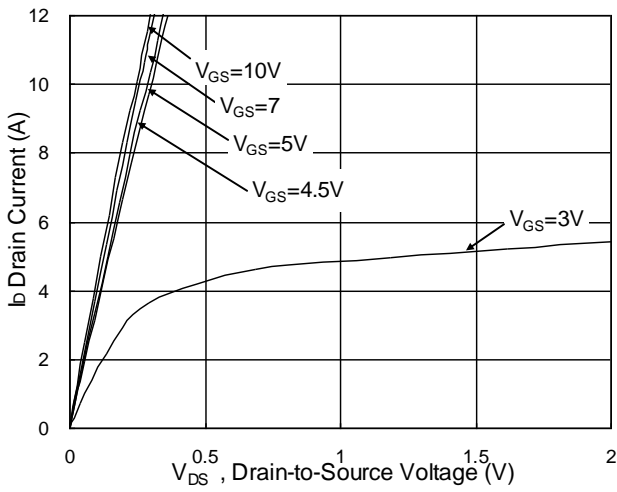


Fig.1 Typical Output Characteristics

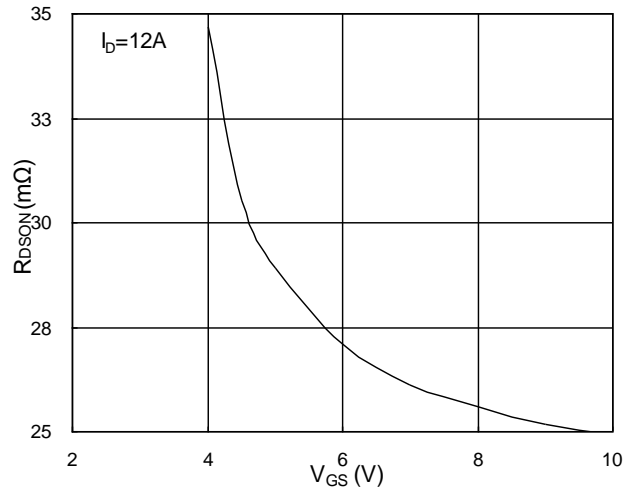


Fig.2 On-Resistance v.s Gate-Source

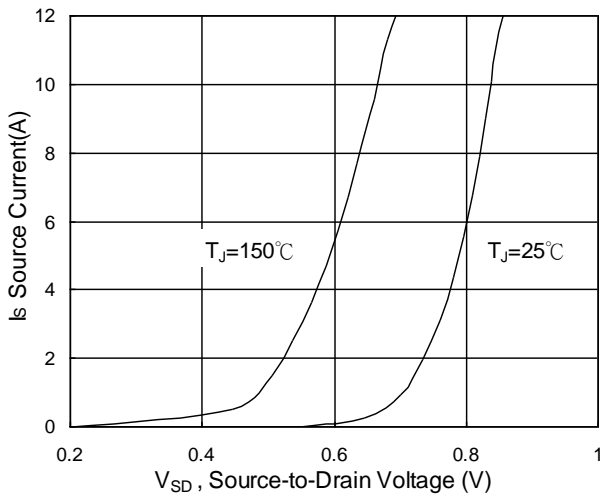


Fig.3 Forward Characteristics of Reverse

