



## N-Channel 60-V (D-S) Single and Quad MOSFETs

| PRODUCT SUMMARY |                       |                               |                  |           |
|-----------------|-----------------------|-------------------------------|------------------|-----------|
| Part Number     | $V_{(BR)DSS}$ Min (V) | $r_{DS(on)}$ Max ( $\Omega$ ) | $V_{GS(th)}$ (V) | $I_D$ (A) |
| 2N6660          | 60                    | 3 @ $V_{GS} = 10$ V           | 0.8 to 2         | 1.1       |
| VQ1004J/P       |                       | 3.5 @ $V_{GS} = 10$ V         | 0.8 to 2.5       | 0.46      |

## FEATURES

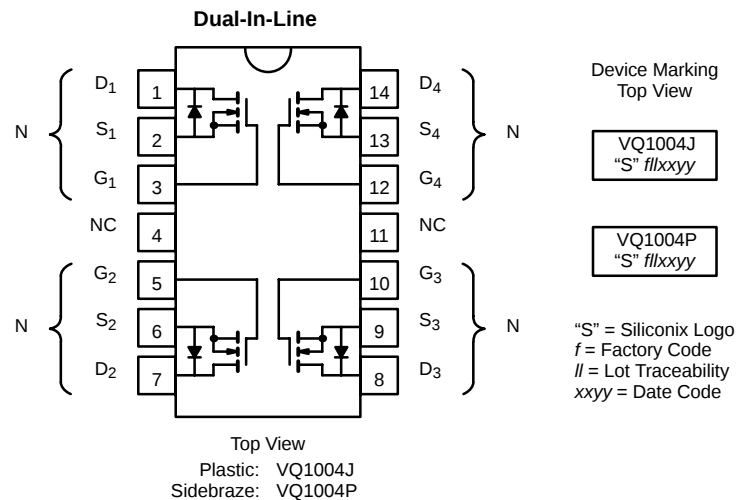
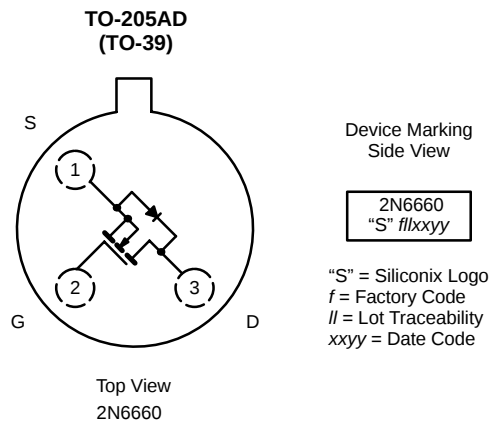
- Low On-Resistance: 1.3  $\Omega$
- Low Threshold: 1.7 V
- Low Input Capacitance: 35 pF
- Fast Switching Speed: 8 ns
- Low Input and Output Leakage

## 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 ( $T_A = 25^\circ\text{C}$  UNLESS OTHERWISE NOTED)

| Parameter                                                 | Symbol         | 2N6660                    | Single   |          | Total Quad | Unit               |
|-----------------------------------------------------------|----------------|---------------------------|----------|----------|------------|--------------------|
|                                                           |                |                           | VQ1004J  | VQ1004P  | VQ1004J/P  |                    |
| Drain-Source Voltage                                      | $V_{DS}$       | 60                        | 60       | 60       |            | V                  |
| Gate-Source Voltage                                       | $V_{GS}$       | $\pm 20$                  | $\pm 30$ | $\pm 20$ |            |                    |
| Continuous Drain Current<br>( $T_J = 150^\circ\text{C}$ ) | $I_D$          | $T_C = 25^\circ\text{C}$  | 1.1      | 0.46     | $\pm 0.46$ | A                  |
|                                                           |                | $T_C = 100^\circ\text{C}$ | 0.8      | 0.26     | 0.26       |                    |
| Pulsed Drain Current <sup>a</sup>                         | $I_{DM}$       | 3                         | 2        | 2        |            |                    |
| Power Dissipation                                         | $P_D$          | $T_C = 25^\circ\text{C}$  | 6.25     | 1.3      | 1.3        | W                  |
|                                                           |                | $T_C = 100^\circ\text{C}$ | 2.5      | 0.52     | 0.52       |                    |
| Thermal Resistance, Junction-to-Ambient <sup>b</sup>      | $R_{thJA}$     | 170                       | 0.96     | 0.96     | 62.5       | $^\circ\text{C/W}$ |
| Thermal Resistance, Junction-to-Case                      | $R_{thJC}$     | 20                        |          |          |            |                    |
| Operating Junction and Storage Temperature Range          | $T_J, T_{stg}$ | -55 to 150                |          |          |            | $^\circ\text{C}$   |

