TOSHIBA Power MOS FET Module Silicon N&P Channel MOS Type (L^2-π-MOSV 6 in 1)

MP6404

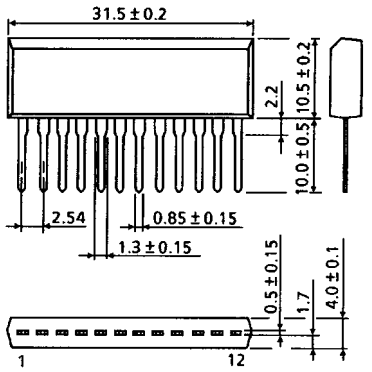
Industrial Applications

High Power High Speed Switching Applications

3-Phase Motor Drive and Stepping Motor Drive Applications

- 4 V gate drive
- Small package by full molding (SIP 12 pin)
- High drain power dissipation (6 devices operation)
  : P_T = 36 W (T_c = 25°C)
- Low drain-source ON resistance: $R_{DS\ (ON)}$ = 120 mΩ (typ.) (Nch)
  160 mΩ (typ.) (Pch)
- High forward transfer admittance: $|Y_{fs}|$ = 5.0 S (typ.) (Nch)
  4.0 S (typ.) (Pch)
- Low leakage current: I_{GSS} = ±10 μA (max) (V_{GS} = ±16 V)
  I_{DSS} = 100 μA (max) (V_{DS} = 60 V)
- Enhancement-mode: V_{th} = 0.8 V to 2.0 V (V_{DS} = 10 V, I_D = 1 mA)

Unit: mm



2, 4, 6, 8, 9, 11	GATE
3, 7, 10	DRAIN
1, 5, 12	SOURCE

JEDEC	—
JEITA	—
TOSHIBA	2-32C1K

Weight: 3.9 g (typ.)

Maximum Ratings (Ta = 25°C)

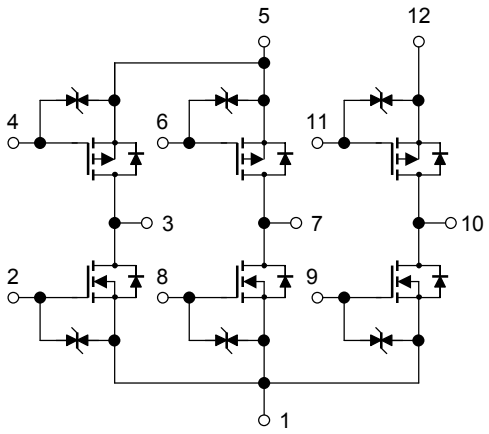
Characteristics		Symbol	Rating		Unit
			Nch	Pch	
Drain-source voltage		V_{DSS}	60	−60	V
Drain-gate voltage (R_{GS} = 20 kΩ)		V_{DGR}	60	−60	V
Gate-source voltage		V_{GSS}	±20	±20	V
Drain current	DC	I_D	5	−5	A
	Pulse	I_{DP}	20	−20	
Drain power dissipation (1 device operation, Ta = 25°C)		P_D	2.2		W
Drain power dissipation (6 devices operation)	Ta = 25°C	P_{DT}	4.4		W
	Tc = 25°C		36		
Single Pulse avalanche energy (Note 1)		E_{AS}	129	273	mJ
Avalanche current		I_{AR}	5	−5	A
Repetitive avalanche energy (Note 2)	1 device operation	E_{AR}	0.22		mJ
	6 device operation	E_{ART}	0.44		
Channel temperature		T_{ch}	150		°C
Storage temperature range		T_{stg}	−55 to 150		°C

Note 1: Avalanche energy (single pulse) applied condition
Nch: V_{DD} = 25 V, starting T_{ch} = 25°C, L = 7 mH, R_G = 25 Ω, I_{AR} = 5 A
Pch: V_{DD} = −25 V, starting T_{ch} = 25°C, L = 14.84 mH, R_G = 25 Ω, I_{AR} = −5 A

Note 2: Repetitive rating; pulse width limited by maximum channel temperature.

This transistor is an electrostatic sensitive device. Please handle with caution.

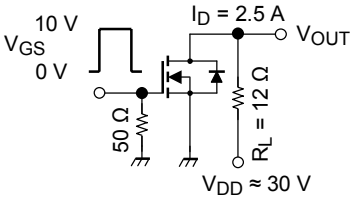
Array Configuration



Thermal Characteristics

Characteristics	Symbol	Max	Unit
Thermal resistance of channel to ambient (6 devices operation, Ta = 25°C)	$\Sigma R_{th\ (ch\text{-}a)}$	28.4	°C/W
Thermal resistance of channel to case (6 devices operation, Tc = 25°C)	$\Sigma R_{th\ (ch\text{-}c)}$	3.47	°C/W
Maximum lead temperature for soldering purposes (3.2 mm from case for t = 10 s)	T_L	260	°C

