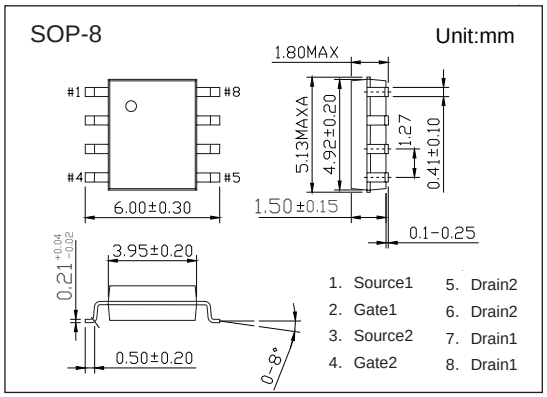
Silicon P,N Channel MOSFET

2NP04

■ Features

- Low drain-source ON-resistance:
  - P Channel $R_{DS(ON)}$ = 38mΩ (typ.)(V_{GS}=-10V)
  - N Channel $R_{DS(ON)}$ = 38mΩ(typ.)(V_{GS}=10V)
- High forward transfer admittance:
  - P Channel |Yfs| = 7.3S (typ.)
  - N Channel |Yfs| = 8S (typ.)
- Low leakage current:
  - P Channel I_{DSS} = -10μA(max)(V_{DS}=-30V)
  - N Channel I_{DSS} = 10μA(max)(V_{DS}=30V)
- Enhancement mode:
  - P Channel V_{th} = -0.8 to -2.0 V (V_{DS} = -10V, I_D = -1mA)
  - N Channel V_{th} = 1.3 to 2.5 V (V_{DS} = 10V, I_D = 1mA)

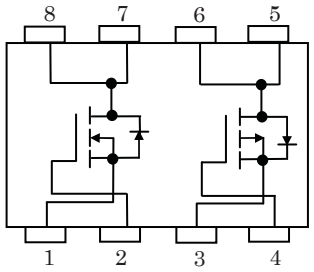


■ Absolute Maximum Ratings Ta = 25℃

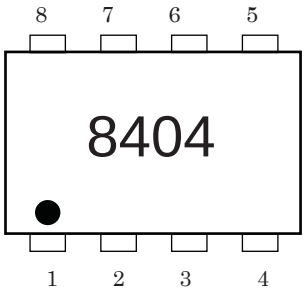
Characteristics		Symbol	Rating		Unit
Drain-source voltage		V_{DSS}	−30	30	V
Drain-gate voltage (R_{GS} = 20 k)		V_{DGR}	−30	30	V
Gate-source voltage		V_{GSS}	±20	±20	V
Drain current	DC (Note 1)	I_D	−4	4	A
	Pulse (Note 1)	I_{DP}	−16	16	
Drain power dissipation (t = 5 s) (Note 2a)	Single-device operation (Note 3a)	$P_{D\ (1)}$	1.48	1.48	W
	Single-device value at dual operation (Note 3b)	$P_{D\ (2)}$	1.23	1.23	
Drain power dissipation (t = 5 s) (Note 2b)	Single-device operation (Note 3a)	$P_{D\ (1)}$	0.58	0.58	
	Single-device value at dual operation (Note 3b)	$P_{D\ (2)}$	0.36	0.36	
Single pulse avalanche energy (Note 4)		E_{AS}	2.6	2.6	mJ
Avalanche current		I_{AR}	−2	2	A
Repetitive avalanche energy Single-device value at dual operation (Note 2a, 3b, 5)		E_{AR}	0.009		mJ
Channel temperature		T_{ch}	150		°C
Storage temperature range		T_{stg}	−55 to 150		°C

Note: For Notes 1 to 5, refer to the next page.

Circuit Configuration



Marking (Note 6)



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■ Thermal Characteristics

Characteristics		Symbol	Max	Unit
Thermal resistance, channel to ambient (t = 5 s) (Note 2a)	Single-device operation (Note 3a)	$R_{th\ (ch\text{-}a)\ (1)}$	84.5	°C/W
	Single-device value at dual operation (Note 3b)	$R_{th\ (ch\text{-}a)\ (2)}$	101.6	
Thermal resistance, channel to ambient (t = 5 s) (Note 2b)	Single-device operation (Note 3a)	$R_{th\ (ch\text{-}a)\ (1)}$	215.5	°C/W
	Single-device value at dual operation (Note 3b)	$R_{th\ (ch\text{-}a)\ (2)}$	347.2	

Note 1: The channel temperature should not exceed 150°C during use.

