

TPN6R003NL

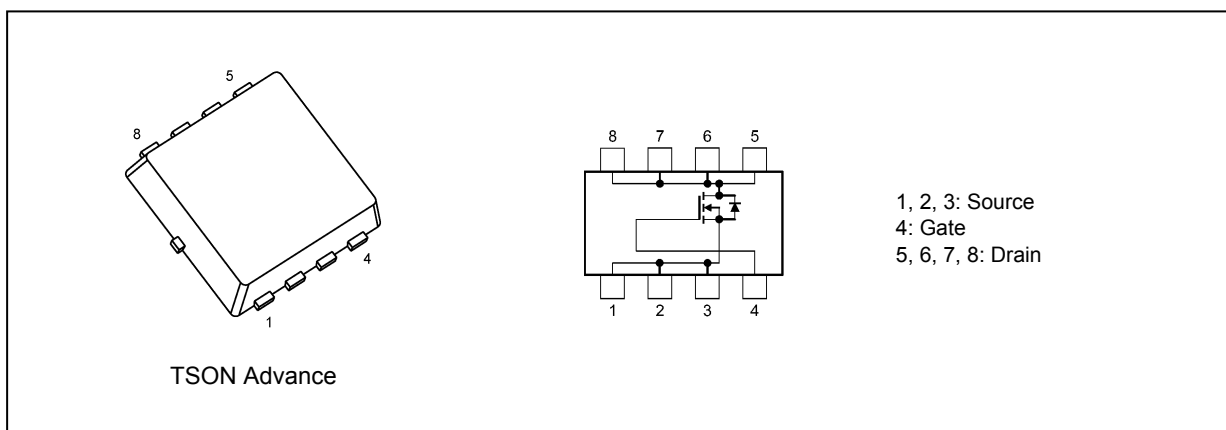
1. Applications

- Switching Voltage Regulators
- DC-DC Converters

2. Features

- (1) High-speed switching
- (2) Small gate charge: $Q_{SW} = 4.3 \text{ nC}$ (typ.)
- (3) Low drain-source on-resistance: $R_{DS(ON)} = 6.8 \text{ m}\Omega$ (typ.) ($V_{GS} = 4.5 \text{ V}$)
- (4) Low leakage current: $I_{DSS} = 10 \text{ }\mu\text{A}$ (max) ($V_{DS} = 30 \text{ V}$)
- (5) Enhancement mode: $V_{th} = 1.3 \text{ to } 2.3 \text{ V}$ ($V_{DS} = 10 \text{ V}$, $I_D = 0.2 \text{ mA}$)

3. Packaging and Internal Circuit



4. Absolute Maximum Ratings (Note) ($T_a = 25 \text{ }^\circ\text{C}$ unless otherwise specified)

| Characteristics | Symbol | Rating | Unit |
|---|-----------|------------|------------------|
| Drain-source voltage | V_{DSS} | 30 | V |
| Gate-source voltage | V_{GSS} | ± 20 | |
| Drain current (DC) (Silicon limit) (Note 1), (Note 2) | I_D | 56 | A |
| Drain current (DC) ($T_c = 25 \text{ }^\circ\text{C}$) (Note 1) | I_D | 27 | |
| Drain current (pulsed) ($t = 1 \text{ ms}$) (Note 1) | I_{DP} | 116 | |
| Power dissipation ($T_c = 25 \text{ }^\circ\text{C}$) | P_D | 32 | W |
| Power dissipation ($t = 10 \text{ s}$) (Note 3) | P_D | 1.9 | |
| Power dissipation ($t = 10 \text{ s}$) (Note 4) | P_D | 0.7 | |
| Single-pulse avalanche energy (Note 5) | E_{AS} | 39 | mJ |
| Avalanche current | I_{AR} | 27 | A |
| Channel temperature | T_{ch} | 150 | $^\circ\text{C}$ |
| Storage temperature | T_{stg} | -55 to 150 | |

Note: Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) are within the absolute maximum ratings.