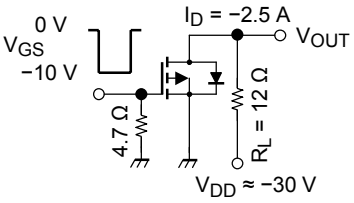
Electrical Characteristics (Ta = 25°C) (Nch MOS FET)

Characteristics		Symbol	Test Condition	Min	Typ.	Max	Unit
Gate leakage current		I_{GSS}	V_{GS} = ±16 V, V_{DS} = 0 V	—	—	±10	μA
Drain cut-off current		I_{DSS}	V_{DS} = 60 V, V_{GS} = 0 V	—	—	100	μA
Drain source breakdown voltage		$V_{(BR)\ DSS}$	I_D = 10 mA, V_{GS} = 0 V	60	—	—	V
Gate threshold voltage		V_{th}	V_{DS} = 10 V, I_D = 1 mA	0.8	—	2.0	V
Drain-source ON resistance		$R_{DS\ (ON)}$	V_{GS} = 4 V, I_D = 2.5 A	—	0.21	0.32	Ω
			V_{GS} = 10 V, I_D = 2.5 A	—	0.12	0.16	
Forward transfer admittance		$\|Y_{fs}\|$	V_{DS} = 10 V, I_D = 2.5 A	3.0	5.0	—	S
Input capacitance		C_{iss}	V_{DS} = 10 V, V_{GS} = 0 V, f = 1 MHz	—	370	—	pF
Reverse transfer capacitance		C_{rss}		—	60	—	pF
Output capacitance		C_{oss}		—	180	—	pF
Switching time	Rise time	t_r		—	18	—	μs
	Turn-on time	t_{on}		—	25	—	
	Fall time	t_f		—	55	—	
	Turn-off time	t_{off}	V_{IN}: t_r, t_f < 5 ns, duty ≤ 1%, t_w = 10 μs	—	170	—	
Total gate charge (gate-source plus gate-drain)		Q_g	V_{DD} ≈ 48 V, V_{GS} = 10 V, I_D = 5 A	—	12	—	nC
Gate-source charge		Q_{gs}		—	8	—	nC
Gate-drain (“miller”) charge		Q_{gd}		—	4	—	nC

Source-Drain Diode Ratings and Characteristics (Ta = 25°C)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Continuous drain reverse current	I_{DR}	—	—	—	5	A
Pulse drain reverse current	I_{DRP}	—	—	—	20	A
Diode forward voltage	V_{DSF}	I_{DR} = 5 A, V_{GS} = 0 V	—	—	−1.7	V
Reverse recovery time	t_{rr}	I_{DR} = 5 A, V_{GS} = 0 V	—	70	—	ns
Reverse recovery charge	Q_{rr}	dI_{DR}/dt = 50 A/μs	—	0.1	—	μC

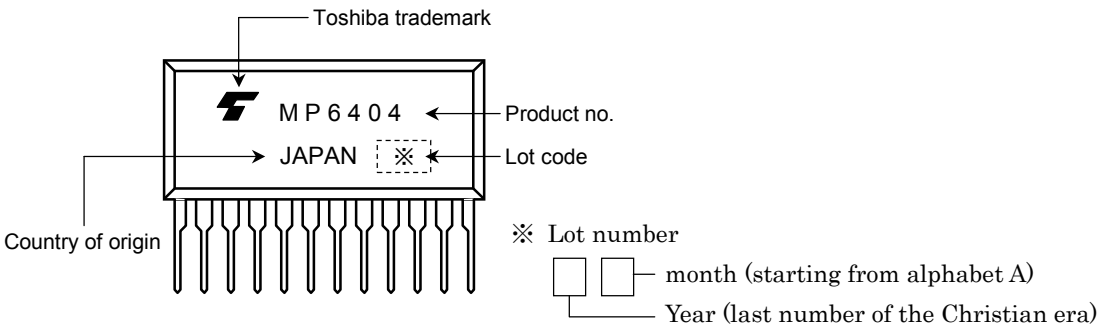
Electrical Characteristics (Ta = 25°C) (Pch MOS FET)