## Notes

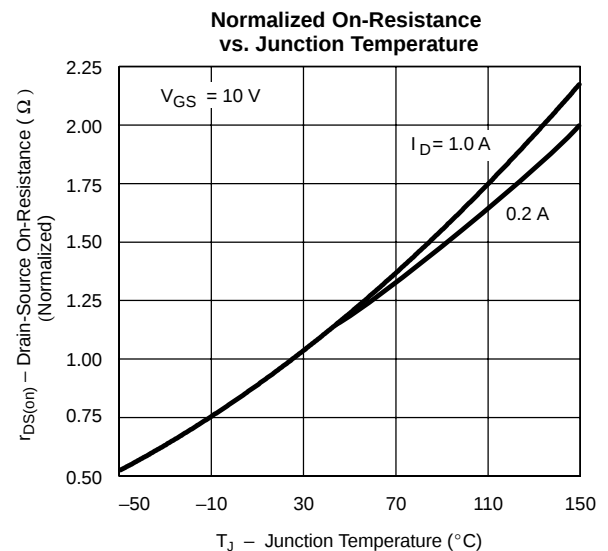
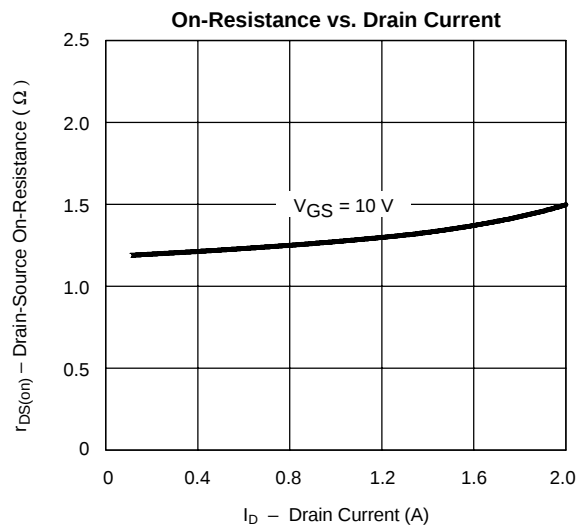
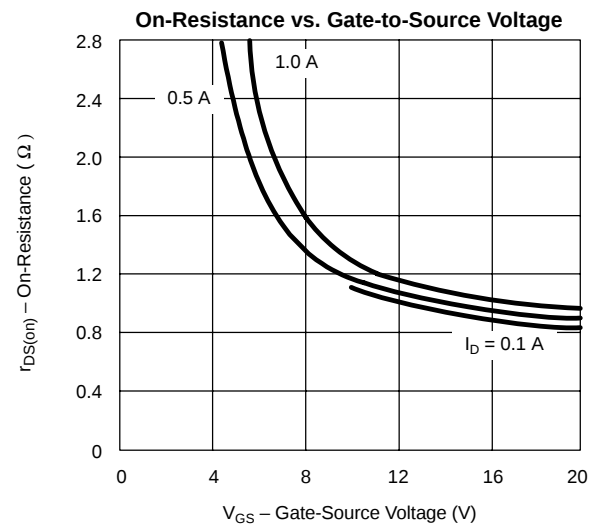
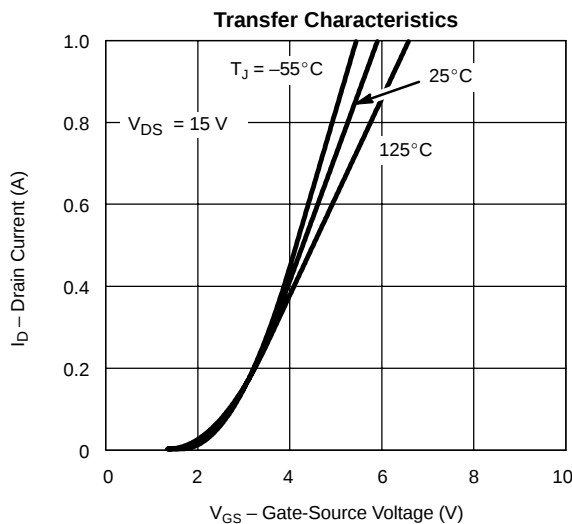