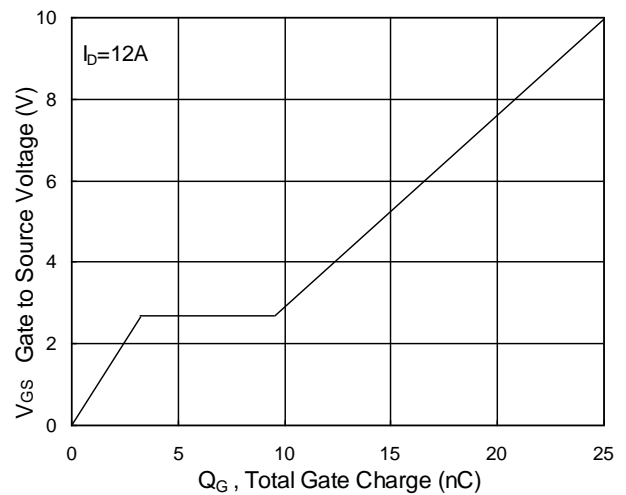


Fig.4 Gate-Charge Characteristics

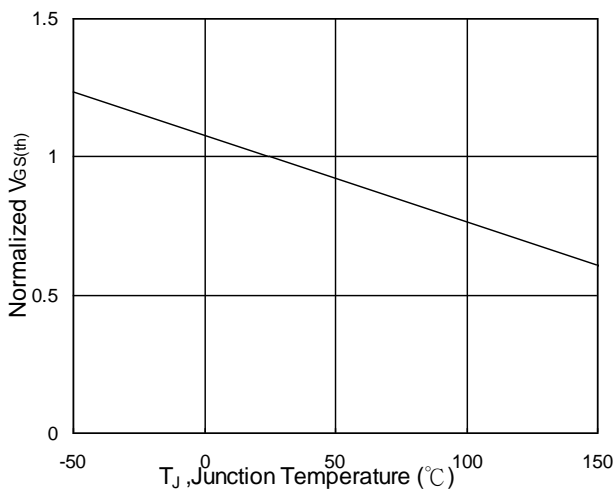


Fig.5 Normalized  $V_{GS(th)}$  v.s  $T_J$

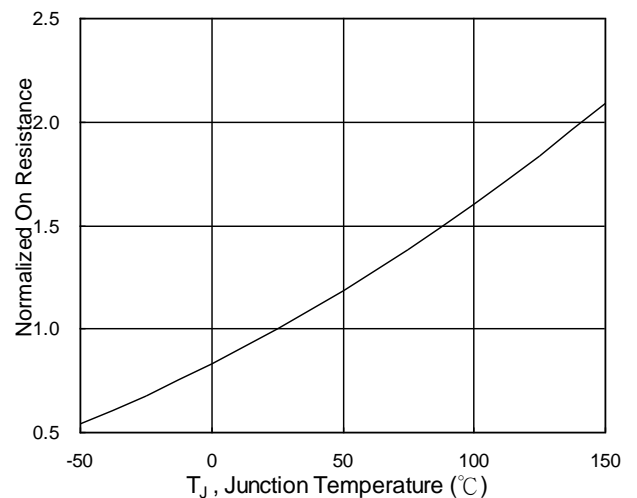
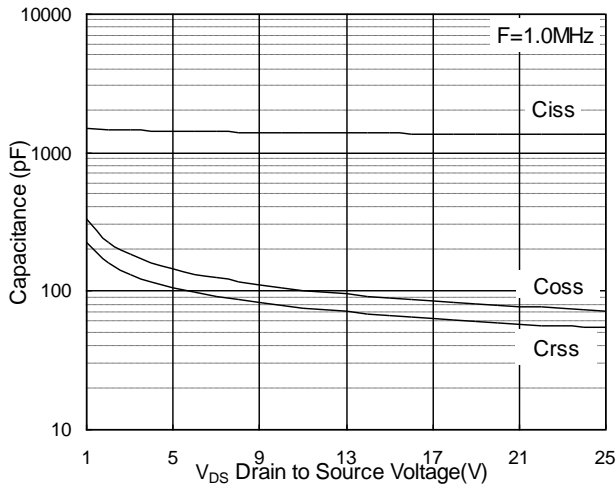