Characteristics		Symbol	Test Condition	Min	Typ.	Max	Unit
Gate leakage current		I_{GSS}	V_{GS} = ±16 V, V_{DS} = 0 V	—	—	±10	μA
Drain cut-off current		I_{DSS}	V_{DS} = −60 V, V_{GS} = 0 V	—	—	−100	μA
Drain source breakdown voltage		$V_{(BR)\ DSS}$	I_D = −10 mA, V_{GS} = 0 V	−60	—	—	V
Gate threshold voltage		V_{th}	V_{DS} = −10 V, I_D = −1 mA	−0.8	—	−2.0	V
Drain-source ON resistance		$R_{DS\ (ON)}$	V_{GS} = −4 V, I_D = −2.5 A	—	0.24	0.28	Ω
			V_{GS} = −10 V, I_D = −2.5 A	—	0.16	0.19	
Forward transfer admittance		$\|Y_{fs}\|$	V_{DS} = −10 V, I_D = −2.5 A	2.0	4.0	—	S
Input capacitance		C_{iss}	V_{DB} = −10 V, V_{GS} = 0 V, f = 1 MHz	—	630	—	pF
Reverse transfer capacitance		C_{rss}		—	95	—	pF
Output capacitance		C_{oss}		—	290	—	pF
Switching time	Rise time	t_r		—	25	—	μs
	Turn-on time	t_{on}		—	45	—	
	Fall time	t_f		—	55	—	
	Turn-off time	t_{off}	V_{IN}: t_r, t_f < 5 ns, duty ≤ 1%, t_w = 10 μs	—	200	—	
Total gate charge (gate-source plus gate-drain)		Q_g	V_{DD} ≈ −48 V, V_{GS} = −10 V, I_D = −5 A	—	22	—	nC
Gate-source charge		Q_{gs}		—	16	—	nC
Gate-drain (“miller”) charge		Q_{gd}		—	6	—	nC

Source-Drain Diode Ratings and Characteristics (Ta = 25°C)

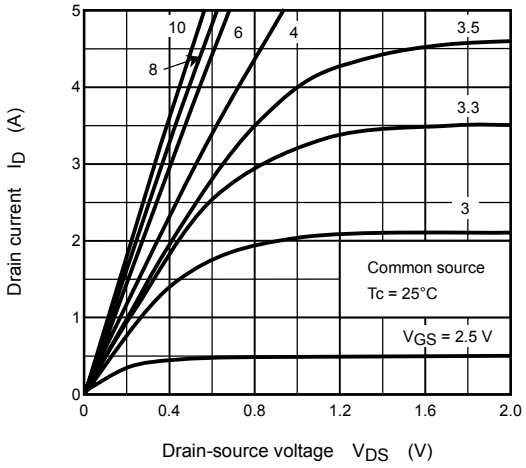
Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Continuous drain reverse current	I_{DR}	—	—	—	−5	A
Pulse drain reverse current	I_{DRP}	—	—	—	−20	A
Diode forward voltage	V_{DSF}	I_{DR} = −5 A, V_{GS} = 0 V	—	—	1.7	V
Reverse recovery time	t_{rr}	I_{DR} = −5 A, V_{GS} = 0 V	—	80	—	ns
Reverse recovery charge	Q_{rr}	dI_{DR}/dt = 50 A/μs	—	0.1	—	μC