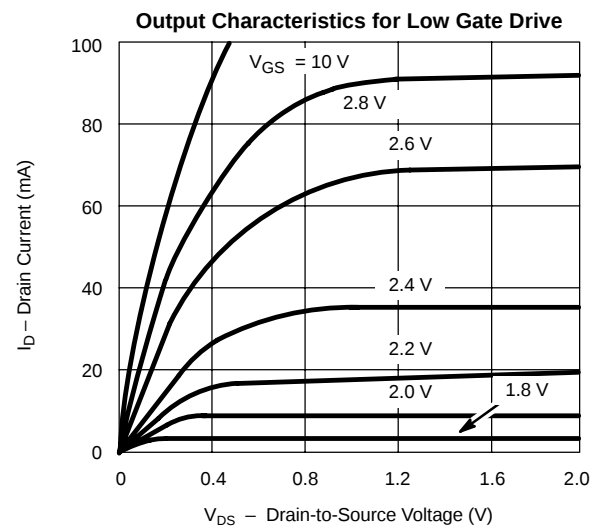
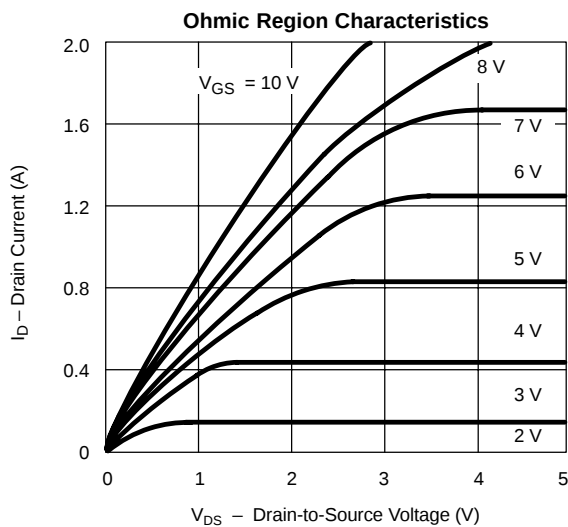
- a. Pulse width limited by maximum junction temperature.  
b. This parameter not registered with JEDEC.