Fig.6 Normalized  $R_{DS(on)}$  v.s  $T_J$

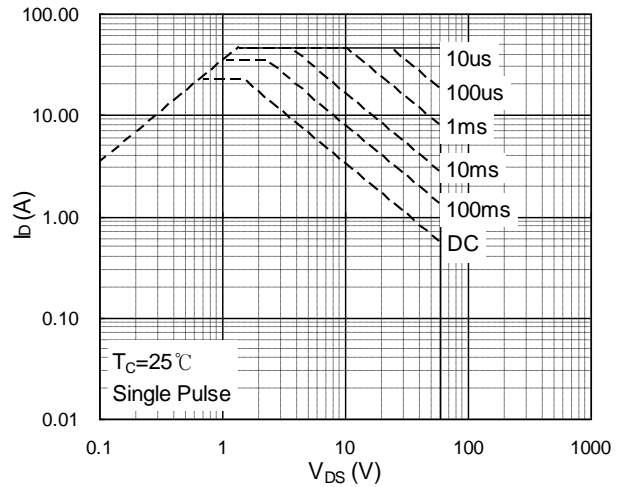
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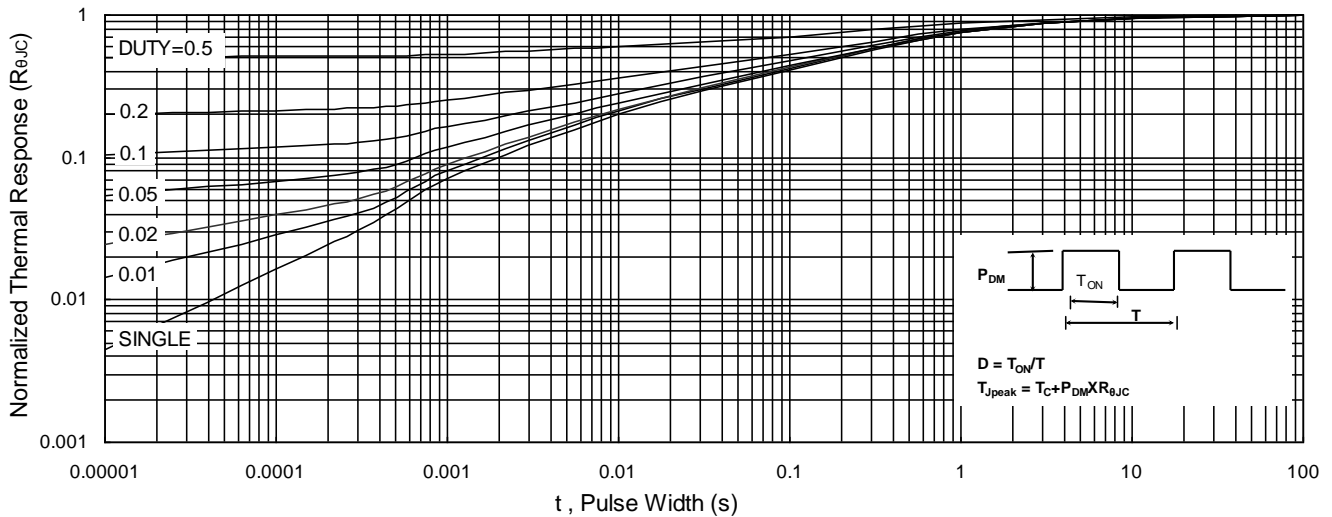
$V_{DS}=-60V, I_D=-18A, R_{DS(ON)}=70m\Omega$