Note 2: (a) Device mounted on a glass-epoxy board (a) (b) Device mounted on a glass-epoxy board (b)

Note 3: a) The power dissipation and thermal resistance values shown are for a single device. (During single-device operation, power is only applied to one device.)

b) The power dissipation and thermal resistance values shown are for a single device. (During dual operation, power is evenly applied to both devices.)

Note 4: P Channel: V_{DD} = –24 V, T_{ch} = 25°C (initial), L = 0.5 mH, R_G = 25 , I_{AR} = –2 A
N Channel: V_{DD} = 24 V, T_{ch} = 25°C (initial), L = 0.5 mH, R_G = 25 , I_{AR} = 2 A

Note 5: Repetitive rating: pulse width limited by maximum channel temperature

Note 6: ● on the lower left of the marking indicates Pin 1.

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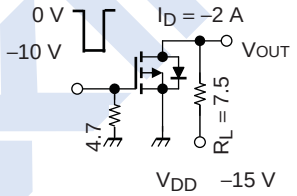
■ Electrical Characteristics Ta = 25℃(P-ch)

Characteristics		Symbol	Test Condition	Min	Typ.	Max	Unit
Gate leakage current		I_{GSS}	V_{GS} = ±20 V, V_{DS} = 0 V			±100	nA
Drain cut-off current		I_{DSS}	V_{DS} = –30 V, V_{GS} = 0 V			–10	μA
Drain-source breakdown voltage		$V_{(BR)\ DSS}$	I_D = –10 mA, V_{GS} = 0 V	–30			V
		$V_{(BR)\ DSX}$	I_D = –10 mA, V_{GS} = 20 V	–10			
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} = –4.5 V, I_D = –2.0 A			80	m
			V_{GS} = –10 V, I_D = –2.0 A			50	
Forward transfer admittance		$\|Y_{fs}\|$	V_{DS} = –10 V, I_D = –2.0 A	3.7			S
Input capacitance		C_{iss}	V_{DS} = –10 V, V_{GS} = 0 V, f = 1 MHz		510		pF
Reverse transfer capacitance		C_{rss}			110		
Output capacitance		C_{oss}			170		
Switching time	Rise time	t_r			11		ns
	Turn-on time	t_{on}			20		
	Fall time	t_f			37		
	Turn-off time	t_{off}	Duty 1%, t_w = 10 μs		99		
Total gate charge (gate-source plus gate-drain)		Q_g	V_{DD} –24 V, V_{GS} = –10 V, I_D = –4 A		13		nC
Gate-source charge 1		Q_{gs1}			1.7		
Gate-drain (“miller”) charge		Q_{gd}			4.6		

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

Characteristics		Symbol	Test Condition	Min	Typ.	Max	Unit
Drain reverse current	Pulse (Note 1)	I_{DRP}				–16	A
Forward voltage (diode)		V_{DSF}	I_{DR} = –4 A, V_{GS} = 0 V			1.2	V

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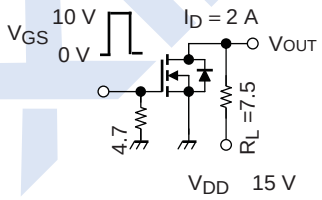
■ Electrical Characteristics Ta = 25℃(N-ch)

Characteristics		Symbol	Test Condition	Min	Typ.	Max	Unit
Gate leakage current		I_{GSS}	V_{GS} = ±20 V, V_{DS} = 0 V			±100	nA
Drain cut-off current		I_{DSS}	V_{DS} = 30 V, V_{GS} = 0 V			10	μA
Drain-source breakdown voltage		$V_{(BR)\ DSS}$	I_D = 10 mA, V_{GS} = 0 V	30			V
		$V_{(BR)\ DSX}$	I_D = 10 mA, V_{GS} = –20 V	10			
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} = 4.5 V, I_D = 2 A			80	m
			V_{GS} = 10 V, I_D = 2 A			50	
Forward transfer admittance		$\|Y_{fs}\|$	V_{DS} = 10 V, I_D = 2 A	4			S
Input capacitance		C_{iss}	V_{DS} = 10 V, V_{GS} = 0 V, f = 1 MHz		190		pF
Reverse transfer capacitance		C_{rss}			45		
Output capacitance		C_{oss}			60		
Switching time	Rise time	t_r	 Duty 1%, t_W = 10 μs		4.5		ns
	Turn-on time	t_{on}			9.0		
	Fall time	t_f			3.0		
	Turn-off time	t_{off}			12		
Total gate charge (gate-source plus gate-drain)		Q_g	V_{DD} 24 V, V_{GS} = 10 V, I_D = 4 A		4.6		nC
Gate-source charge 1		Q_{gs1}			0.7		
Gate-drain (“miller”) charge		Q_{gd}			1.4		