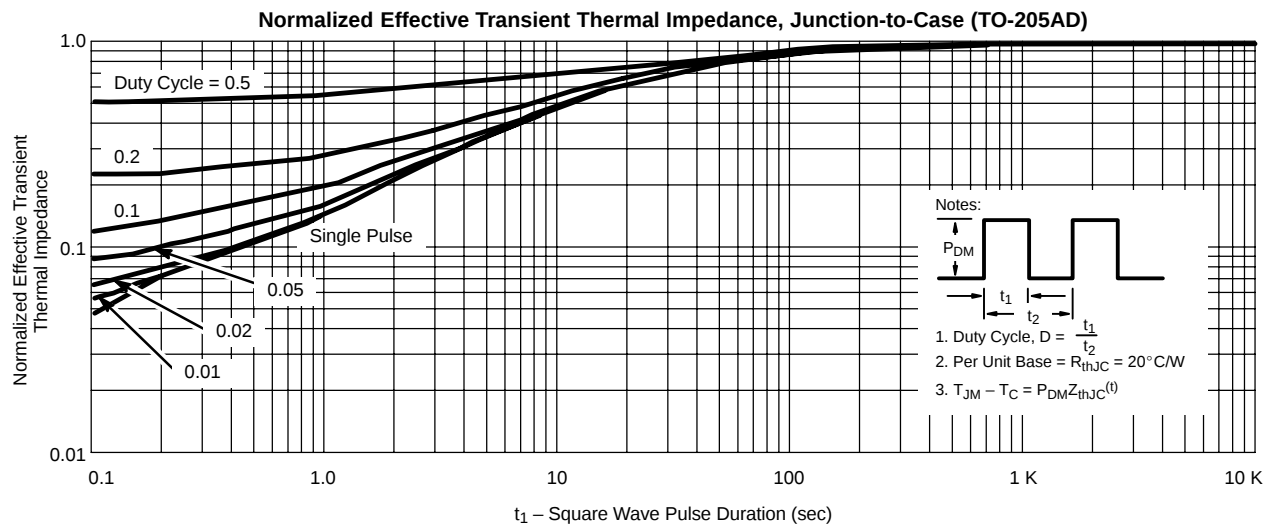
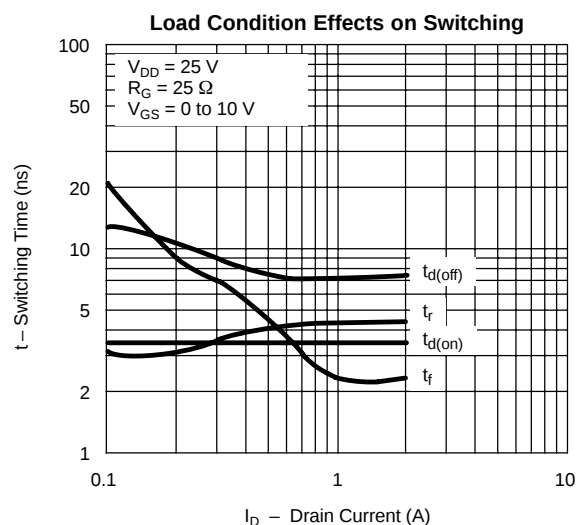
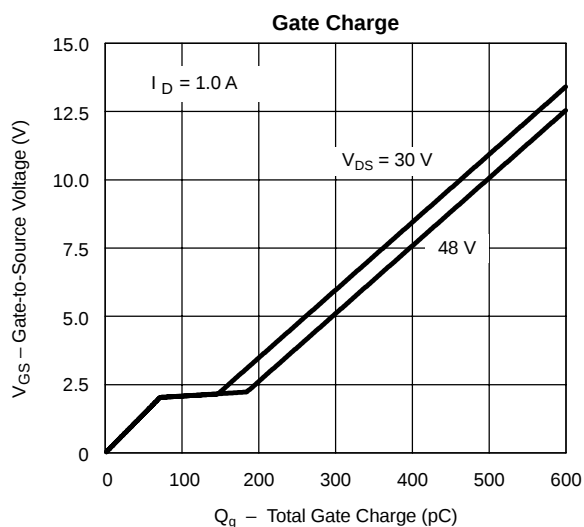
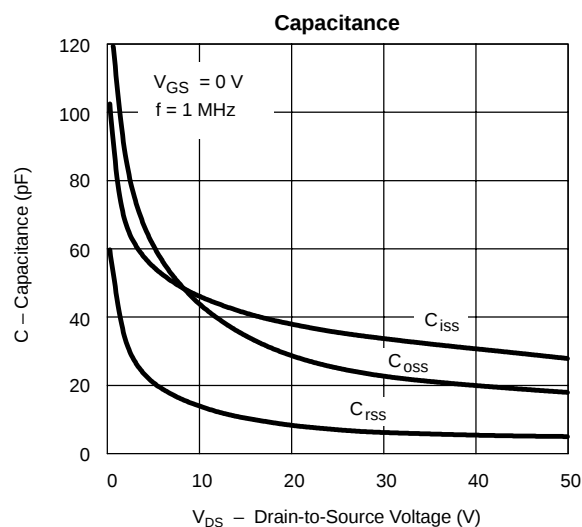
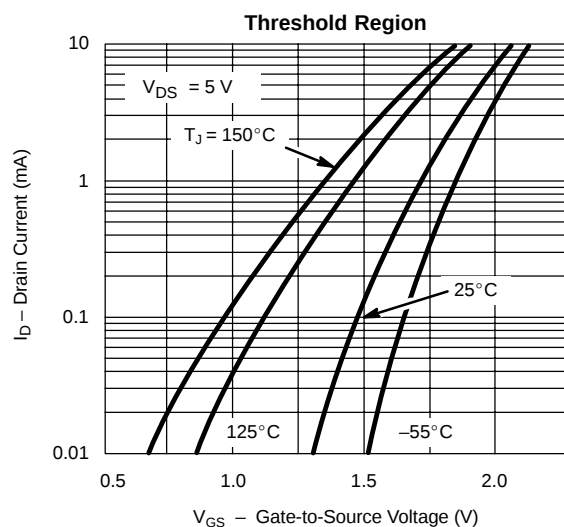
| SPECIFICATIONS (T <sub>A</sub> = 25 °C UNLESS OTHERWISE NOTED) |                      |                                                                                                                         |                  |        |       |           |       |      |
|----------------------------------------------------------------|----------------------|-------------------------------------------------------------------------------------------------------------------------|------------------|--------|-------|-----------|-------|------|
| Parameter                                                      | Symbol               | Test Conditions                                                                                                         | Typ <sup>a</sup> | Limits |       |           |       | Unit |
|                                                                |                      |                                                                                                                         |                  | 2N6660 |       | VQ1004J/P |       |      |
|                                                                |                      |                                                                                                                         |                  | Min    | Max   | Min       | Max   |      |
| Static                                                         |                      |                                                                                                                         |                  |        |       |           |       |      |
| Drain-Source Breakdown Voltage                                 | V <sub>(BR)DSS</sub> | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 10 μA                                                                           | 75               | 60     |       | 60        |       | V    |
| Gate-Threshold Voltage                                         | V <sub>GS(th)</sub>  | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 1 mA                                                               | 1.7              | 0.8    | 2     | 0.8       | 2.5   |      |
| Gate-Body Leakage                                              | I <sub>GSS</sub>     | V <sub>DS</sub> = 0 V, V <sub>GS</sub> = ± 15 V                                                                         |                  |        | ± 100 |           | ± 100 | nA   |
|                                                                |                      | T <sub>C</sub> = 125 °C                                                                                                 |                  |        | ± 500 |           | ± 500 |      |