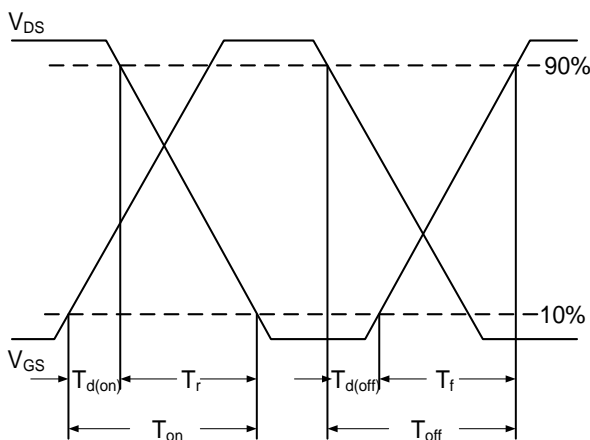
**Fig.7 Capacitance**



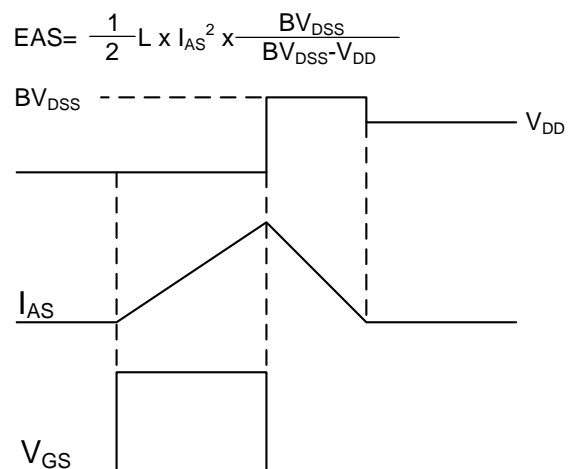
**Fig.8 Safe Operating Area**



**Fig.9 Normalized Maximum Transient Thermal Impedance**



**Fig.10 Switching Time Waveform**



**Fig.11 Unclamped Inductive Waveform**

### P-Channel Typical Characteristics

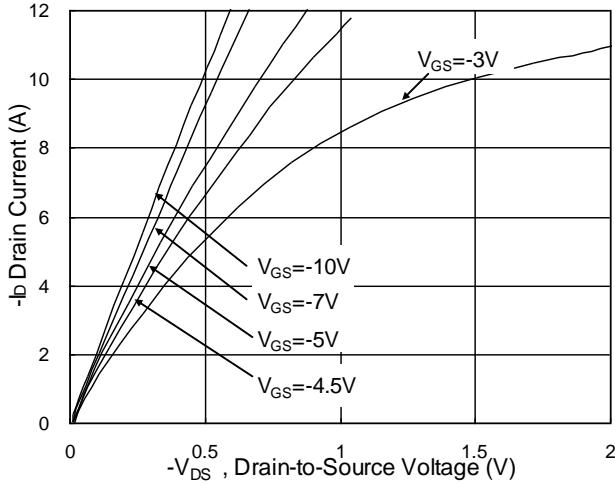


Fig.1 Typical Output Characteristics