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

Characteristics		Symbol	Test Condition	Min	Typ.	Max	Unit
Drain reverse current	Pulse (Note 1)	I_{DRP}				16	A
Forward voltage (diode)		V_{DSF}	I_{DR} = 4 A, V_{GS} = 0 V			–1.2	V

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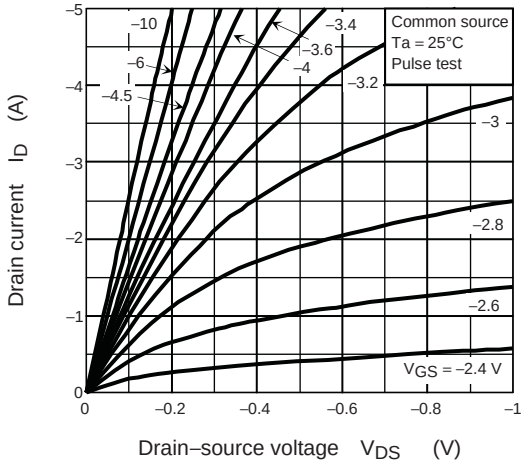
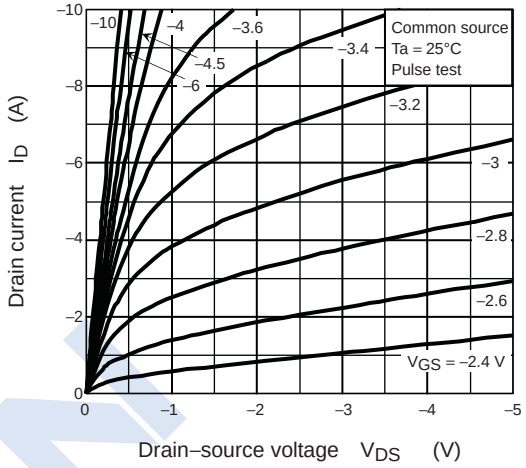
■ Typical Characterisitics (P-ch)

