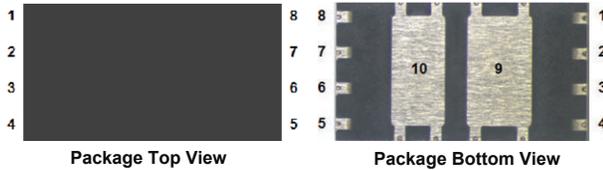


# Automotive 40 V N- and P-Channel Common Drain MOSFET Pair and 200 V N-Channel MOSFET

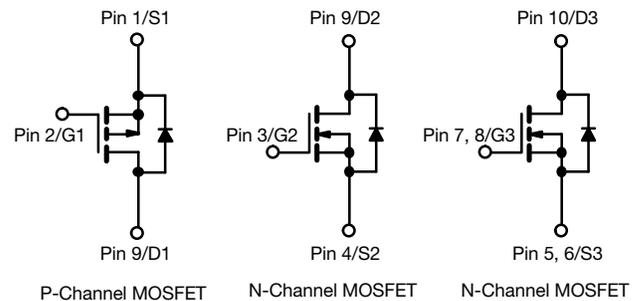


## FEATURES

- Optimized triple die package
- TrenchFET® power MOSFET
- 100 %  $R_g$  and UIS tested
- AEC-Q101 qualified
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)



PRODUCT SUMMARY			
	N-CH 2	P-CH 1	N-CH 3
$V_{DS}$ (V)	40	-40	200
$R_{DS(on)}$ ( $\Omega$ ) at $V_{GS} = 10$ V	0.0092	0.030	0.075
$R_{DS(on)}$ ( $\Omega$ ) at $V_{GS} = 4.5$ V	0.0135	0.048	-
$I_D$ (A)	30	-30	16
$Q_g$ typ. (nC)	25.5	30.2	11
Configuration	N- and p-pair		
Package	Triple die		



ABSOLUTE MAXIMUM RATINGS ( $T_A = 25$ °C, unless otherwise noted)						
PARAMETER	SYMBOL	N-CH 2	P-CH 1	N-CH 3	UNIT	
Drain-source voltage	$V_{DS}$	40	-40	200	V	
Gate-source voltage	$V_{GS}$	20	20	20		
Continuous drain current ( $T_J = 175$ °C)	$I_D$	$T_C = 25$ °C	30	-30	16	A
		$T_C = 125$ °C	30	-30	9.1	
Pulsed drain current ( $t = 300$ $\mu$ s)	$I_{DM}$	120	-120	50		
Continuous source drain current	$I_S$	$T_C = 25$ °C	30	-30	16	
		$T_C = 125$ °C	30	-30	10	
Single pulse avalanche current	$I_{AS}$	26.5	-25	16		
Single pulse avalanche energy	$E_{AS}$	35	31	12.8	mJ	
Maximum power dissipation	$P_D$	$T_C = 25$ °C	48	48	50	W
		$T_C = 125$ °C	16	16	16	
Operating junction and storage temperature range	$T_J, T_{stg}$	-55 to +175			°C	

THERMAL RESISTANCE RATINGS					
PARAMETER	SYMBOL	N-CH 2	P-CH 1	N-CH 3	UNIT
Junction-to-case (drain)	$R_{thJC}$	2.6	2.6	3.0	°C/W

### Notes

- Package limited,  $T_C = 25$  °C
- Surface mounted on 1" x 1" FR4 board
- $t = 10$  s
- See solder profile ([www.vishay.com/doc?73257](http://www.vishay.com/doc?73257)). The end of the lead terminal is exposed copper (not plated) as a result of the singulation process in manufacturing
- Rework conditions: manual soldering with a soldering iron is not recommended for leadless components



<b>SPECIFICATIONS</b> ( $T_J = 25\text{ }^\circ\text{C}$ , unless otherwise noted)							
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNIT	
<b>Static</b>							
Drain-source breakdown voltage	$V_{DS}$	$V_{GS} = 0\text{ V}, I_D = 250\text{ }\mu\text{A}$	N-Ch 2	40	-	-	V
		$V_{GS} = 0\text{ V}, I_D = -250\text{ }\mu\text{A}$	P-Ch 1	-40	-	-	
		$V_{GS} = 0\text{ V}, I_D = 250\text{ }\mu\text{A}$	N-Ch 3	200	-	-	
Gate-source threshold voltage	$V_{GS(th)}$	$V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$	N-Ch 2	1.5	2.0	2.5	V
		$V_{DS} = V_{GS}, I_D = -250\text{ }\mu\text{A}$	P-Ch 1	1.5	2.0	2.5	
		$V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$	N-Ch 3	2.5	3.0	3.5	
Gate-source leakage	$I_{GSS}$	$V_{DS} = 0\text{ V}, V_{GS} = \pm 20\text{ V}$	N-Ch 2	-	-	$\pm 100$	nA
			P-Ch 1	-	-	$\pm 100$	
			N-Ch 3	-	-	$\pm 100$	
Zero gate voltage drain current	$I_{DSS}$	$V_{DS} = 40\text{ V}, V_{GS} = 0\text{ V}$	N-Ch 2	-	-	1	mA
		$V_{DS} = -40\text{ V}, V_{GS} = 0\text{ V}$	P-Ch 1	-	-	-1	
		$V_{DS} = 200\text{ V}, V_{GS} = 0\text{ V}$	N-Ch 3	-	-	1	
		$V_{DS} = 40\text{ V}, V_{GS} = 0\text{ V}, T_J = 125\text{ }^\circ\text{C}$	N-Ch 2	-	-	50	
		$V_{DS} = -40\text{ V}, V_{GS} = 0\text{ V}, T_J = 125\text{ }^\circ\text{C}$	P-Ch 1	-	-	-50	
		$V_{DS} = 200\text{ V}, V_{GS} = 0\text{ V}, T_J = 125\text{ }^\circ\text{C}$	N-Ch 3	-	-	50	
On-state drain current <sup>a</sup>	$I_{D(on)}$	$V_{DS} \geq 5\text{ V}, V_{GS} = 10\text{ V}$	N-Ch 2	25	-	-	A
		$V_{DS} \leq 5\text{ V}, V_{GS} = -10\text{ V}$	P-Ch 1	-25	-	-	
		$V_{DS} \geq 5\text{ V}, V_{GS} = 10\text{ V}$	N-Ch 3	20	-	-	
Drain-source on-state resistance <sup>a</sup>	$R_{DS(on)}$	$V_{GS} = 10\text{ V}, I_D = 9.8\text{ A}$	N-Ch 2	-	0.0077	0.0092	$\Omega$
		$V_{GS} = -10\text{ V}, I_D = -6\text{ A}$	P-Ch 1	-	0.0220	0.0300	
		$V_{GS} = 10\text{ V}, I_D = 5\text{ A}$	N-Ch 3	-	0.0710	0.0750	
		$V_{GS} = 4.5\text{ V}, I_D = 8.9\text{ A}$	N-Ch 2	-	0.0940	0.0135	
		$V_{GS} = 4.5\text{ V}, I_D = -4.7\text{ A}$	P-Ch 1	-	0.0360	0.0480	
Forward transconductance <sup>a</sup>	$g_{fs}$	$V_{DS} = 15\text{ V}, I_D = 9.8\text{ A}$	N-Ch 2	-	65	-	S
		$V_{DS} = -15\text{ V}, I_D = 6\text{ A}$	P-Ch 1	-	16	-	
		$V_{DS} = 15\text{ V}, I_D = 19\text{ A}$	N-Ch 3	-	19	-	
<b>Dynamic <sup>b</sup></b>							
Input capacitance	$C_{iss}$	$V_{DS} = 20\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$	N-Ch 2	-	1474	-	pF
		$V_{DS} = -20\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$	P-Ch 1	-	1302	-	
		$V_{DS} = 100\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$	N-Ch 3	-	600	-	
Output capacitance	$C_{oss}$	$V_{DS} = 20\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$	N-Ch 2	-	218	-	pF
		$V_{DS} = -20\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$	P-Ch 1	-	222	-	
		$V_{DS} = 100\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$	N-Ch 3	-	70	-	
Reverse transfer capacitance	$C_{rss}$	$V_{DS} = 20\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$	N-Ch 2	-	89	-	pF
		$V_{DS} = -20\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$	P-Ch 1	-	154	-	
		$V_{DS} = 100\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$	N-Ch 3	-	5	-	
Total gate charge	$Q_g$	$V_{DS} = 20\text{ V}, V_{GS} = 10\text{ V}, I_D = 10\text{ A}$	N-Ch 2	-	23	-	nC
		$V_{DS} = -20\text{ V}, V_{GS} = -10\text{ V}, I_D = -10\text{ A}$	P-Ch 1	-	30.2	-	
		$V_{DS} = 100\text{ V}, V_{GS} = 10\text{ V}, I_D = 10\text{ A}$	N-Ch 3	-	11	-	
Gate-source charge	$Q_{gs}$	$V_{DS} = 20\text{ V}, V_{GS} = 10\text{ V}, I_D = 10\text{ A}$	N-Ch 2	-	4.4	-	nC
		$V_{DS} = -20\text{ V}, V_{GS} = -10\text{ V}, I_D = -10\text{ A}$	P-Ch 1	-	4.1	-	
		$V_{DS} = 100\text{ V}, V_{GS} = 10\text{ V}, I_D = 10\text{ A}$	N-Ch 3	-	3.2	-	
Gate-drain charge	$Q_{gd}$	$V_{DS} = 20\text{ V}, V_{GS} = 10\text{ V}, I_D = 10\text{ A}$	N-Ch 2	-	4.3	-	nC
		$V_{DS} = -20\text{ V}, V_{GS} = -10\text{ V}, I_D = -10\text{ A}$	P-Ch 1	-	7.4	-	
		$V_{DS} = 100\text{ V}, V_{GS} = 10\text{ V}, I_D = 10\text{ A}$	N-Ch 3	-	3	-	
Gate resistance	$R_g$	$f = 1\text{ MHz}$	N-Ch 2	-	-	2.1	$\Omega$
			P-Ch 1	-	-	9.5	
			N-Ch 3	-	-	2.4	



