

### N-Channel Enhancement-Mode MOS Transistors

#### Product Summary

Part Number	V <sub>(BR)DSS</sub> Min (V)	r <sub>DS(on)</sub> Max (Ω)	V <sub>GS(th)</sub> (V)	I <sub>D</sub> (A)
2N6659	35	1.8 @ V <sub>GS</sub> = 10 V	0.8 to 2	1.4
2N6660	60	3 @ V <sub>GS</sub> = 10 V	0.8 to 2	1.1
VQ1004J/P	60	3.5 @ V <sub>GS</sub> = 10 V	0.8 to 2.5	0.46

#### Features

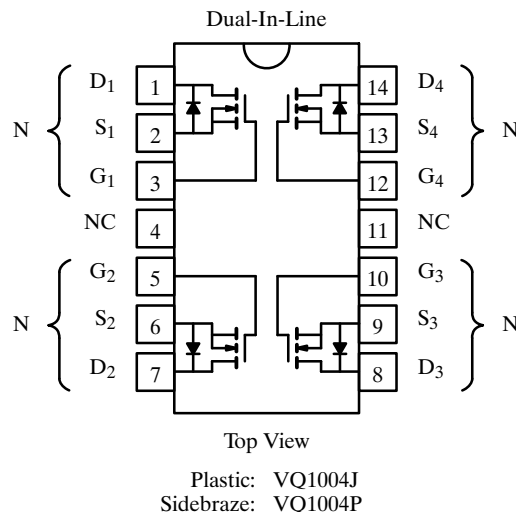
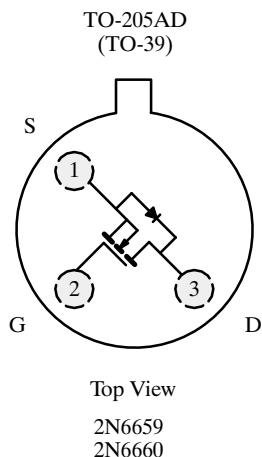
- Low On-Resistance: 1.3 Ω
- Low Threshold: 1.7 V
- Low Input Capacitance: 35 pF
- Fast Switching Speed: 8 ns
- Low Input and Output Leakage

#### Benefits

- Low Offset Voltage
- Low-Voltage Operation
- Easily Driven Without Buffer
- High-Speed Circuits
- Low Error Voltage

#### Applications

- Direct Logic-Level Interface: TTL/CMOS
- Drivers: Relays, Solenoids, Lamps, Hammers, Displays, Memories, Transistors, etc.
- Battery Operated Systems
- Solid-State Relays



#### Absolute Maximum Ratings (T<sub>C</sub> = 25°C Unless Otherwise Noted)

Parameter	Symbol	2N6659	2N6660	Single		Total Quad	Unit	
				VQ1004J	VQ1004P	VQ1004J/P		
Drain-Source Voltage	V <sub>DS</sub>	35	60	60	60		V	
Gate-Source Voltage	V <sub>GS</sub>	±20	±20	±30	±20			
Continuous Drain Current (T <sub>J</sub> = 150°C)	I <sub>D</sub>	T <sub>C</sub> = 25°C	1.4	1.1	0.46	±0.46		A
		T <sub>C</sub> = 100°C	1	0.8	0.26	0.26		
Pulsed Drain Current <sup>a</sup>	I <sub>DM</sub>	3	3	2	2			
Power Dissipation	P <sub>D</sub>	T <sub>C</sub> = 25°C	6.25	6.25	1.3	1.3	2	W
		T <sub>C</sub> = 100°C	2.5	2.5	0.52	0.52	0.8	
Maximum Junction-to-Ambient <sup>b</sup>	R <sub>thJA</sub>	170	170	0.96	0.96	62.5	°C/W	
Maximum Junction-to-Case	R <sub>thJC</sub>	20	20				W	
Operating Junction and Storage Temperature Range	T <sub>J</sub> , T <sub>stg</sub>	-55 to 150						°C

Notes

- a. Pulse width limited by maximum junction temperature.  
b. This parameter not registered with JEDEC.