Marking

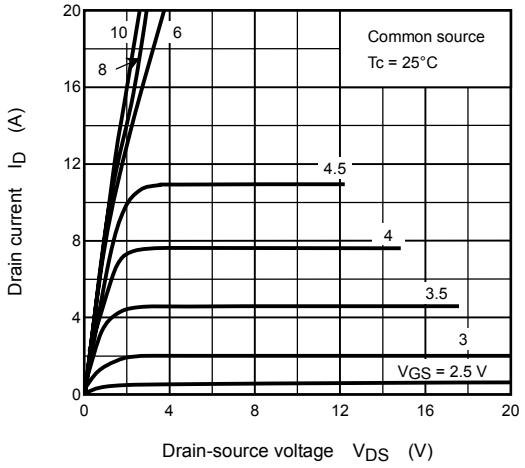


Nch MOS FET

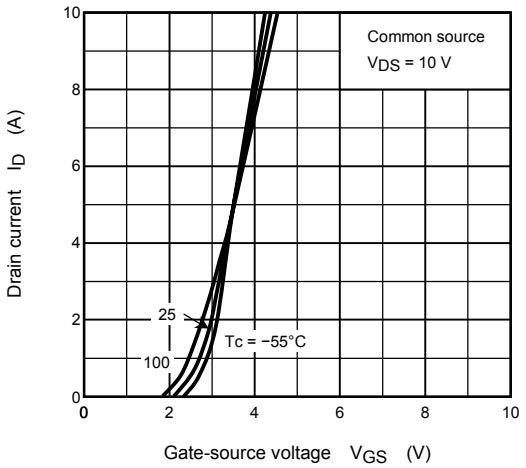
$I_D - V_{DS}$



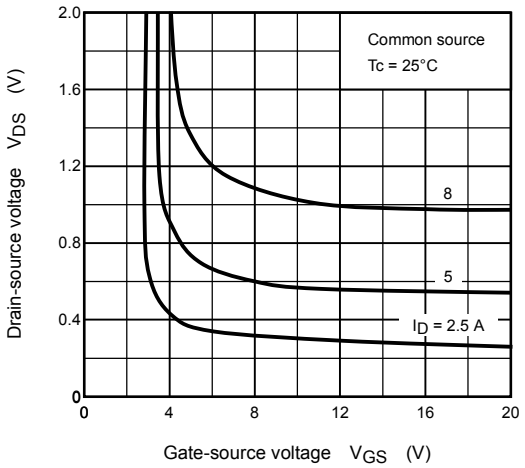
$I_D - V_{DS}$



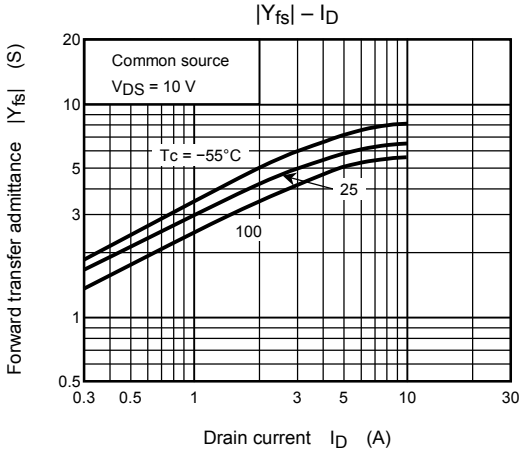
$I_D - V_{GS}$



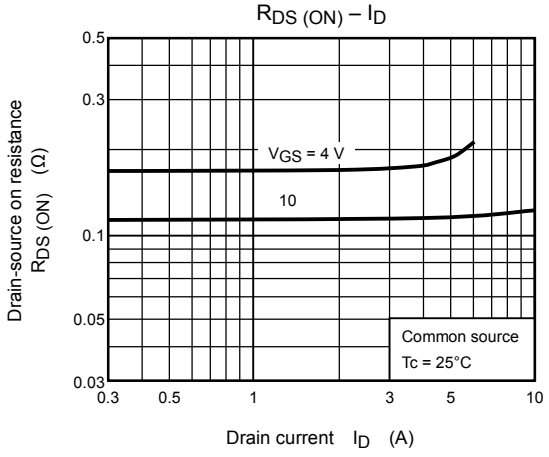
$V_{DS} - V_{GS}$



$|Y_{fs}| - I_D$

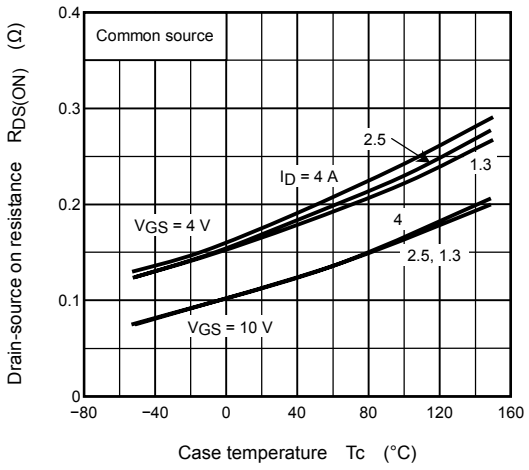


$R_{DS\ (ON)} - I_D$

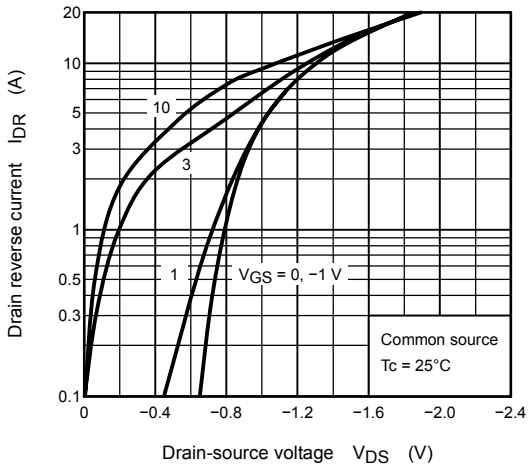


Nch MOS FET

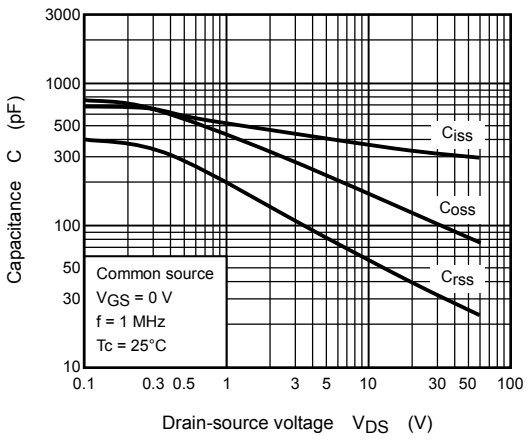
$R_{DS\ (ON)}$ – Tc



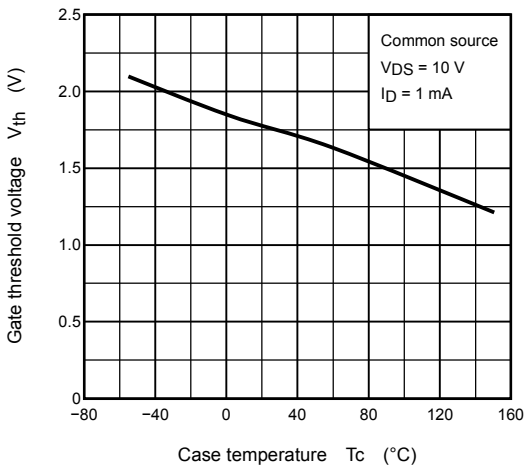
I_{DR} – V_{DS}



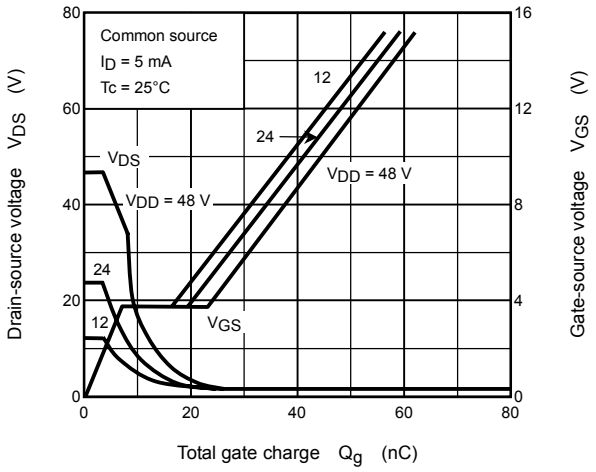