<b>SPECIFICATIONS</b> ( $T_J = 25\text{ }^\circ\text{C}$ , unless otherwise noted)							
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNIT	
<b>Dynamic <sup>b</sup></b>							
Turn-on delay time	$t_{d(on)}$	$V_{DD} = 20\text{ V}, R_L = 2\ \Omega,$ $I_D = 10\text{ A}, V_{GEN} = 10\text{ V}, R_g = 1\ \Omega$	N-Ch 2	-	8	-	ns
		$V_{DD} = -20\text{ V}, R_L = 2\ \Omega,$ $I_D = -10\text{ A}, V_{GEN} = -10\text{ V}, R_g = 1\ \Omega$	P-Ch 1	-	7	-	
		$V_{DD} = 100\text{ V}, R_L = 5.2\ \Omega,$ $I_D = 10\text{ A}, V_{GEN} = 10\text{ V}, R_g = 2.5\ \Omega$	N-Ch 3	-	9	-	
Rise time	$t_r$	$V_{DD} = 20\text{ V}, R_L = 2\ \Omega,$ $I_D = 10\text{ A}, V_{GEN} = 10\text{ V}, R_g = 1\ \Omega$	N-Ch 2	-	12	-	
		$V_{DD} = -20\text{ V}, R_L = 2\ \Omega,$ $I_D = -10\text{ A}, V_{GEN} = -10\text{ V}, R_g = 1\ \Omega$	P-Ch 1	-	9	-	
		$V_{DD} = 100\text{ V}, R_L = 5.2\ \Omega,$ $I_D = 10\text{ A}, V_{GEN} = 10\text{ V}, R_g = 2.5\ \Omega$	N-Ch 3	-	3	-	
Turn-off delay time	$t_{d(off)}$	$V_{DD} = 20\text{ V}, R_L = 2\ \Omega,$ $I_D = 10\text{ A}, V_{GEN} = 10\text{ V}, R_g = 1\ \Omega$	N-Ch 2	-	22	-	
		$V_{DD} = -20\text{ V}, R_L = 2\ \Omega,$ $I_D = -10\text{ A}, V_{GEN} = -10\text{ V}, R_g = 1\ \Omega$	P-Ch 1	-	43	-	
		$V_{DD} = 100\text{ V}, R_L = 5.2\ \Omega,$ $I_D = 10\text{ A}, V_{GEN} = 10\text{ V}, R_g = 2.5\ \Omega$	N-Ch 3	-	14	-	
Fall time	$t_f$	$V_{DD} = 20\text{ V}, R_L = 2\ \Omega,$ $I_D = 10\text{ A}, V_{GEN} = 10\text{ V}, R_g = 1\ \Omega$	N-Ch 2	-	10	-	
		$V_{DD} = -20\text{ V}, R_L = 2\ \Omega,$ $I_D = -10\text{ A}, V_{GEN} = -10\text{ V}, R_g = 1\ \Omega$	P-Ch 1	-	19	-	
		$V_{DD} = 100\text{ V}, R_L = 5.2\ \Omega,$ $I_D = 10\text{ A}, V_{GEN} = 10\text{ V}, R_g = 2.5\ \Omega$	N-Ch 3	-	2	-	
<b>Source-Drain Diode Ratings and Characteristics</b>							
Pulsed current	$I_{SM}$		N-Ch 2	-	-	120	A
			P-Ch 1	-	-	-120	
			N-Ch 3	-	-	50	
Forward voltage	$V_{SD}$	$I_S = 6.5\text{ A}, V_{GS} = 0\text{ V}$	N-Ch 2	-	0.79	-	V
		$I_S = -3.4\text{ A}, V_{GS} = 0\text{ V}$	P-Ch 1	-	-0.78	-	
		$I_S = 19\text{ A}, V_{GS} = 0\text{ V}$	N-Ch 3	-	0.9	-	

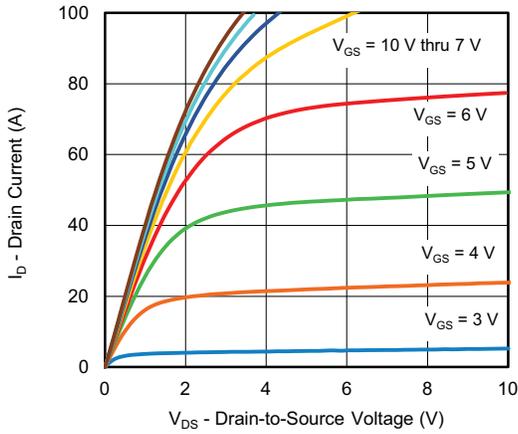
**Notes**

- a. Pulse test; pulse width  $\leq 300\ \mu\text{s}$ , duty cycle  $\leq 2\ \%$
- b. Guaranteed by design, not subject to production testing

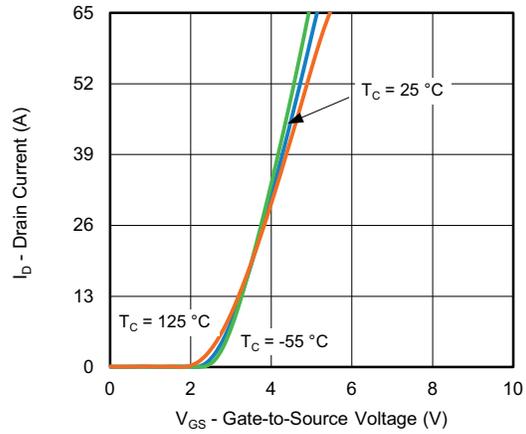
Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.