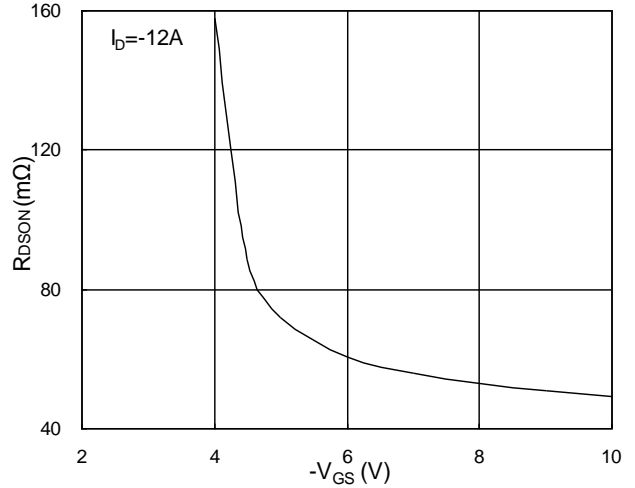


Fig.2 On-Resistance v.s Gate-Source

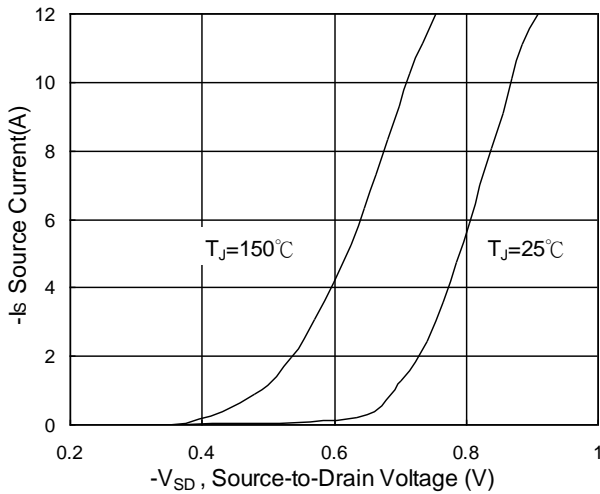


Fig.3 Forward Characteristics of Reverse

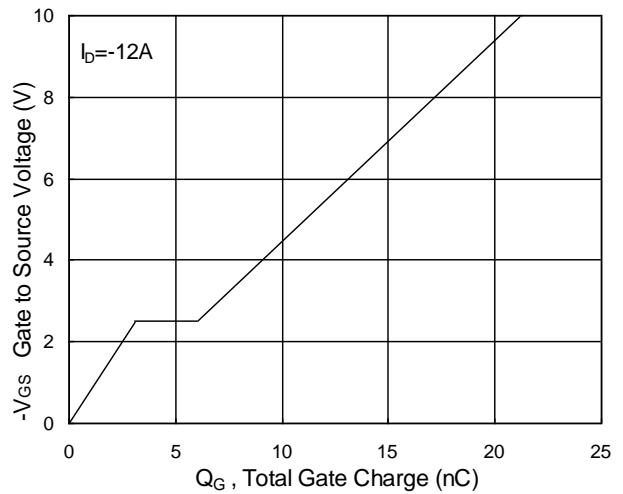


Fig.4 Gate-Charge Characteristics

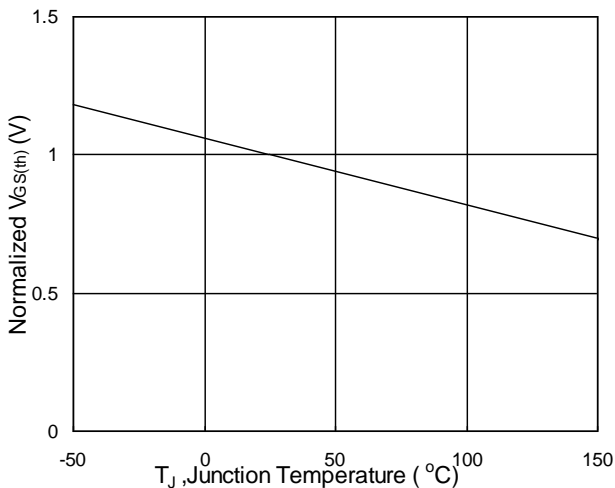


Fig.5 Normalized  $V_{GS(th)}$  v.s  $T_J$

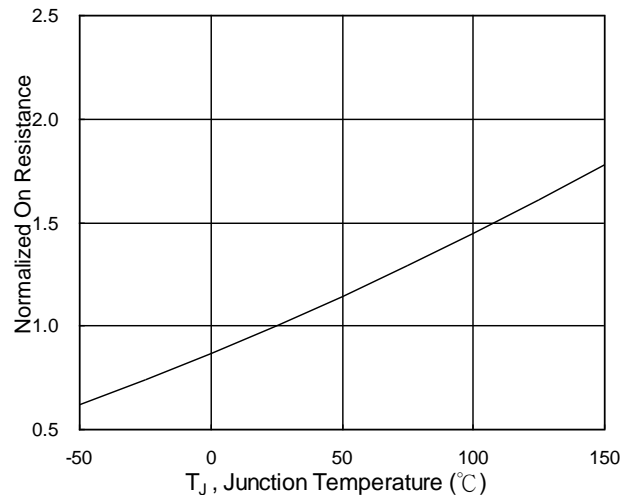
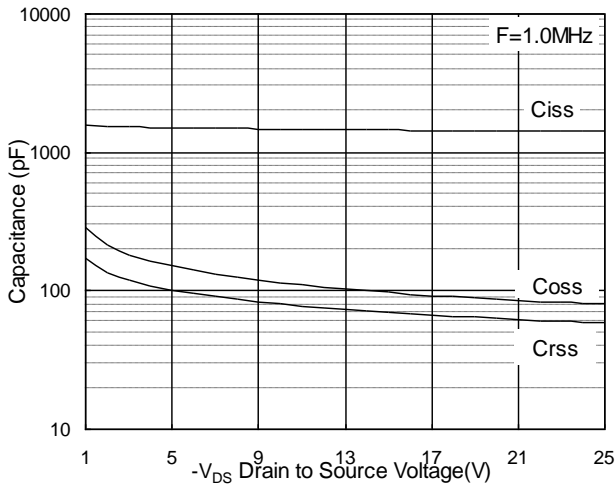