Capacitance – V_{DS}



V_{th} – Tc

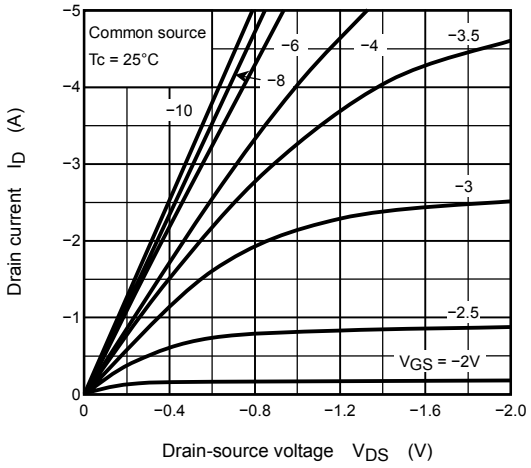


Dynamic Input/Output Characteristics

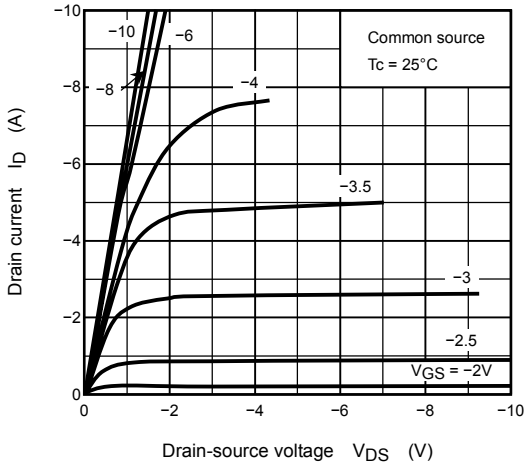


Pch MOS FET

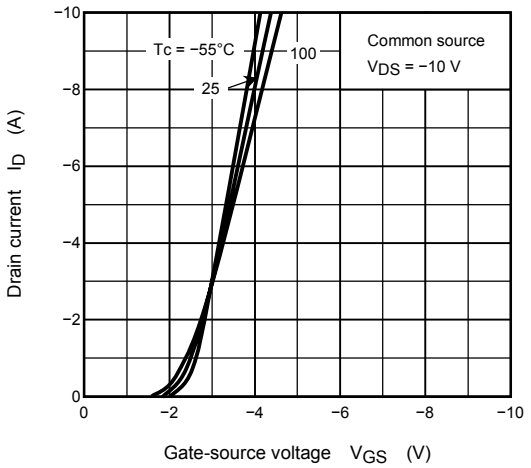
$I_D - V_{DS}$



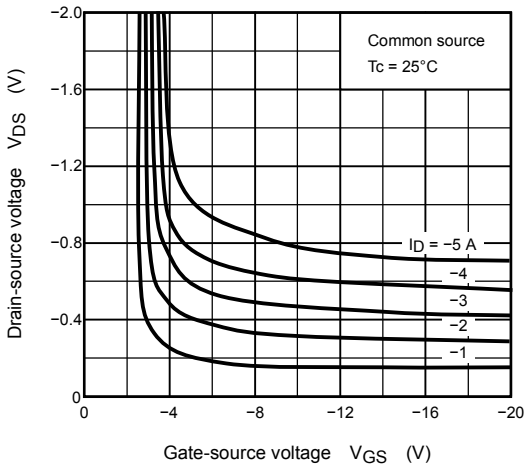
$I_D - V_{DS}$



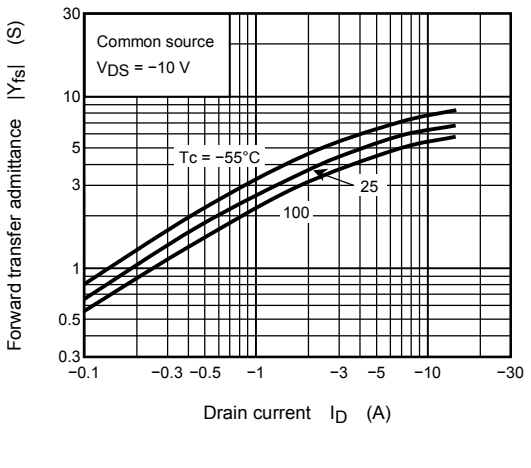
$I_D - V_{GS}$



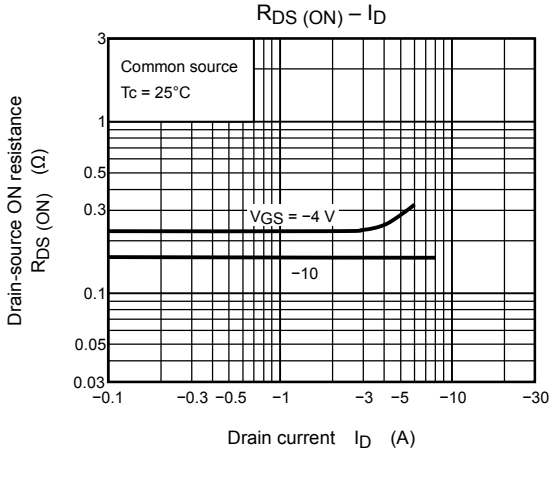
$V_{DS} - V_{GS}$



$|Y_{fs}| - I_D$

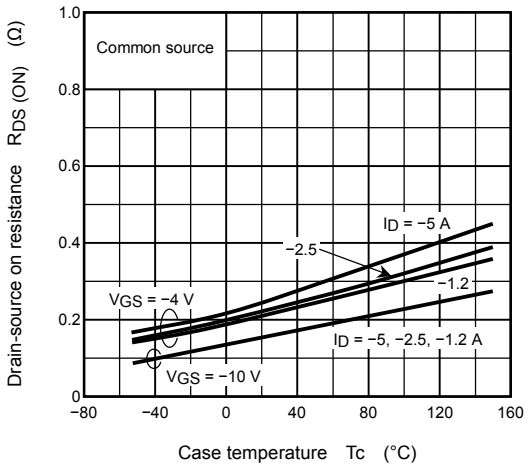


$R_{DS\ (ON)} - I_D$

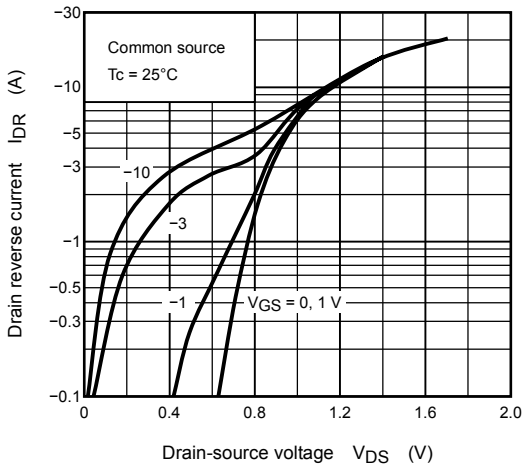


Pch MOS FET

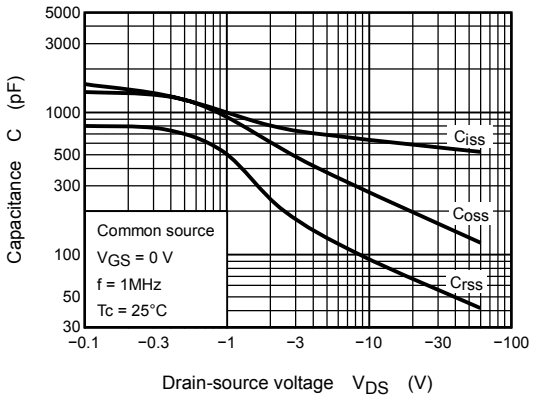
$R_{DS\ (ON)}$ – Tc