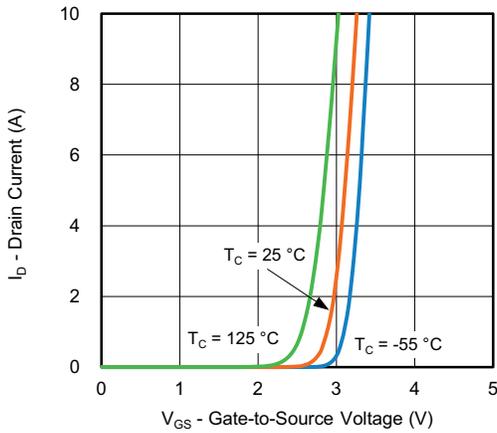
CHANNEL-1 TYPICAL CHARACTERISTICS (T<sub>A</sub> = 25 °C, unless otherwise noted)



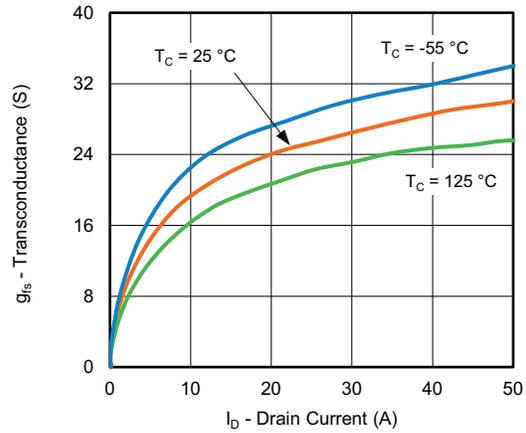
Output Characteristics



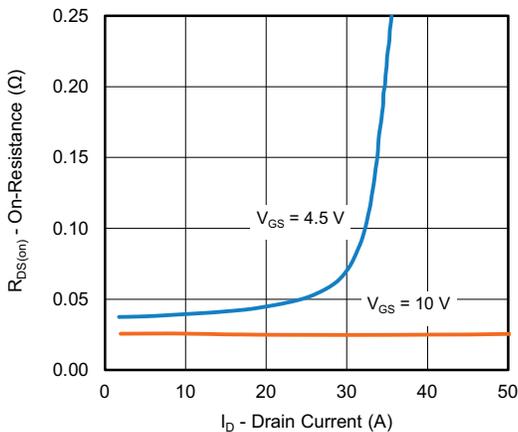
Transfer Characteristics



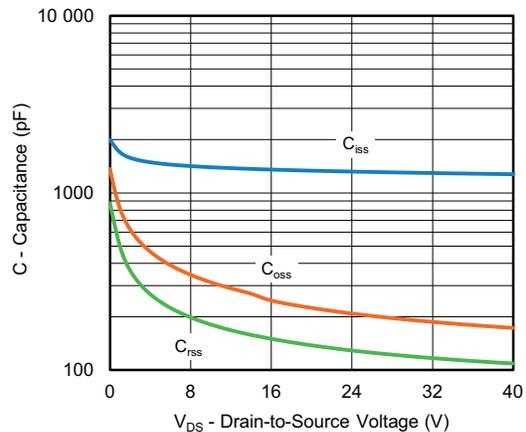
Transfer Characteristics



Transconductance



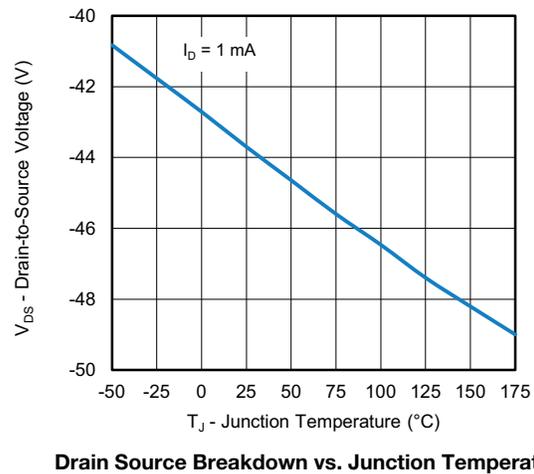
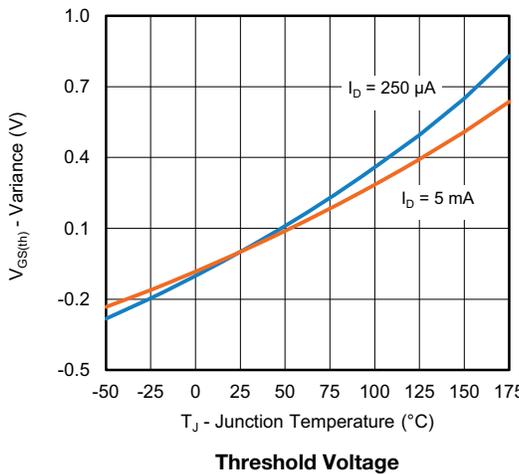
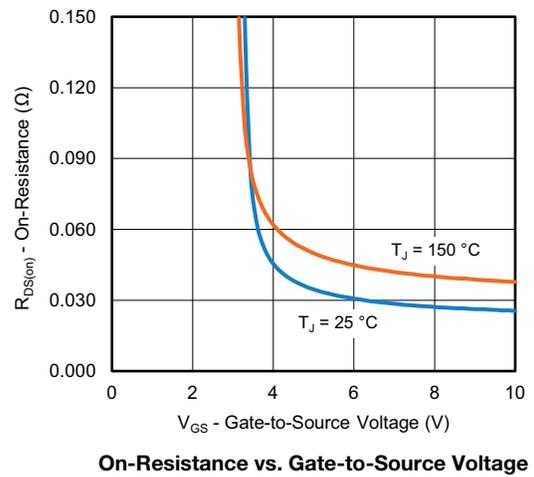
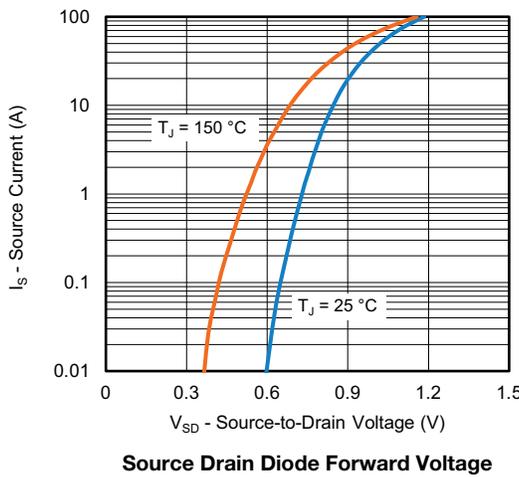
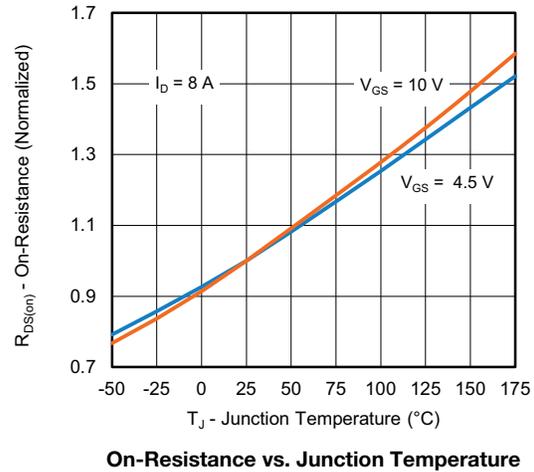
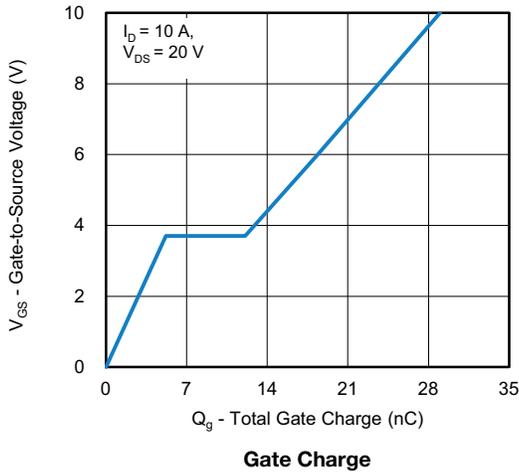
On-Resistance vs. Drain Current