Please design the appropriate reliability upon reviewing the Toshiba Semiconductor Reliability Handbook ("Handling Precautions"/"Derating Concept and Methods") and individual reliability data (i.e. reliability test report and estimated failure rate, etc).

Start of commercial production

2013-07

5. Thermal Characteristics

| Characteristics | Symbol | Max | Unit |
|---|----------------|------|----------------------|
| Channel-to-case thermal resistance ($T_c = 25\text{ }^{\circ}\text{C}$) | $R_{th(ch-c)}$ | 3.9 | $^{\circ}\text{C/W}$ |
| Channel-to-ambient thermal resistance ($t = 10\text{ s}$) (Note 3) | $R_{th(ch-a)}$ | 65.7 | |
| Channel-to-ambient thermal resistance ($t = 10\text{ s}$) (Note 4) | $R_{th(ch-a)}$ | 178 | |

Note 1: Ensure that the channel temperature does not exceed $150\text{ }^{\circ}\text{C}$.

Note 2: Limited by silicon chip capability.

Note 3: Device mounted on a glass-epoxy board (a), Figure 5.1

Note 4: Device mounted on a glass-epoxy board (b), Figure 5.2

Note 5: $V_{DD} = 24\text{ V}$, $T_{ch} = 25\text{ }^{\circ}\text{C}$ (initial), $L = 42\text{ }\mu\text{H}$, $I_{AR} = 27\text{ A}$



Fig. 5.1 Device Mounted on a Glass-Epoxy Board (a)



Fig. 5.2 Device Mounted on a Glass-Epoxy Board (b)

Note: This transistor is sensitive to electrostatic discharge and should be handled with care.

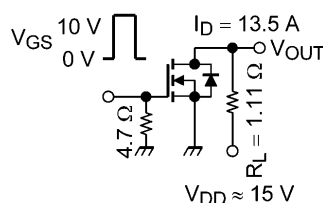
6. Electrical Characteristics

6.1. Static Characteristics ($T_a = 25\text{ }^{\circ}\text{C}$ unless otherwise specified)

| Characteristics | Symbol | Test Condition | Min | Typ. | Max | Unit |
|--------------------------------|---------------|--|-----|------|-----------|------------------|
| Gate leakage current | I_{GSS} | $V_{GS} = \pm 20\text{ V}$, $V_{DS} = 0\text{ V}$ | — | — | ± 0.1 | μA |
| Drain cut-off current | I_{DSS} | $V_{DS} = 30\text{ V}$, $V_{GS} = 0\text{ V}$ | — | — | 10 | |
| Drain-source breakdown voltage | $V_{(BR)DSS}$ | $I_D = 10\text{ mA}$, $V_{GS} = 0\text{ V}$ | 30 | — | — | V |
| | $V_{(BR)DSX}$ | $I_D = 10\text{ mA}$, $V_{GS} = -20\text{ V}$ | 15 | — | — | |
| Gate threshold voltage | V_{th} | $V_{DS} = 10\text{ V}$, $I_D = 0.2\text{ mA}$ | 1.3 | — | 2.3 | |
| Drain-source on-resistance | $R_{DS(ON)}$ | $V_{GS} = 4.5\text{ V}$, $I_D = 8\text{ A}$ | — | 6.8 | 8.3 | $\text{m}\Omega$ |
| | | $V_{GS} = 10\text{ V}$, $I_D = 13.5\text{ A}$ | — | 5.2 | 6.0 | |

6.2. Dynamic Characteristics ($T_a = 25\text{ }^{\circ}\text{C}$ unless otherwise specified)

| Characteristics | Symbol | Test Condition | Min | Typ. | Max | Unit |
|--------------------------------|-----------|---|-----|------|------|-------------|
| Input capacitance | C_{iss} | $V_{DS} = 15\text{ V}$, $V_{GS} = 0\text{ V}$, $f = 1\text{ MHz}$ | — | 1050 | 1400 | pF |
| Reverse transfer capacitance | C_{rss} | | — | 37 | 84 | |
| Output capacitance | C_{oss} | | — | 600 | — | |
| Gate resistance | r_g | — | — | 1.1 | 1.7 | Ω |
| Switching time (rise time) | t_r | See Fig. 6.2.1 | — | 4.1 | — | ns |
| Switching time (turn-on time) | t_{on} | | — | 11 | — | |
| Switching time (fall time) | t_f | | — | 3.3 | — | |
| Switching time (turn-off time) | t_{off} | | — | 18 | — | |