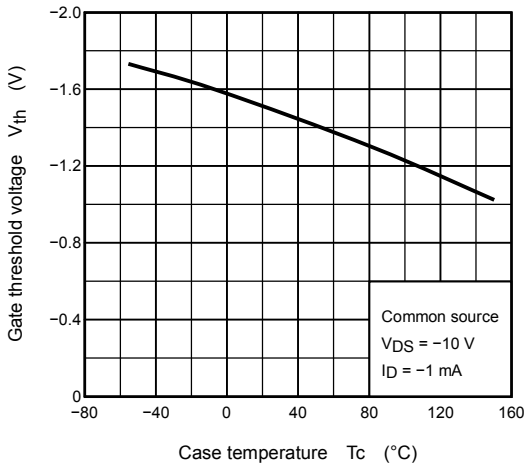
I_{DR} – V_{DS}



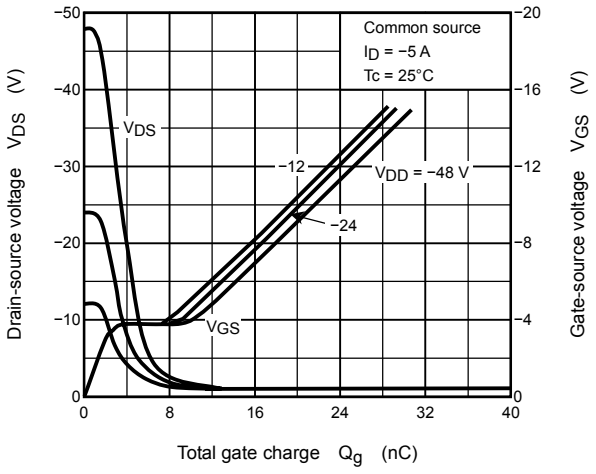
Capacitance – V_{DS}



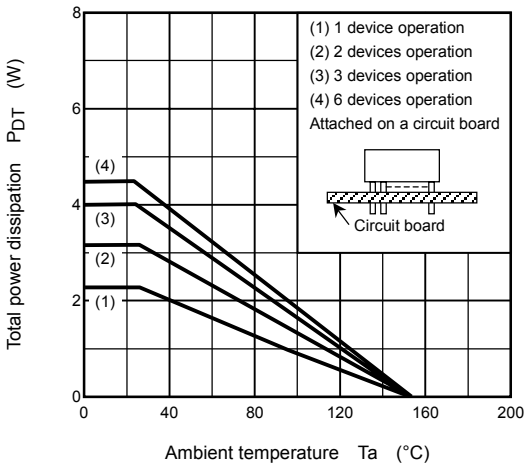
V_{th} – Tc



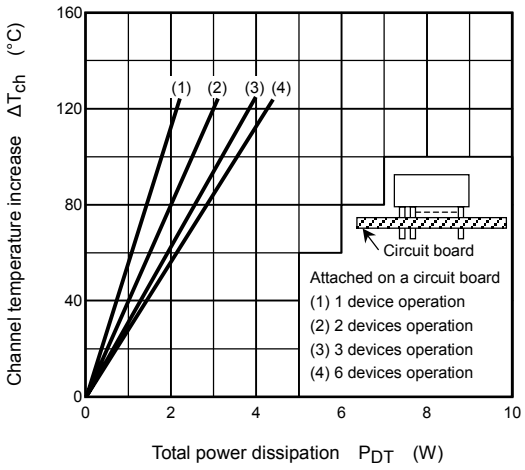
Dynamic Input/Output Characteristics



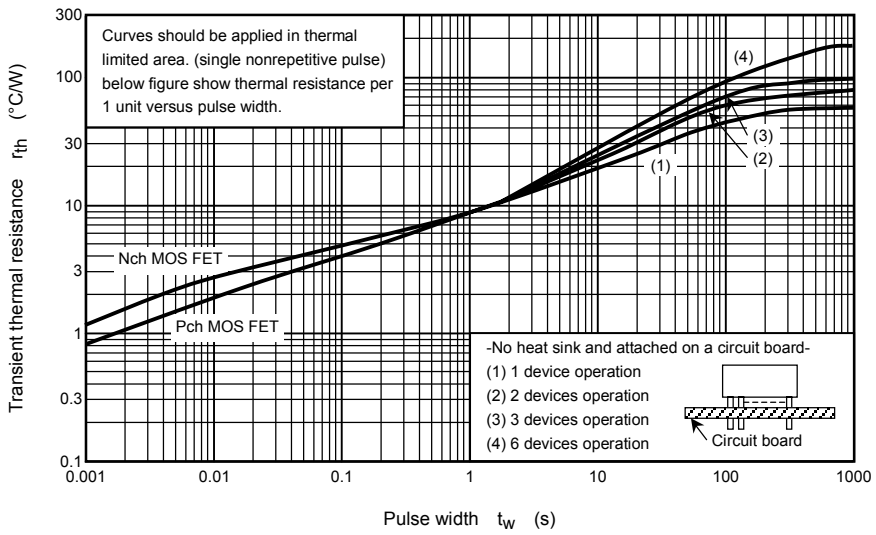
P_{DT} – Ta



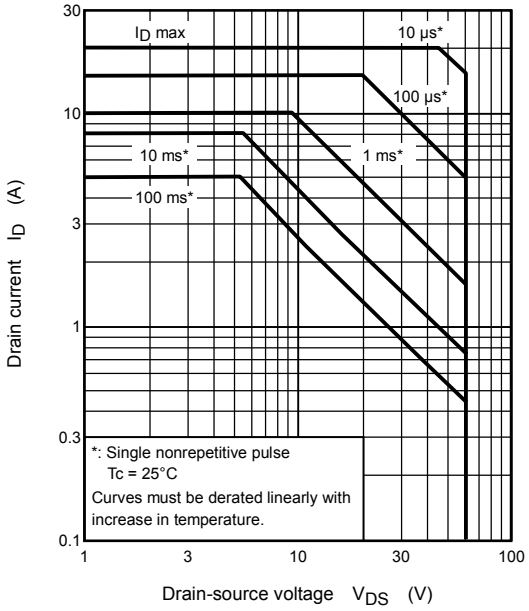
ΔT_{ch} – P_{DT}



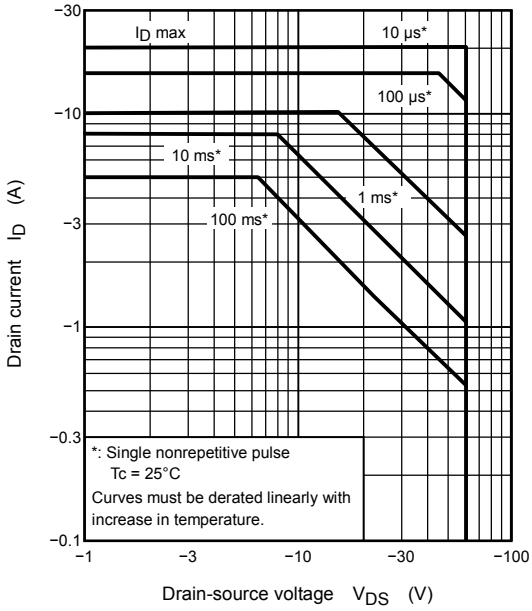
r_{th} – t_w



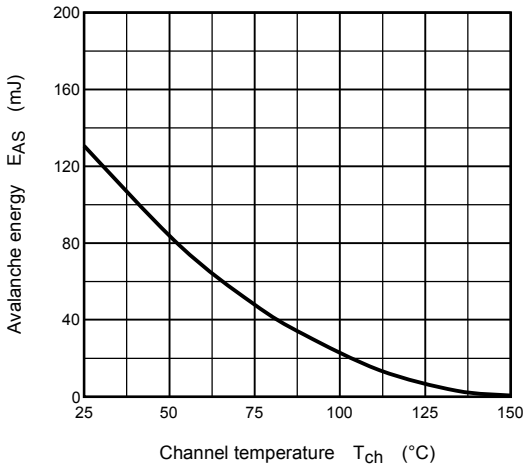
Safe Operating Area
(be applicable to Nch MOS FET)



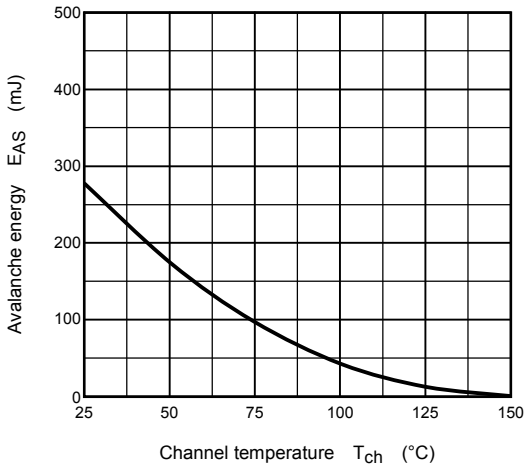
Safe Operating Area
(be applicable to Pch MOS FET)