Capacitance

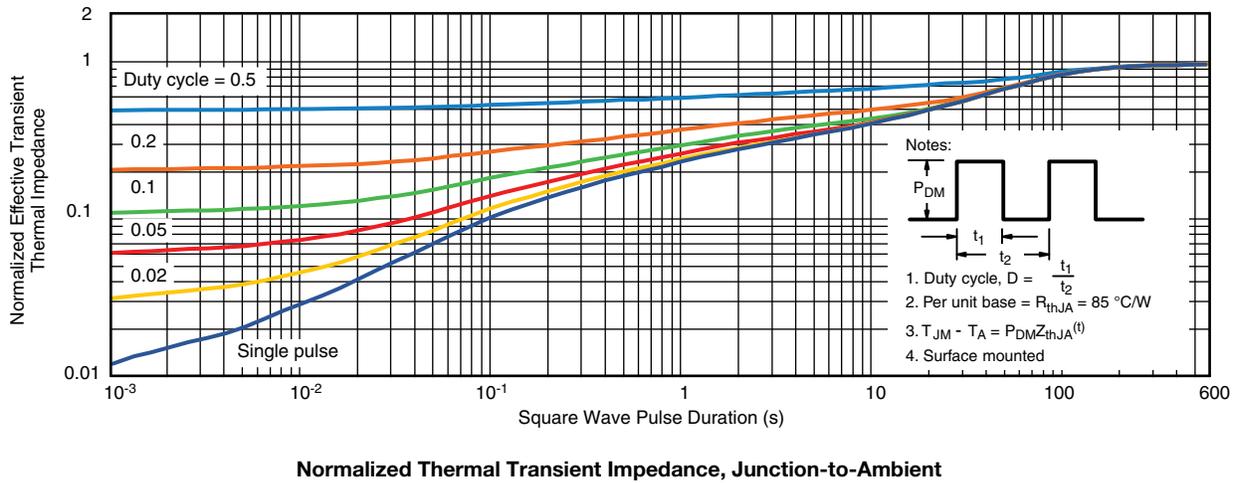
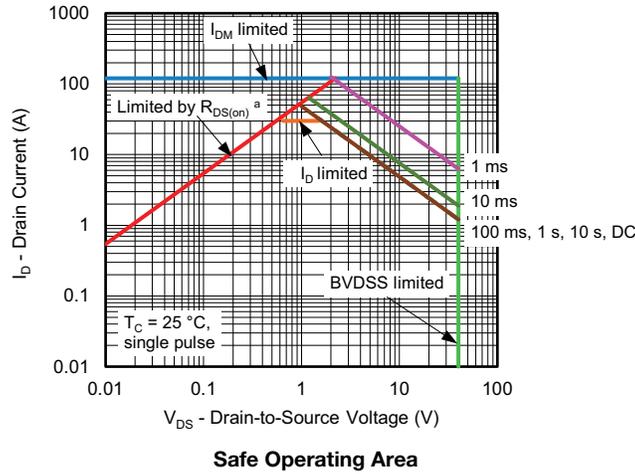


CHANNEL-1 TYPICAL CHARACTERISTICS (T<sub>A</sub> = 25 °C, unless otherwise noted)





**CHANNEL-1 TYPICAL CHARACTERISTICS** ( $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise noted)

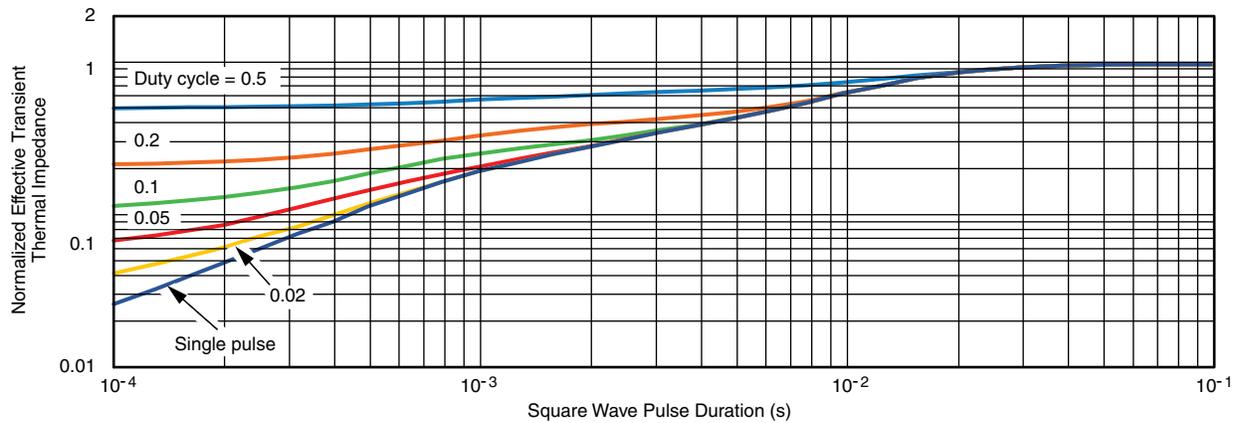


**Note**

a.  $V_{GS} >$  minimum  $V_{GS}$  at which  $R_{DS(on)}$  is specified



**CHANNEL-1 TYPICAL CHARACTERISTICS** ( $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise noted)



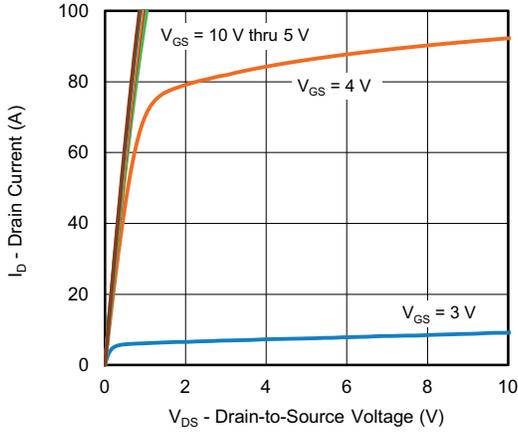
**Normalized Thermal Transient Impedance, Junction-to-Case**