Duty $\leq 1\%$, $t_w = 10\text{ }\mu\text{s}$

Fig. 6.2.1 Switching Time Test Circuit

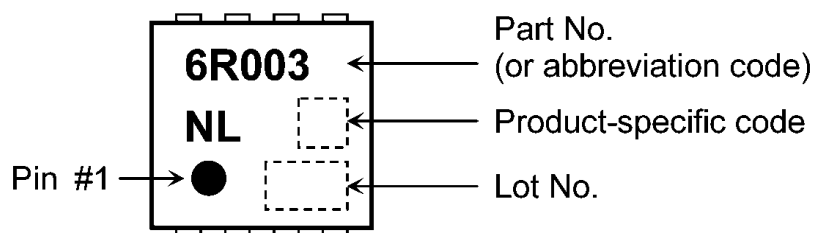
6.3. Gate Charge Characteristics ($T_a = 25\text{ }^{\circ}\text{C}$ unless otherwise specified)

| Characteristics | Symbol | Test Condition | Min | Typ. | Max | Unit |
|---|-----------|--|-----|------|-----|------|
| Total gate charge (gate-source plus gate-drain) | Q_g | $V_{DD} \approx 15\text{ V}$, $V_{GS} = 10\text{ V}$, $I_D = 27\text{ A}$ | — | 17 | — | nC |
| | | $V_{DD} \approx 15\text{ V}$, $V_{GS} = 4.5\text{ V}$, $I_D = 27\text{ A}$ | — | 8.2 | — | |
| Gate-source charge 1 | Q_{gs1} | $V_{DD} \approx 15\text{ V}$, $V_{GS} = 10\text{ V}$, $I_D = 27\text{ A}$ | — | 3.7 | — | |
| Gate-drain charge | Q_{gd} | | — | 2.3 | — | |
| Gate switch charge | Q_{SW} | | — | 4.3 | — | |

6.4. Source-Drain Characteristics ($T_a = 25\text{ }^{\circ}\text{C}$ unless otherwise specified)

| Characteristics | Symbol | Test Condition | Min | Typ. | Max | Unit |
|---|-----------|--|-----|------|------|------|
| Reverse drain current (pulsed) (Note 6) | I_{DRP} | — | — | — | 116 | A |
| Diode forward voltage | V_{DSF} | $I_{DR} = 27\text{ A}$, $V_{GS} = 0\text{ V}$ | — | — | -1.2 | V |

Note 6: Ensure that the channel temperature does not exceed $150\text{ }^{\circ}\text{C}$.