### Specifications<sup>a</sup>

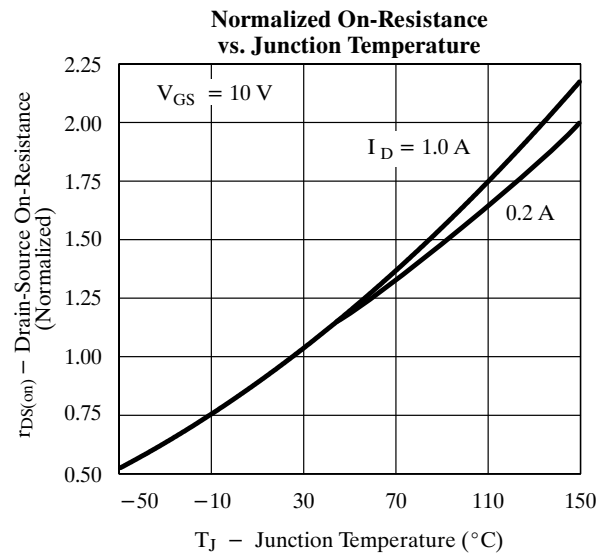
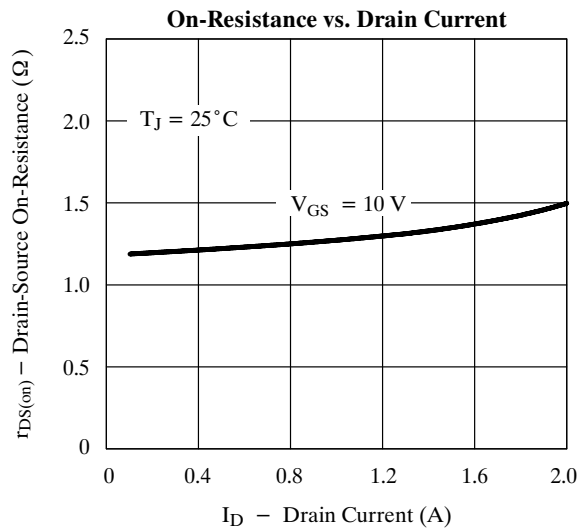
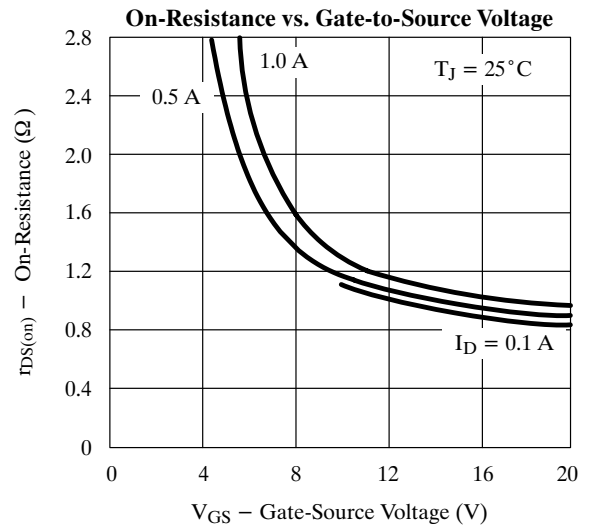
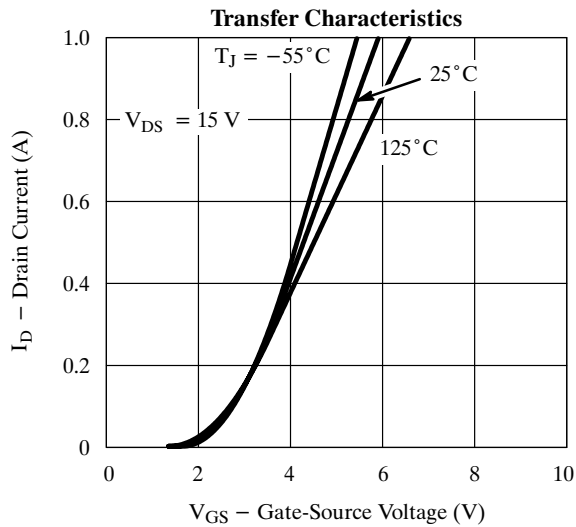
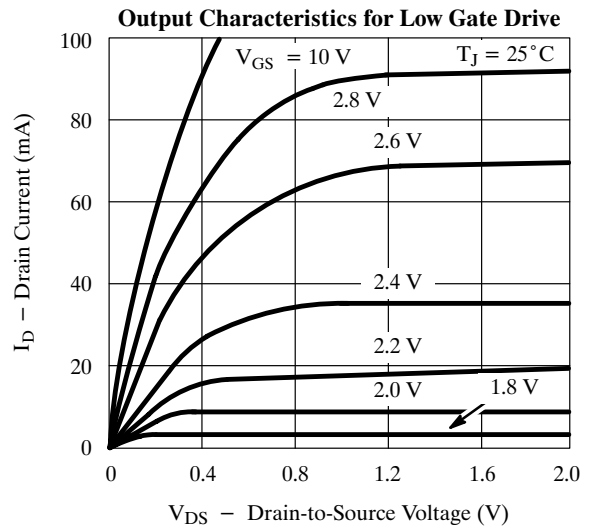
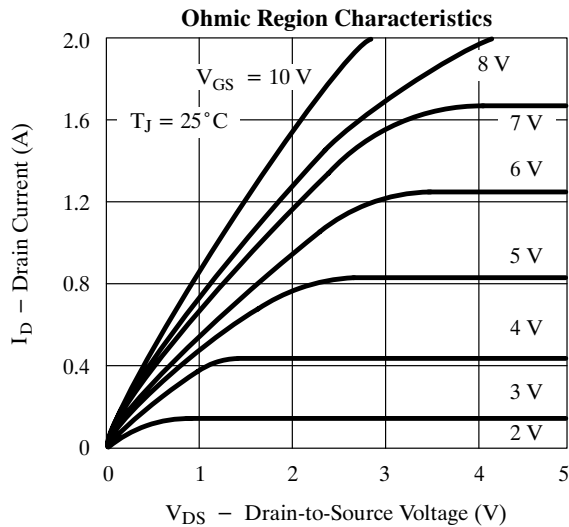
Parameter	Symbol	Test Conditions	Typ <sup>b</sup>	Limits						Unit
				2N6659		2N6660		VQ1004J/P		
				Min	Max	Min	Max	Min	Max	
<b>Static</b>										
Drain-Source Breakdown Voltage	$V_{(BR)DSS}$	$V_{GS} = 0\text{ V}, I_D = 10\ \mu\text{A}$	75	35		60		60		V
Gate-Threshold Voltage	$V_{GS(th)}$	$V_{DS} = V_{GS}, I_D = 1\text{ mA}$	1.7	0.8	2	0.8	2	0.8	2.5	
Gate-Body Leakage	$I_{GSS}$	$V_{DS} = 0\text{ V}, V_{GS} = \pm 15\text{ V}$ $T_C = 125^\circ\text{C}$			$\pm 100$		$\pm 100$		$\pm 100$	nA
					$\pm 500$		$\pm 500$		$\pm 500$	
Zero Gate Voltage Drain Current	$I_{DSS}$	$V_{DS} = 60\text{ V}, V_{GS} = 0\text{ V}$ $V_{DS} = 35\text{ V}, V_{GS} = 0\text{ V}$ $V_{DS} = 48\text{ V}, V_{GS} = 0\text{ V}$ $T_C = 125^\circ\text{C}$ $V_{DS} = 28\text{ V}, V_{GS} = 0\text{ V}$ $T_C = 125^\circ\text{C}$					10			$\mu\text{A}$
					10					
							500		500	
					500					
On-State Drain Current <sup>c</sup>	$I_{D(on)}$	$V_{DS} = 10\text{ V}, V_{GS} = 10\text{ V}$	3	1.5		1.5		1.5		A
Drain-Source On-Resistance <sup>c</sup>	$r_{DS(on)}$	$V_{GS} = 5\text{ V}, I_D = 0.3\text{ A}^e$ $V_{GS} = 10\text{ V}, I_D = 1\text{ A}$ $T_C = 125^\circ\text{C}^e$	2		5		5		5	$\Omega$