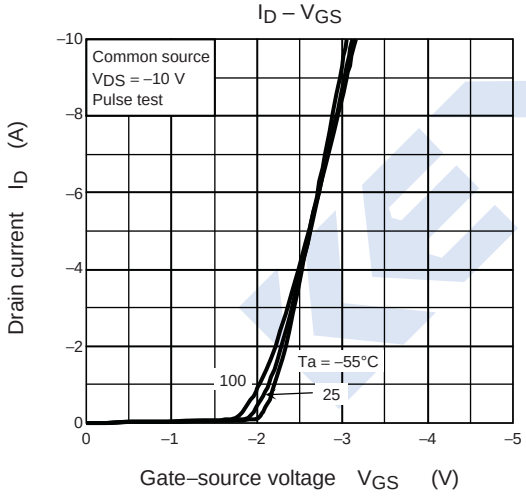
$I_D - V_{DS}$



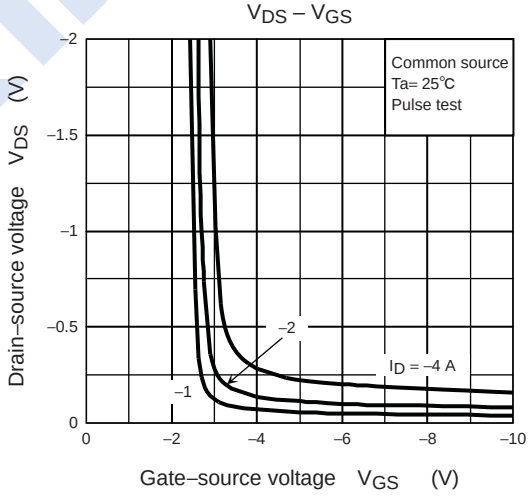
$I_D - V_{DS}$



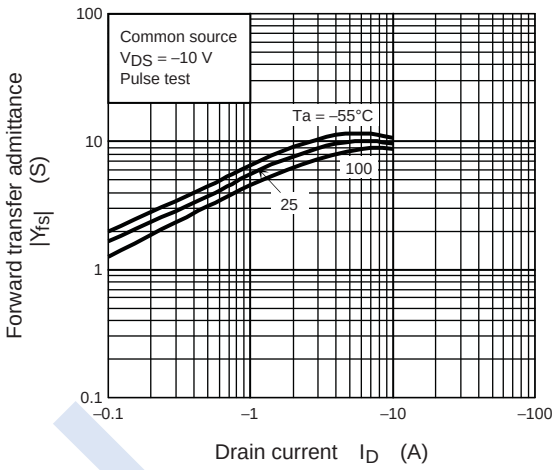
$I_D - V_{GS}$



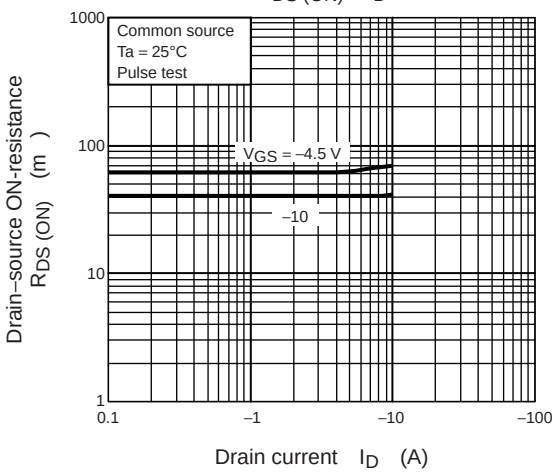
$V_{DS} - V_{GS}$



$|Y_{fs}| - I_D$



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



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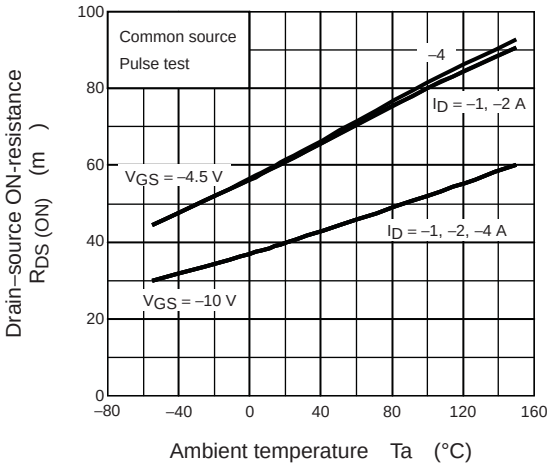
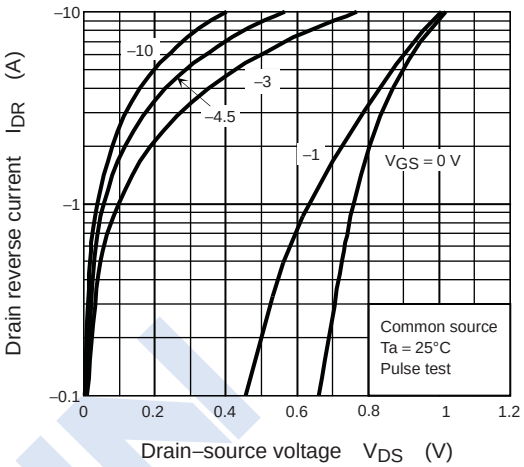
■ Typical Characterisitics (P-ch)