7. Marking**Fig. 7.1 Marking**

8. Characteristics Curves (Note)

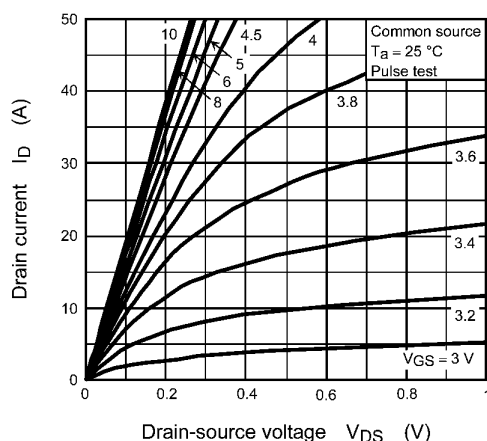


Fig. 8.1 $I_D - V_{DS}$

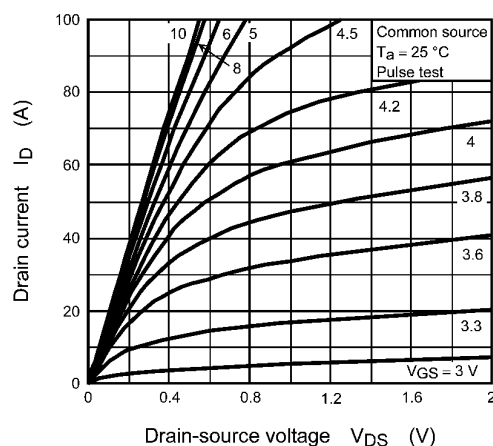


Fig. 8.2 $I_D - V_{DS}$

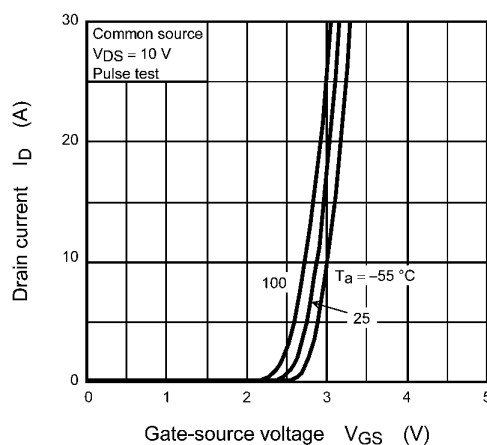


Fig. 8.3 $I_D - V_{GS}$

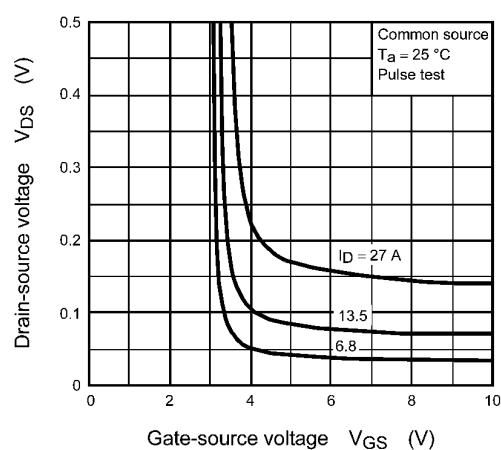


Fig. 8.4 $V_{DS} - V_{GS}$

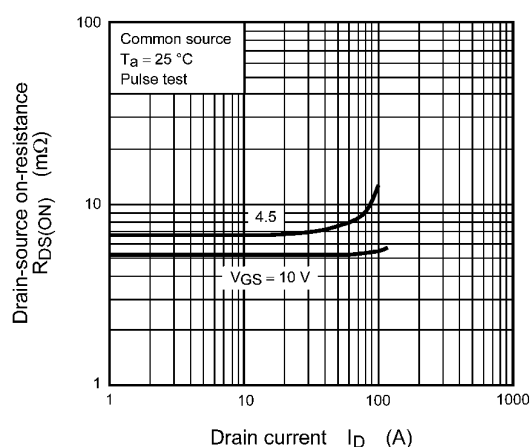


Fig. 8.5 $R_{DS(ON)} - I_D$