			1.3		1.8		3		3.5	
			2.4		3.6		4.2		4.9	
Forward Transconductance <sup>c</sup>	$g_{fs}$	$V_{DS} = 10\text{ V}, I_D = 0.5\text{ A}$	350	170		170		170		mS
Common Source Output Conductance <sup>c</sup>	$g_{os}$	$V_{DS} = 10\text{ V}, I_D = 0.1\text{ A}$	1							
Diode Forward Voltage	$V_{SD}$	$I_S = 0.99\text{ A}, V_{GS} = 0\text{ V}$	0.8							V
<b>Dynamic</b>										
Input Capacitance	$C_{iss}$	$V_{DS} = 24\text{ V}, V_{GS} = 0\text{ V}$ $f = 1\text{ MHz}$	35		50		50		60	$\text{pF}$
Output Capacitance	$C_{oss}$		25		40		40		50	
Reverse Transfer Capacitance	$C_{rss}$		7		10		10		10	
Drain-Source Capacitance	$C_{ds}$		30		40		40			
<b>Switching<sup>d</sup></b>										
Turn-On Time	$t_{ON}$	$V_{DD} = 25\text{ V}, R_L = 23\ \Omega$ $I_D \cong 1\text{ A}, V_{GEN} = 10\text{ V}$ $R_G = 25\ \Omega$	8		10		10		10	ns
Turn-Off Time	$t_{OFF}$		8.5		10		10		10	

Notes

- $T_A = 25^\circ\text{C}$  unless otherwise noted.
- For DESIGN AID ONLY, not subject to production testing.
- Pulse test:  $PW \leq 80\ \mu\text{s}$  duty cycle  $\leq 1\%$ .
- Switching time is essentially independent of operating temperature.
- This parameter not registered with JEDEC on 2N6659 and 2N6660.

VNDQ06

## Typical Characteristics (25°C Unless Otherwise Noted)



## 2N6659/2N6660, VQ1004J/P

### Typical Characteristics (25°C Unless Otherwise Noted)