**Note**

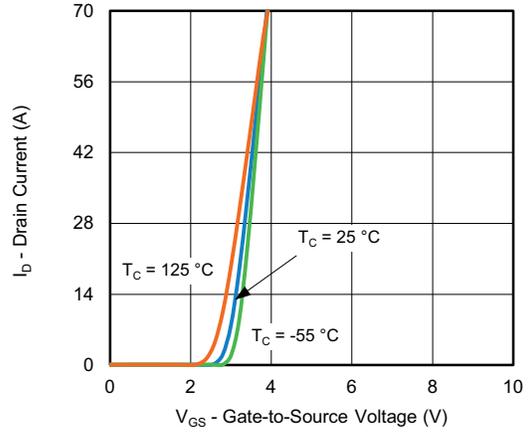
- The characteristics shown in the two graphs
  - Normalized Transient Thermal Impedance Junction-to-Ambient (25 °C)
  - Normalized Transient Thermal Impedance Junction-to-Case (25 °C)are given for general guidelines only to enable the user to get a “ball park” indication of part capabilities. The data are extracted from single pulse transient thermal impedance characteristics which are developed from empirical measurements. The latter is valid for the part mounted on printed circuit board - FR4, size 1" x 1" x 0.062", double sided with 2 oz. copper, 100 % on both sides. The part capabilities can widely vary depending on actual application parameters and operating conditions



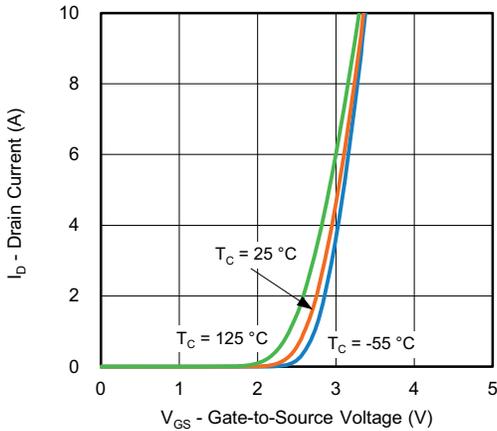
**CHANNEL-2 TYPICAL CHARACTERISTICS** ( $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise noted)