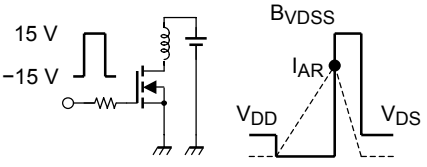


$E_{AS} - T_{ch}$
(be applicable to Nch MOS FET)



$E_{AS} - T_{ch}$
(be applicable to Pch MOS FET)

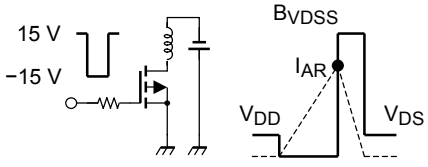




TEST CIRCUIT TEST WAVE FORM

Peak I_{AR} = 5 A, R_G = 25 Ω
V_{DD} = 25 V, L = 7 mH

$$E_{AS} = \frac{1}{2} \cdot L \cdot I^2 \cdot \left(\frac{B_{VDSS}}{B_{VDSS} - V_{DD}} \right)$$



TEST CIRCUIT TEST WAVE FORM

Peak I_{AR} = −5 A, R_G = 25 Ω
V_{DD} = −25 V, L = 14.84 mH

$$E_{AS} = \frac{1}{2} \cdot L \cdot I^2 \cdot \left(\frac{B_{VDSS}}{B_{VDSS} - V_{DD}} \right)$$

RESTRICTIONS ON PRODUCT USE

000707EAA

- TOSHIBA is continually working to improve the quality and reliability of its products. Nevertheless, semiconductor devices in general can malfunction or fail due to their inherent electrical sensitivity and vulnerability to physical stress. It is the responsibility of the buyer, when utilizing TOSHIBA products, to comply with the standards of safety in making a safe design for the entire system, and to avoid situations in which a malfunction or failure of such TOSHIBA products could cause loss of human life, bodily injury or damage to property.
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