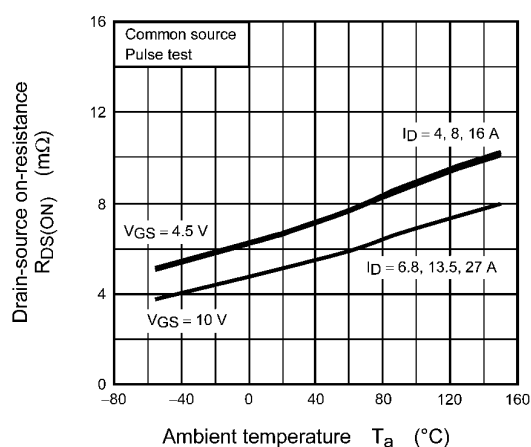


Fig. 8.6 $R_{DS(ON)} - T_a$

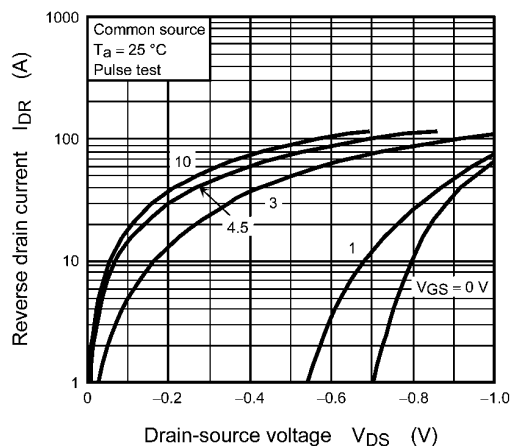


Fig. 8.7 $I_{DR} - V_{DS}$

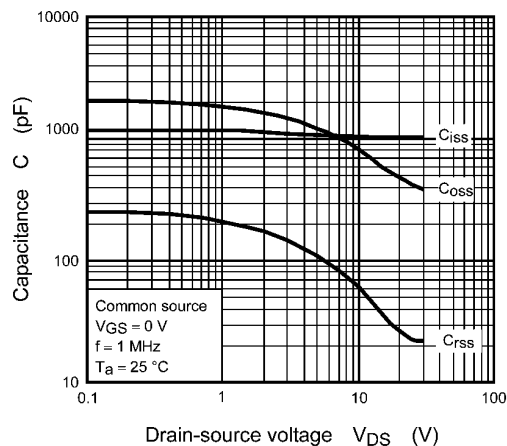


Fig. 8.8 Capacitance - V_{DS}

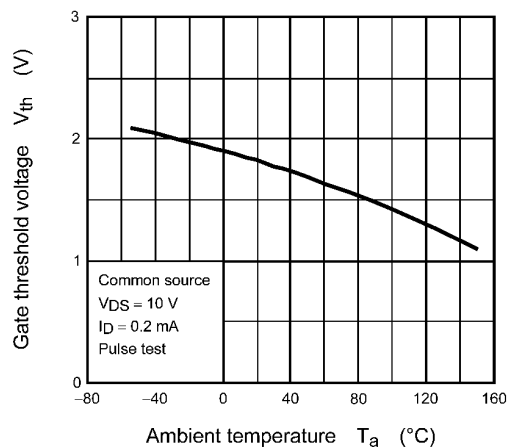


Fig. 8.9 $V_{th} - T_a$

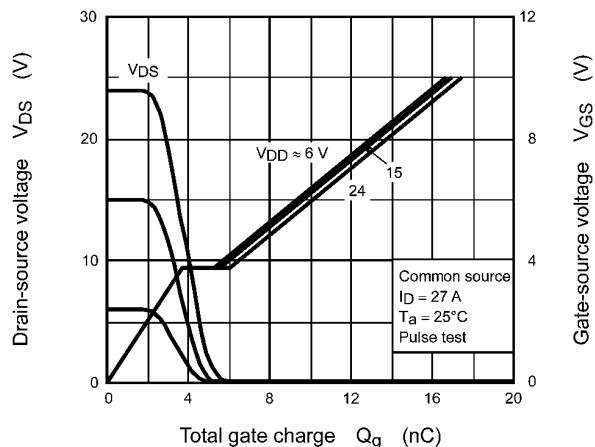
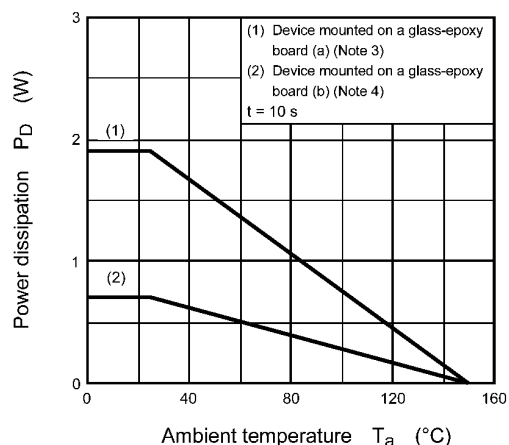
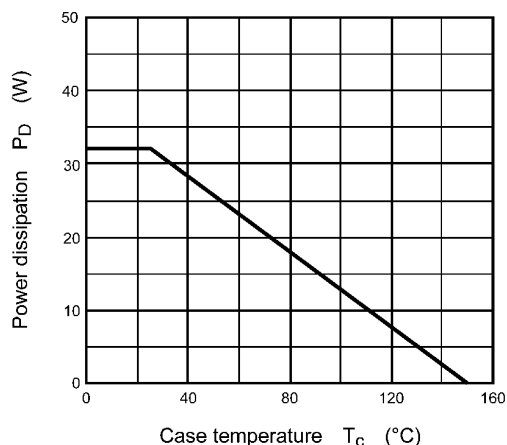