| Zero Gate Voltage Drain Current                                | I <sub>DSS</sub>     | V <sub>DS</sub> = 60 V, V <sub>GS</sub> = 0 V                                                                           |                  |        | 10    |           |       | μA   |
|                                                                |                      | V <sub>DS</sub> = 35 V, V <sub>GS</sub> = 0 V                                                                           |                  |        |       |           |       |      |
|                                                                |                      | V <sub>DS</sub> = 48 V, V <sub>GS</sub> = 0 V                                                                           |                  |        |       |           | 1     |      |
|                                                                |                      | T <sub>C</sub> = 125 °C                                                                                                 |                  |        | 500   |           | 500   |      |
|                                                                |                      | V <sub>DS</sub> = 28 V, V <sub>GS</sub> = 0 V                                                                           |                  |        |       |           |       |      |
|                                                                |                      | T <sub>C</sub> = 125 °C                                                                                                 |                  |        |       |           |       |      |
| On-State Drain Current <sup>b</sup>                            | I <sub>D(on)</sub>   | V <sub>DS</sub> = 10 V, V <sub>GS</sub> = 10 V                                                                          | 3                | 1.5    |       | 1.5       |       | A    |
| Drain-Source On-Resistance <sup>b</sup>                        | r <sub>DS(on)</sub>  | V <sub>GS</sub> = 5 V, I <sub>D</sub> = 0.3 A <sup>d</sup>                                                              | 2                |        | 5     |           | 5     | Ω    |
|                                                                |                      | V <sub>GS</sub> = 10 V, I <sub>D</sub> = 1 A                                                                            | 1.3              |        | 3     |           | 3.5   |      |
|                                                                |                      | T <sub>C</sub> = 125 °C <sup>d</sup>                                                                                    | 2.4              |        | 4.2   |           | 4.9   |      |
| Forward Transconductance <sup>b</sup>                          | g <sub>fs</sub>      | V <sub>DS</sub> = 10 V, I <sub>D</sub> = 0.5 A                                                                          | 350              | 170    |       | 170       |       | mS   |