Fig.6 Normalized  $R_{DSON}$  v.s  $T_J$

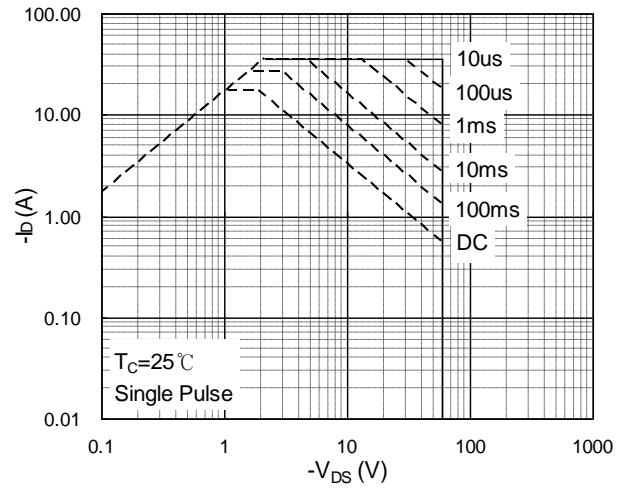
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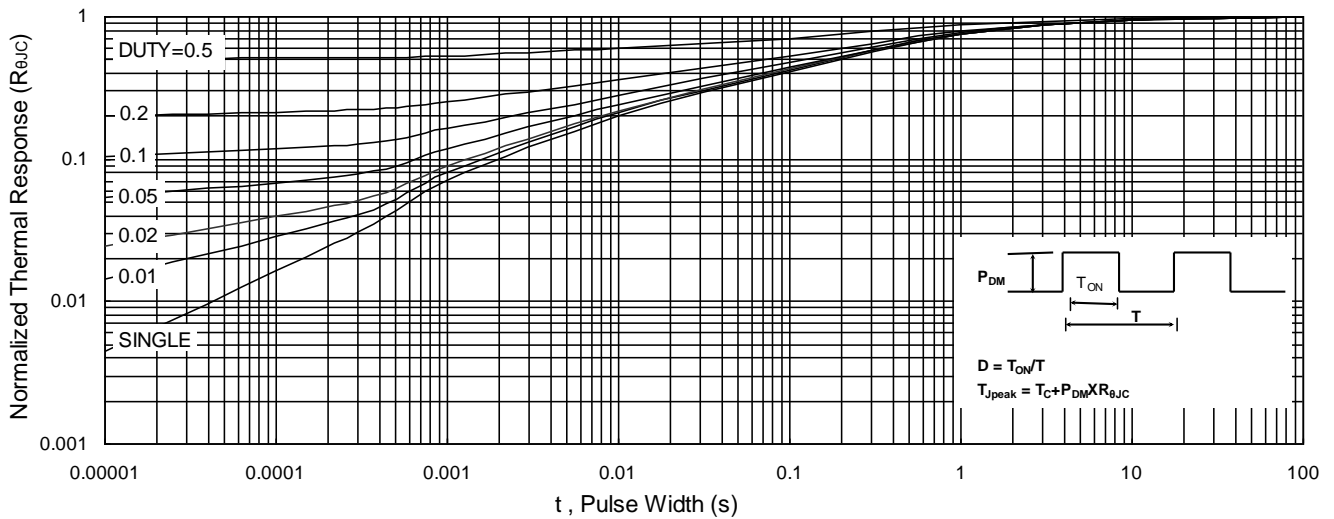
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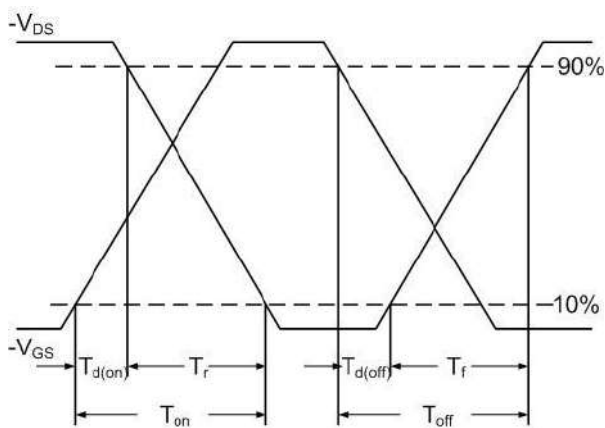
**Fig.7 Capacitance**