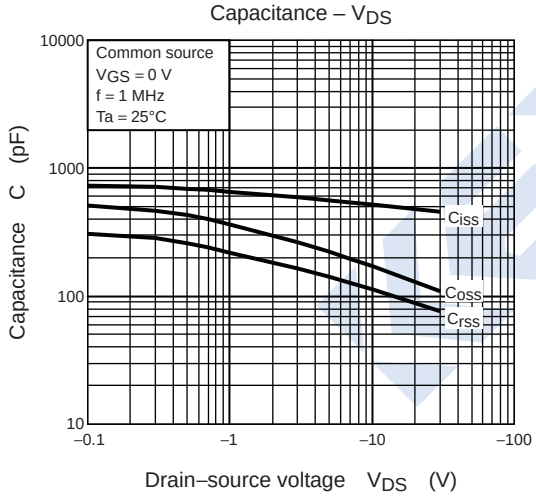
$R_{DS\ (ON)}$ – Ta



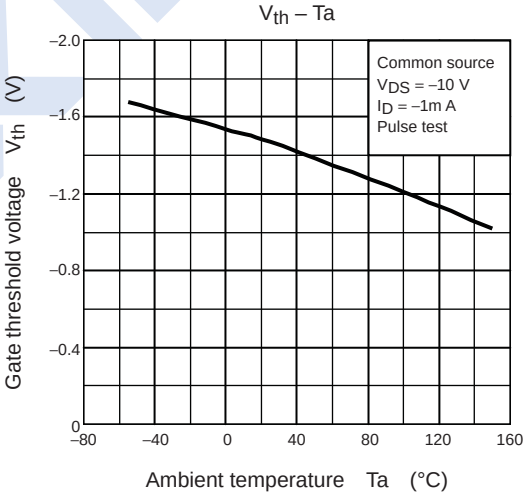
I_{DR} – V_{DS}



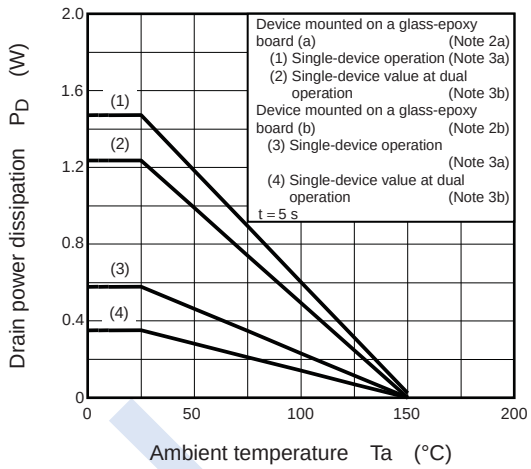
Capacitance – V_{DS}



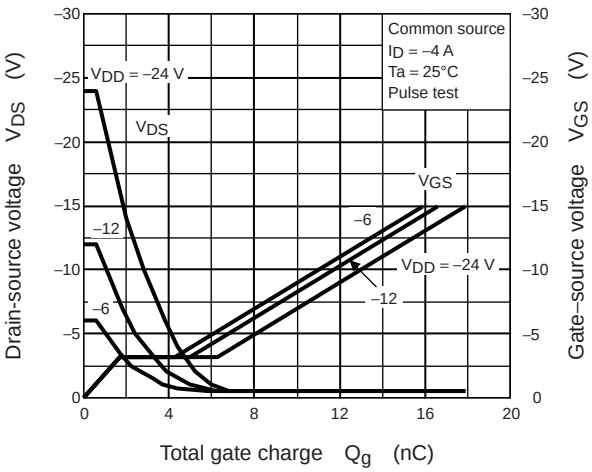
V_{th} – Ta



P_D – Ta



Dynamic input/output characteristics



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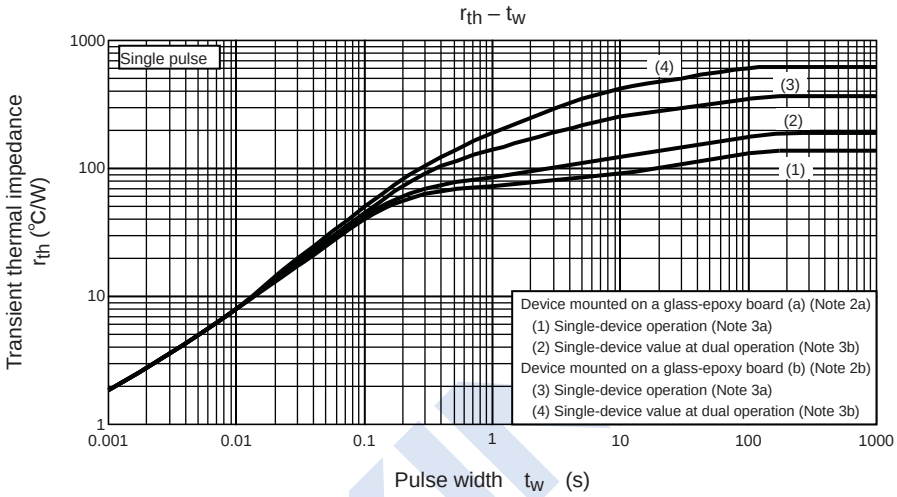
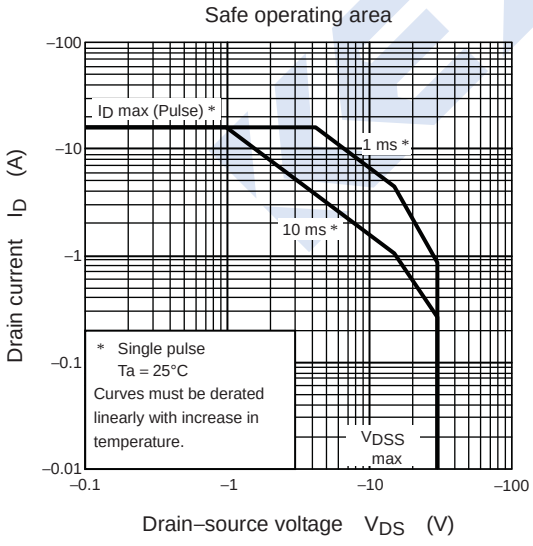
■ Typical Characterisitics (P-ch)