| Common Source Output Conductance <sup>b</sup>                  | g <sub>os</sub>      | V <sub>DS</sub> = 10 V, I <sub>D</sub> = 0.1 A                                                                          | 1                |        |       |           |       |      |
| Diode Forward Voltage                                          | V <sub>SD</sub>      | I <sub>S</sub> = 0.99 A, V <sub>GS</sub> = 0 V                                                                          | 0.8              |        |       |           |       | V    |
| Dynamic                                                        |                      |                                                                                                                         |                  |        |       |           |       |      |
| Input Capacitance                                              | C <sub>iss</sub>     | V <sub>DS</sub> = 24 V, V <sub>GS</sub> = 0 V<br>f = 1 MHz                                                              | 35               |        | 50    |           | 60    | pF   |
| Output Capacitance                                             | C <sub>oss</sub>     |                                                                                                                         | 25               |        | 40    |           | 50    |      |
| Reverse Transfer Capacitance                                   | C <sub>rss</sub>     |                                                                                                                         | 7                |        | 10    |           | 10    |      |
| Drain-Source Capacitance                                       | C <sub>ds</sub>      |                                                                                                                         | 30               |        | 40    |           |       |      |
| Switching <sup>c</sup>                                         |                      |                                                                                                                         |                  |        |       |           |       |      |
| Turn-On Time                                                   | t <sub>ON</sub>      | V <sub>DD</sub> = 25 V, R <sub>L</sub> = 23 Ω<br>I <sub>D</sub> ≅ 1 A, V <sub>GEN</sub> = 10 V<br>R <sub>G</sub> = 25 Ω | 8                |        | 10    |           | 10    | ns   |
| Turn-Off Time                                                  | t <sub>OFF</sub>     |                                                                                                                         | 8.5              |        | 10    |           | 10    |      |

## Notes

- a. For DESIGN AID ONLY, not subject to production testing.  
b. Pulse test:  $PW \leq 80\text{ }\mu\text{s}$  duty cycle  $\leq 1\%$ .  
c. Switching time is essentially independent of operating temperature.  
d. This parameter not registered with JEDEC on 2N6660.

VNDQ06

**TYPICAL CHARACTERISTICS ( $T_A = 25^\circ\text{C}$  UNLESS OTHERWISE NOTED)**

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