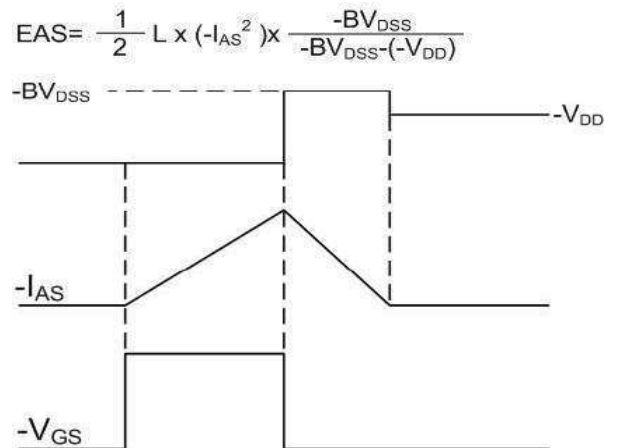
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**Fig.10 Switching Time Waveform**



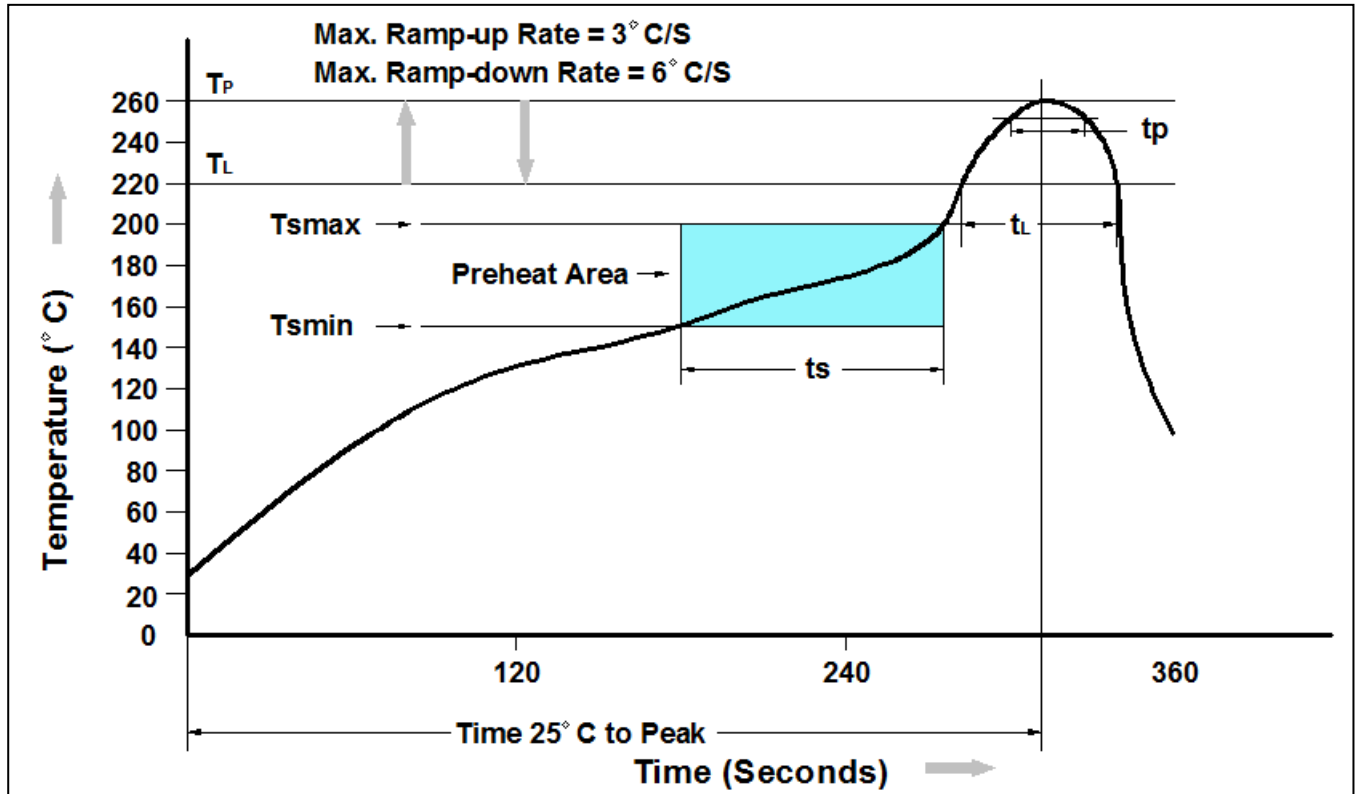
**Fig.11 Unclamped Inductive Waveform**

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## ➤ Recommnd IR Reflow Soldering Thermal Profile