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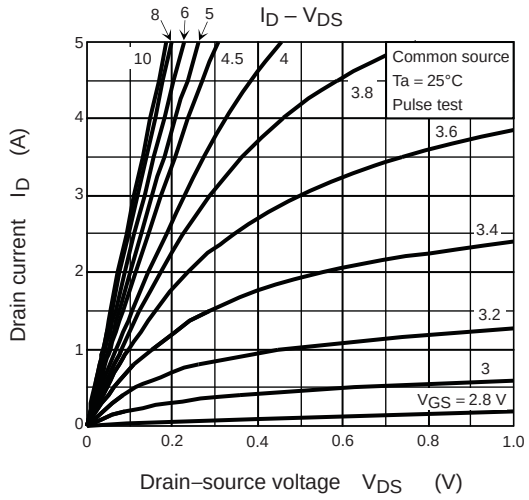
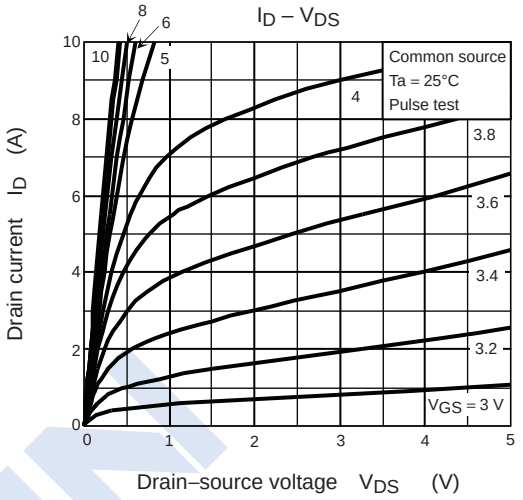
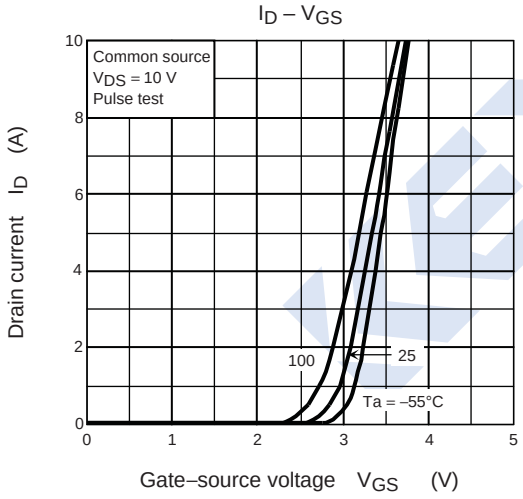
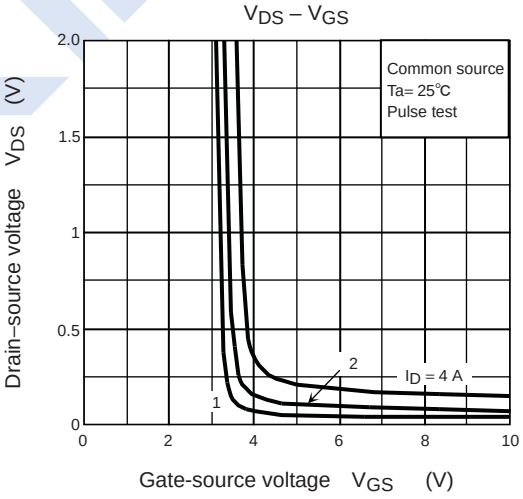
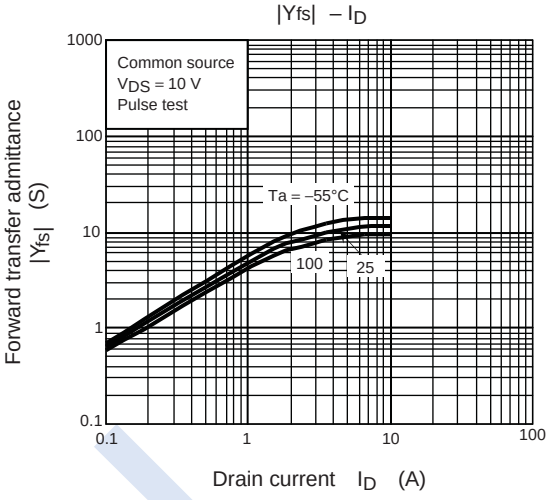
■ Typical Characterisitics (N-ch)