Fig. 8.10 Dynamic Input/Output Characteristics



**Fig. 8.11 $P_D - T_a$
(Guaranteed Maximum)**



**Fig. 8.12 $P_D - T_c$
(Guaranteed Maximum)**

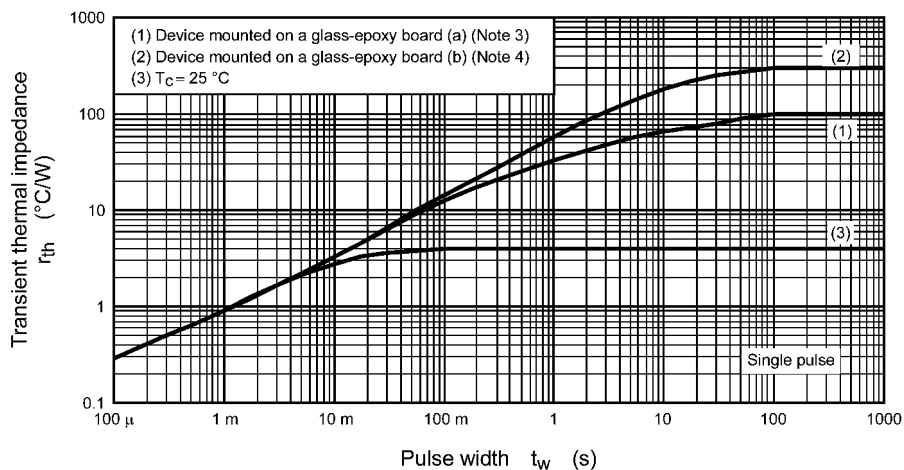


Fig. 8.13 $r_{th} - t_w$
(Guaranteed Maximum)

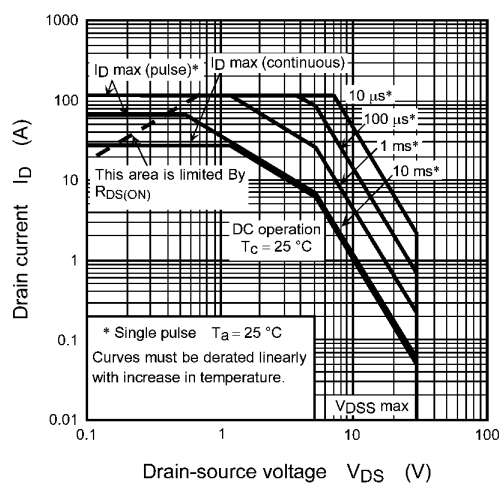


Fig. 8.14 Safe Operating Area
(Guaranteed Maximum)

Note: The above characteristics curves are presented for reference only and not guaranteed by production test, unless otherwise noted.

Package Dimensions

Unit: mm



Weight: 0.02 g (typ.)

| Package Name(s) |
|------------------------|
| TOSHIBA: 2-3X1S |
| Nickname: TSON Advance |

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