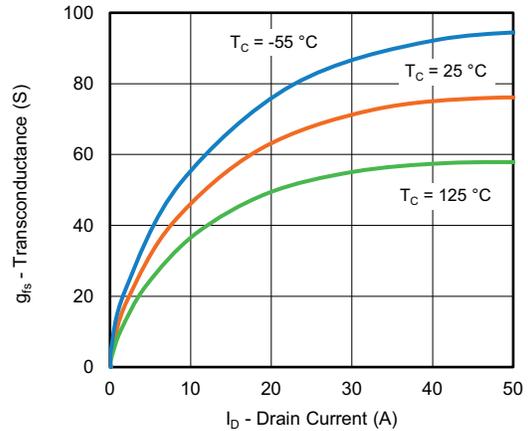
**Output Characteristics**



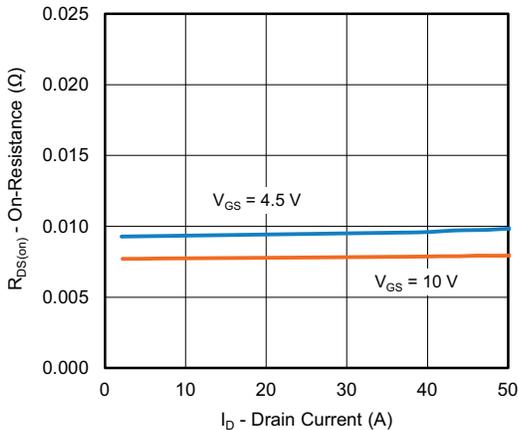
**Transfer Characteristics**



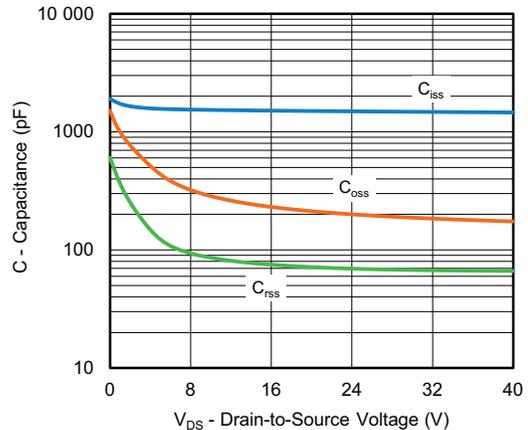
**Transfer Characteristics**



**Transconductance**



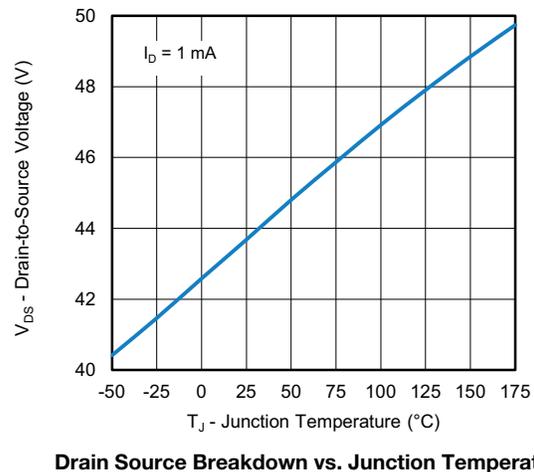
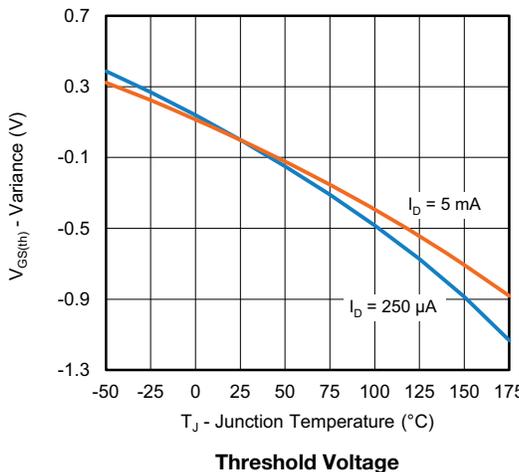
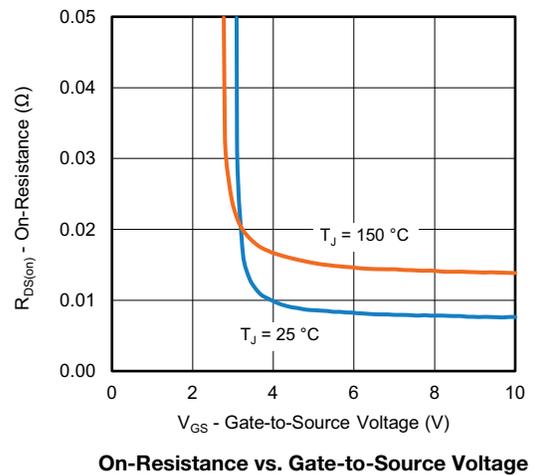
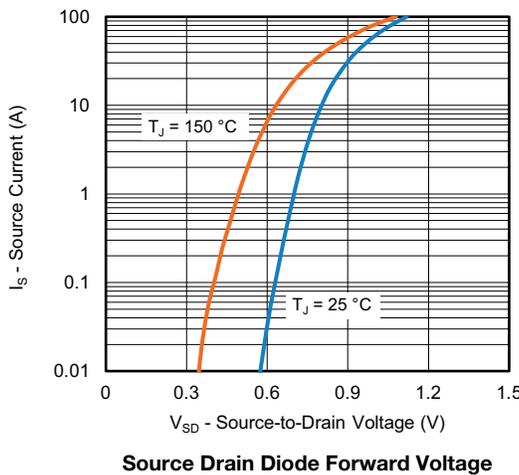
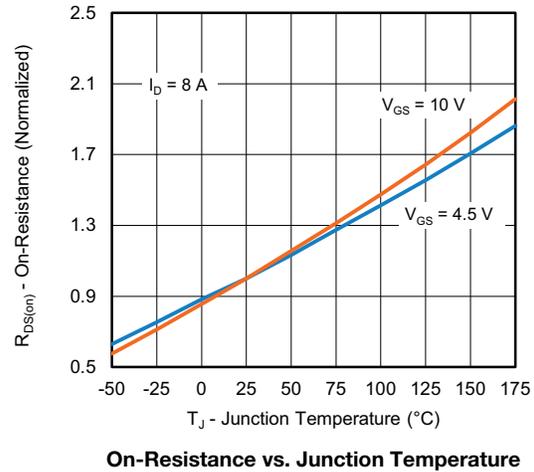
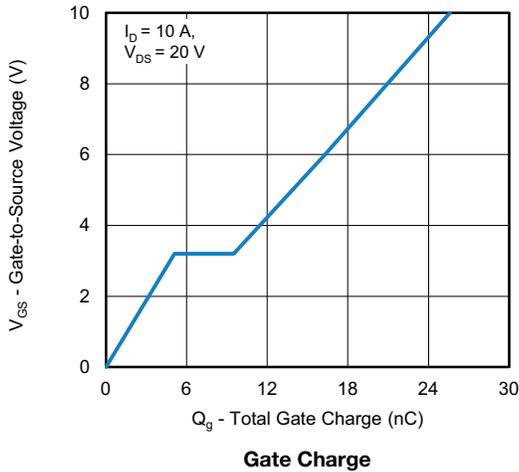
**On-Resistance vs. Drain Current**



**Capacitance**

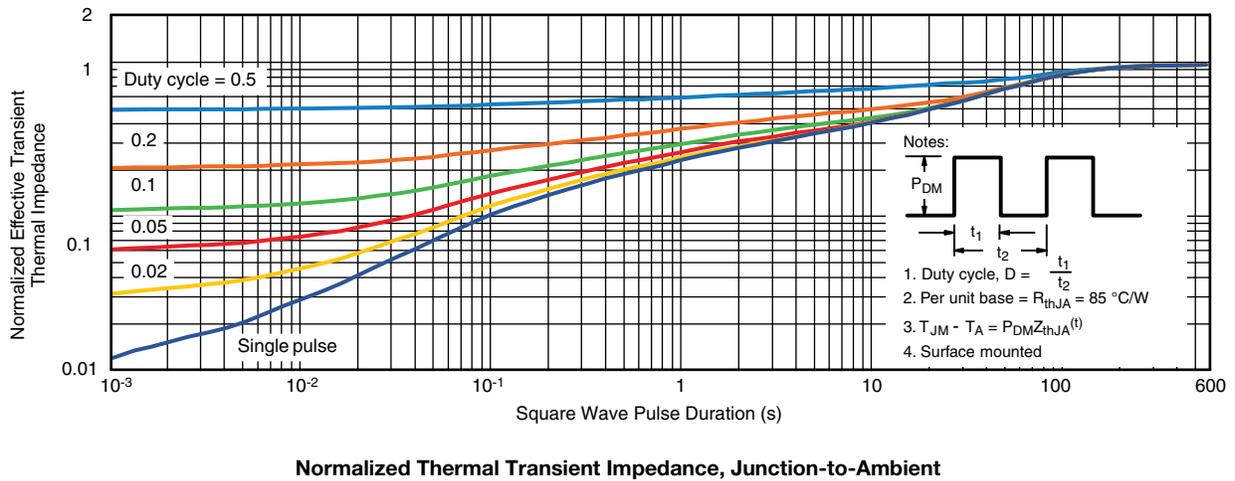
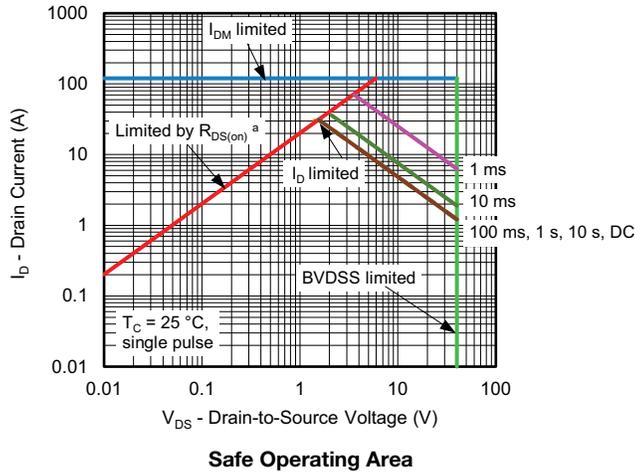


CHANNEL-2 TYPICAL CHARACTERISTICS (T<sub>A</sub> = 25 °C, unless otherwise noted)