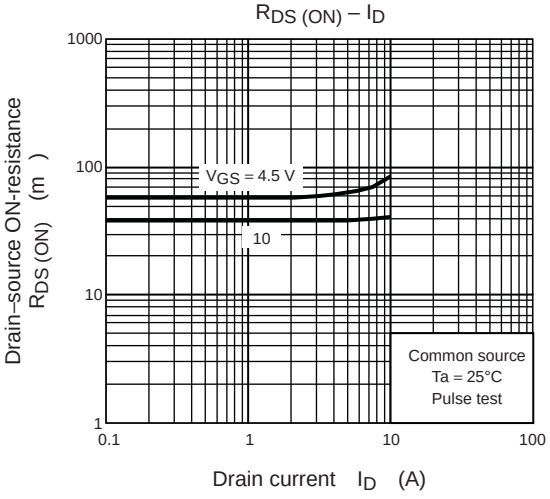












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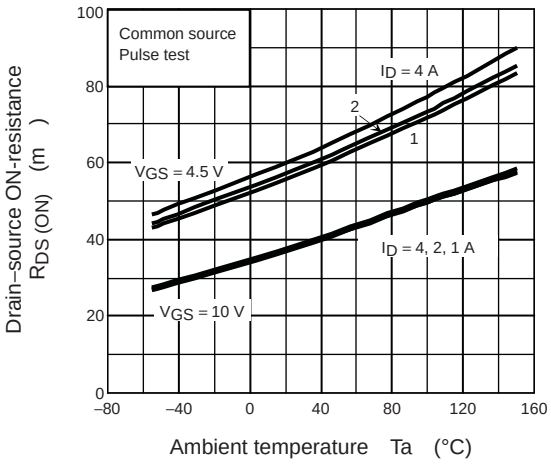
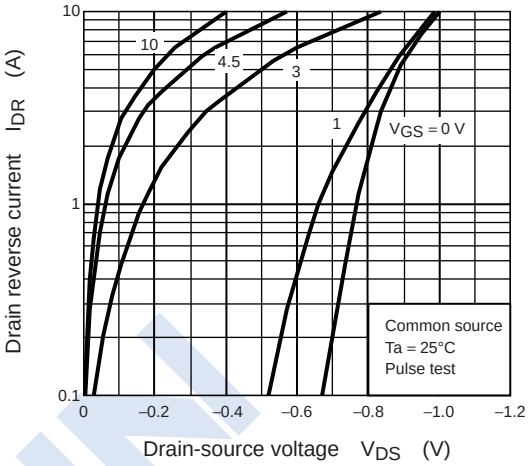
■ Typical Characterisitics (N-ch)