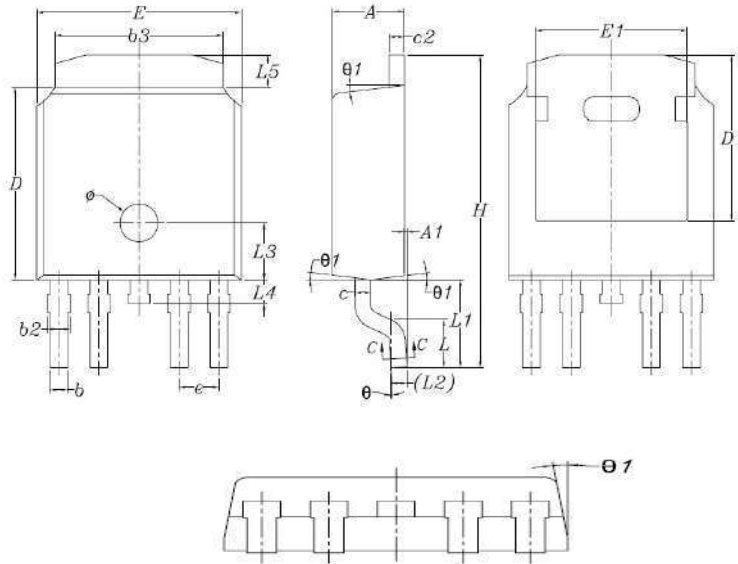
Profile Feature	Pb-Free Assembly Profile
Temperature Min. (T <sub>smin</sub> )	150°C
Temperature Max. (T <sub>smax</sub> )	200°C
Time (t <sub>s</sub> ) from (T <sub>smin</sub> to T <sub>smax</sub> )	60-120 seconds
Average Ramp-up Rate (t <sub>L</sub> to t <sub>P</sub> )	3°C/second max.
Liquidous Temperature (T <sub>L</sub> )	217°C
Time (t <sub>L</sub> ) Maintained Above (T <sub>L</sub> )	60 – 150 seconds
Peak Temperature	260°C +0°C / -5°C
Time (t <sub>P</sub> ) within 5°C of actual Peak Temperature	30 seconds
Ramp-down Rate (T <sub>P</sub> to T <sub>L</sub> )	6°C/second max
Time 25°C to Peak Temperature	8 minutes max.

## ➤ Ordering Information

Part Number	Description	Quantity
PAC69TX01X	TO-252-4L Reel	2500 pcs



### ➤ Package Information ( TO-252-4L)



SYMBOLS	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	2.180	2.400	0.0860	0.0950
A1	-	0.127	-	0.0050
b	0.508	0.711	0.0200	0.0280
b2	0.610	0.790	0.0240	0.0310
b3	5.184	5.461	0.2041	0.2150
c	0.460	0.610	0.0181	0.024
c2	0.460	0.610	0.0181	0.024
D	6.000	6.223	0.2362	0.2450
D1	5.050	--	0.1988	--
E	6.350	6.731	0.2500	0.2650
E1	4.320	--	0.1700	--
e	1.170	1.370	0.0461	0.0539
H	9.500	10.300	0.3740	0.4055
L	1.380	1.780	0.0540	0.0700
L1	2.400	3.000	0.0945	0.1181
L2	0.508BSC		0.020BSC	
L3	1.600	2.000	0.0630	0.0787
L4	--	1.016	--	0.04
L5	0.889	1.270	0.035	0.05
Ø	0°	10°	0°	10°
Ø1	0°	15°	0°	15°
Ø	1.050	1.350	0.0413	0.0531

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