**CHANNEL-2 TYPICAL CHARACTERISTICS** ( $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise noted)

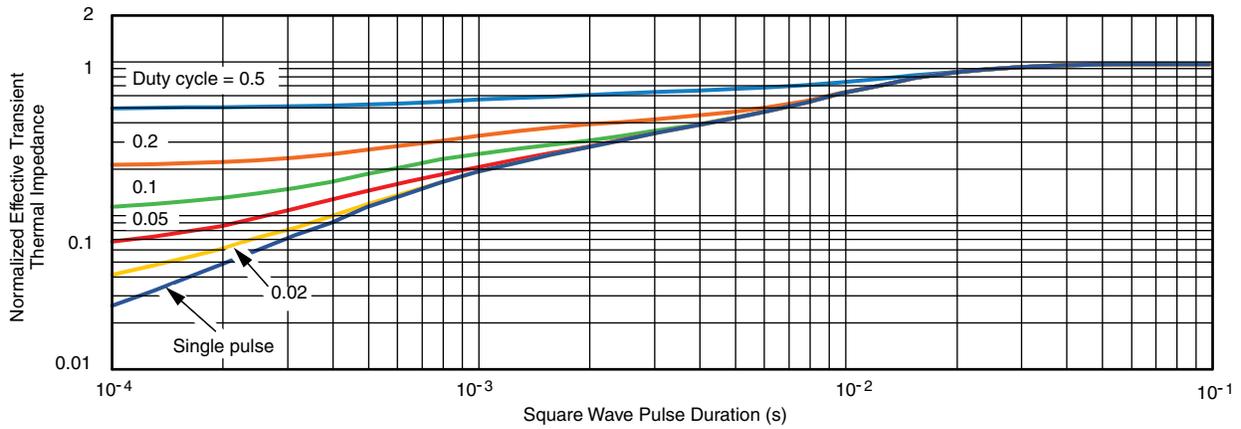


**Note**

a.  $V_{GS} >$  minimum  $V_{GS}$  at which  $R_{DS(on)}$  is specified



**CHANNEL-2 TYPICAL CHARACTERISTICS** ( $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise noted)



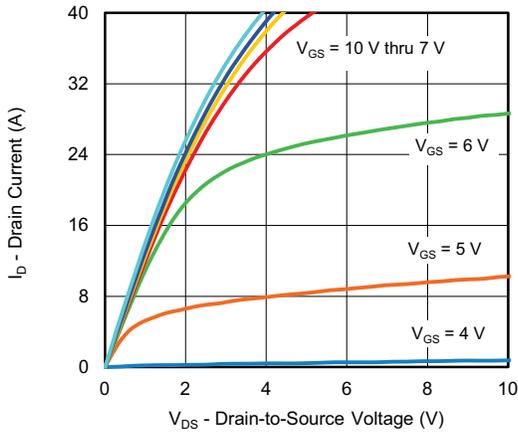
**Normalized Thermal Transient Impedance, Junction-to-Case**

**Note**

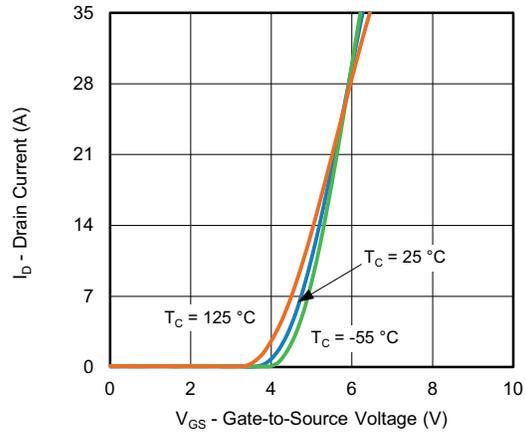
- The characteristics shown in the two graphs
  - Normalized Transient Thermal Impedance Junction-to-Ambient (25 °C)
  - Normalized Transient Thermal Impedance Junction-to-Case (25 °C)
 are given for general guidelines only to enable the user to get a “ball park” indication of part capabilities. The data are extracted from single pulse transient thermal impedance characteristics which are developed from empirical measurements. The latter is valid for the part mounted on printed circuit board - FR4, size 1" x 1" x 0.062", double sided with 2 oz. copper, 100 % on both sides. The part capabilities can widely vary depending on actual application parameters and operating conditions



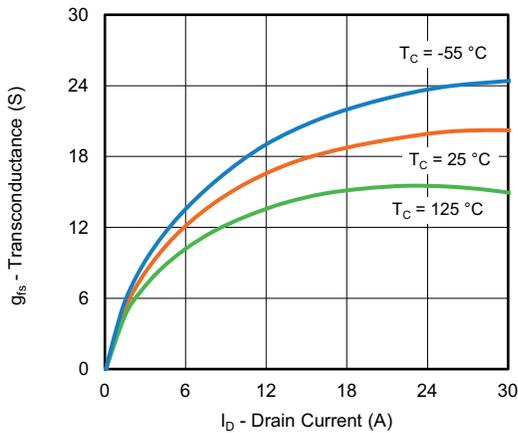
CHANNEL-3 TYPICAL CHARACTERISTICS (T<sub>A</sub> = 25 °C, unless otherwise noted)



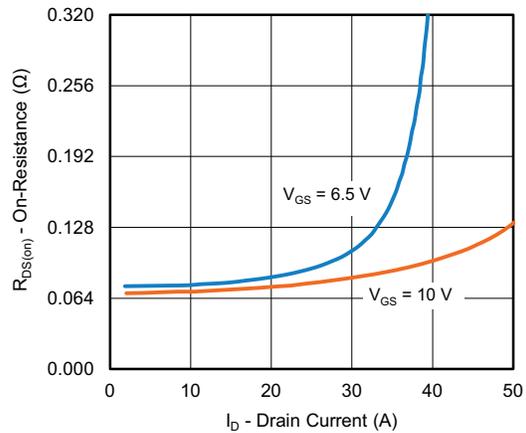
Output Characteristics



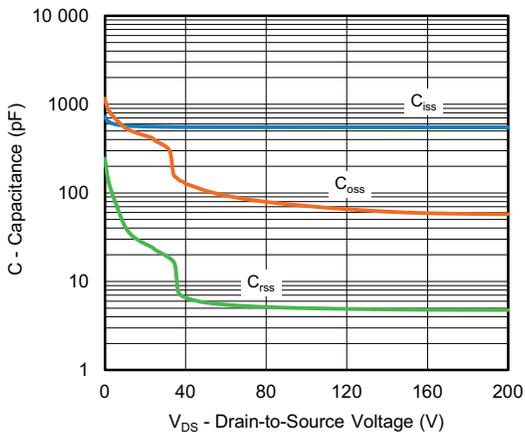
Transfer Characteristics



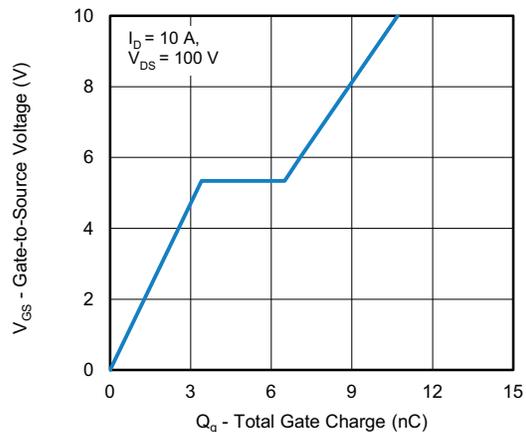
Transconductance



On-Resistance vs. Drain Current



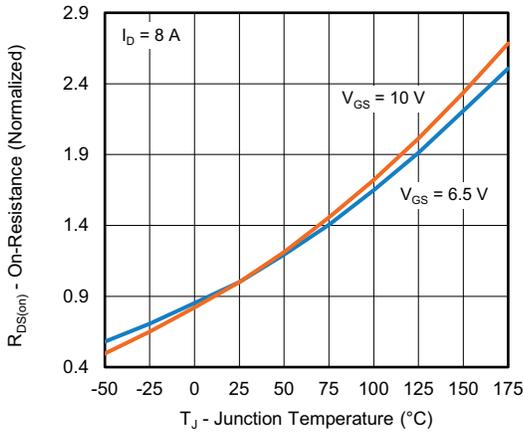
Capacitance



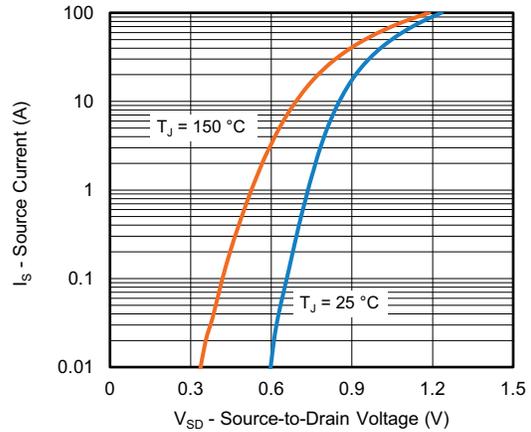
Gate Charge



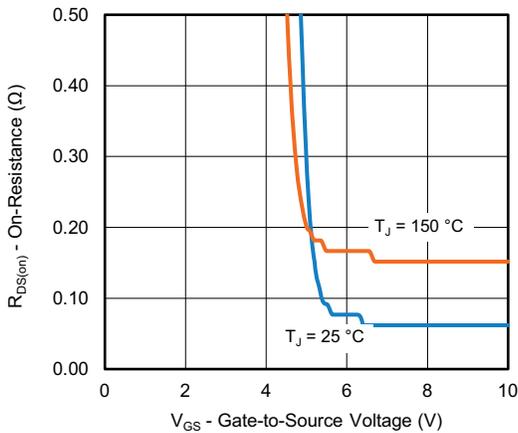
**CHANNEL-3 TYPICAL CHARACTERISTICS** ( $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise noted)