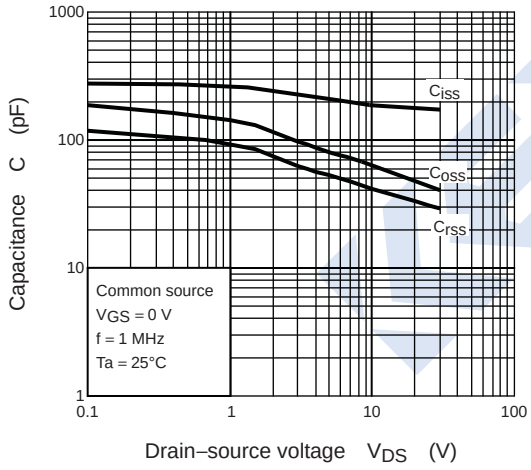
$R_{DS\ (ON)}$ – Ta



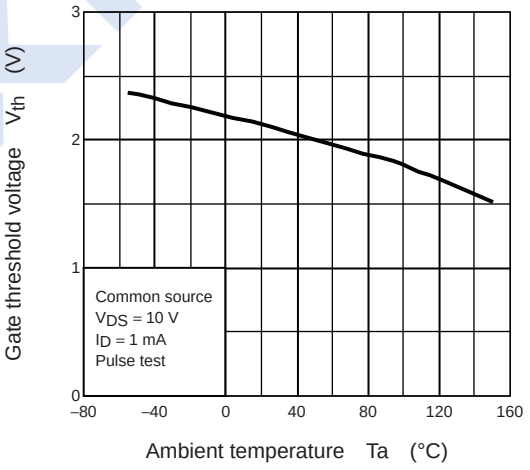
I_{DR} – V_{DS}



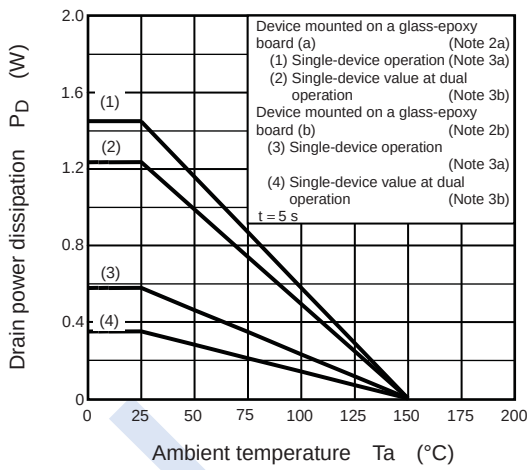
Capacitance – V_{DS}



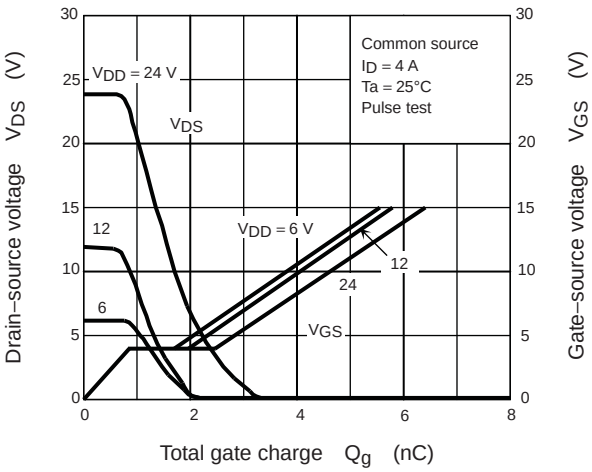
V_{th} – Ta



P_D – Ta



Dynamic input/output characteristics



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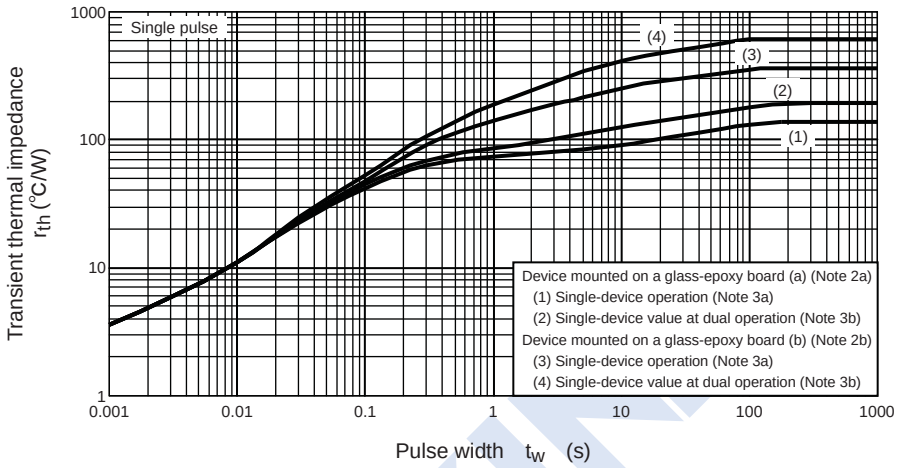
■ Typical Characterisitics (N-ch)

$r_{th} - t_w$



Safe operating area