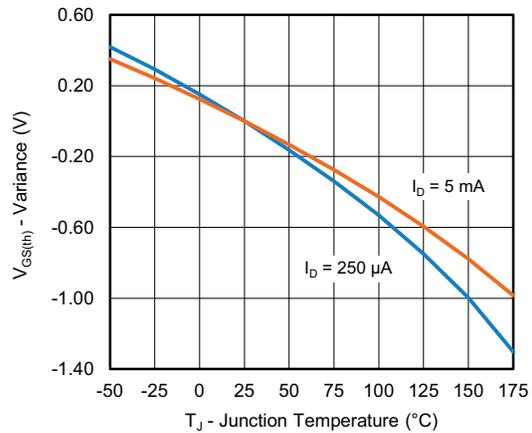
**On-Resistance vs. Junction Temperature**



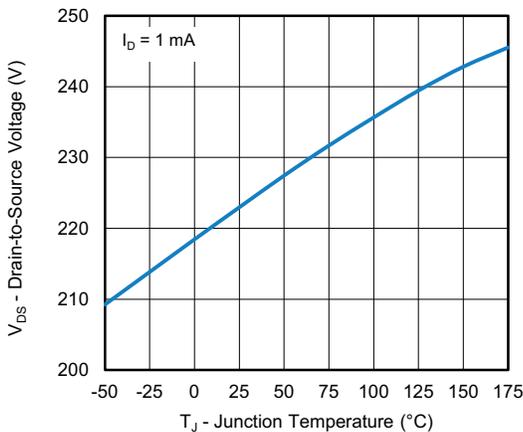
**Source Drain Diode Forward Voltage**



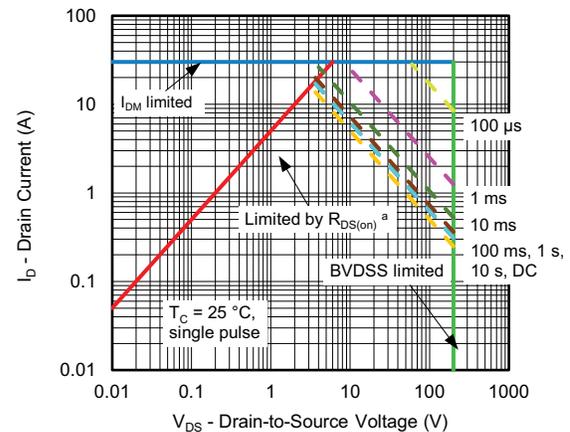
**On-Resistance vs. Gate-to-Source Voltage**



**Threshold Voltage**



**Drain Source Breakdown vs. Junction Temperature**



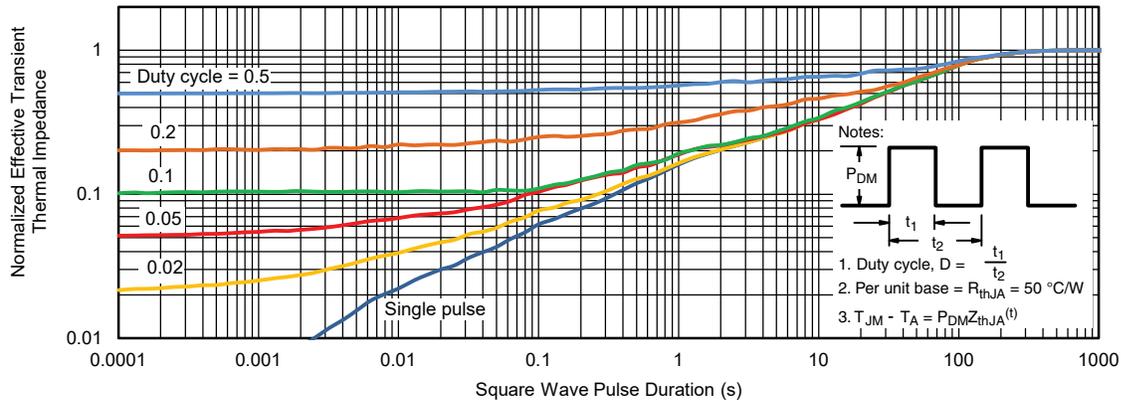
**Safe Operating Area**

**Note**

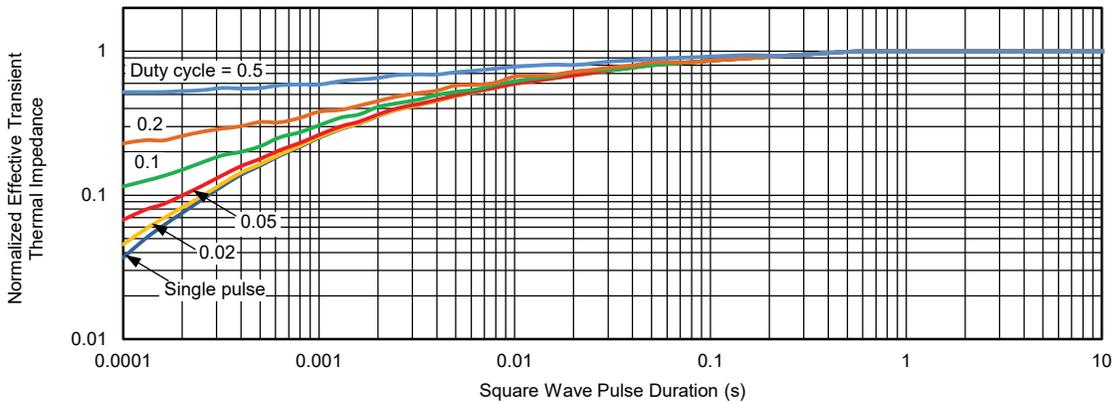
a.  $V_{GS} >$  minimum  $V_{GS}$  at which  $R_{DS(on)}$  is specified



**CHANNEL-3 TYPICAL CHARACTERISTICS** ( $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise noted)



**Normalized Thermal Transient Impedance, Junction-to-Ambient**



**Normalized Thermal Transient Impedance, Junction-to-Case**

**Note**

- The characteristics shown in the two graphs
  - Normalized Transient Thermal Impedance Junction-to-Ambient ( $25\text{ }^\circ\text{C}$ )
  - Normalized Transient Thermal Impedance Junction-to-Case ( $25\text{ }^\circ\text{C}$ )
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