

TOSHIBA Field Effect Transistor Silicon N, P Channel MOS Type

(P Channel U-MOS IV/N Channel U-MOS III)

## TPC8405

Lithium Ion Secondary Battery Applications

Portable Equipment Applications

Notebook PC Applications

- Low drain-source ON resistance  
: P Channel  $R_{DS(ON)} = 25 \text{ m}\Omega$  (typ.)  
N Channel  $R_{DS(ON)} = 20 \text{ m}\Omega$  (typ.)
- High forward transfer admittance  
: P Channel  $|Y_{fs}| = 12 \text{ S}$  (typ.)  
N Channel  $|Y_{fs}| = 14 \text{ S}$  (typ.)
- Low leakage current  
: P Channel  $I_{DSS} = -10 \text{ }\mu\text{A}$  ( $V_{DS} = -30 \text{ V}$ )  
N Channel  $I_{DSS} = 10 \text{ }\mu\text{A}$  ( $V_{DS} = 30 \text{ V}$ )
- Enhancement mode  
: P Channel  $V_{th} = -0.8 \sim -2.0 \text{ V}$  ( $V_{DS} = -10 \text{ V}$ ,  $I_D = -1 \text{ mA}$ )  
N Channel  $V_{th} = 1.3 \sim 2.5 \text{ V}$  ( $V_{DS} = 10 \text{ V}$ ,  $I_D = 1 \text{ mA}$ )

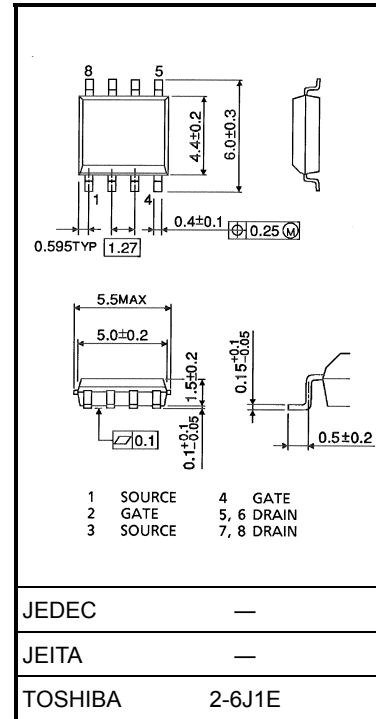
### Maximum Ratings ( $T_a = 25^\circ\text{C}$ )

| Characteristics                                                                     |                                                    | Symbol    | Rating            |                   | Unit             |
|-------------------------------------------------------------------------------------|----------------------------------------------------|-----------|-------------------|-------------------|------------------|
|                                                                                     |                                                    |           | P Channel         | N Channel         |                  |
| Drain-source voltage                                                                |                                                    | $V_{DSS}$ | -30               | 30                | V                |
| Drain-gate voltage ( $R_{GS} = 20 \text{ k}\Omega$ )                                |                                                    | $V_{DGR}$ | -30               | 30                | V                |
| Gate-source voltage                                                                 |                                                    | $V_{GSS}$ | $\pm 20$          | $\pm 20$          | V                |
| Drain current                                                                       | DC (Note 1)                                        | $I_D$     | -4.5              | 6                 | A                |
|                                                                                     | Pulse (Note 1)                                     | $I_{DP}$  | -18               | 24                |                  |
| Drain power dissipation<br>( $t = 10 \text{ s}$ )<br>(Note 2a)                      | Single-device operation<br>(Note 3a)               | $P_D (1)$ | 1.5               | 1.5               | W                |
|                                                                                     | Single-device value at<br>dual operation (Note 3b) | $P_D (2)$ | 1.1               | 1.1               |                  |
| Drain power dissipation<br>( $t = 10 \text{ s}$ )<br>(Note 2b)                      | Single-device operation<br>(Note 3a)               | $P_D (1)$ | 0.75              | 0.75              |                  |
|                                                                                     | Single-device value at<br>dual operation (Note 3b) | $P_D (2)$ | 0.45              | 0.45              |                  |
| Single pulse avalanche energy                                                       |                                                    | $E_{AS}$  | 13.2<br>(Note 4a) | 23.4<br>(Note 4b) | mJ               |
| Avalanche current                                                                   |                                                    | $I_{AR}$  | -4.5              | 6                 | A                |
| Repetitive avalanche energy<br>Single-device value at operation<br>(Note 2a, 3b, 5) |                                                    | $E_{AR}$  | 0.1               |                   | mJ               |
| Channel temperature                                                                 |                                                    | $T_{ch}$  | 150               |                   | $^\circ\text{C}$ |
| Storage temperature range                                                           |                                                    | $T_{stg}$ | -55~150           |                   | $^\circ\text{C}$ |

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

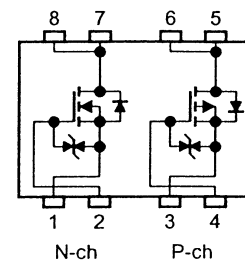
This transistor is an electrostatic-sensitive device. Handle with care.

Unit: mm



Weight: 0.080 g (typ.)

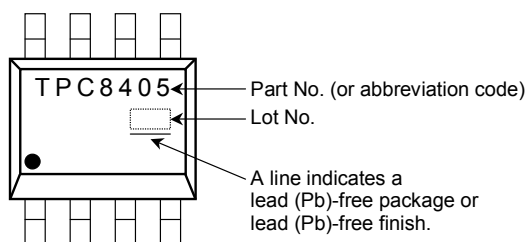
### Circuit Configuration



## Thermal Characteristics

| Characteristics                                                             |                                                       | Symbol            | Max  | Unit                 |
|-----------------------------------------------------------------------------|-------------------------------------------------------|-------------------|------|----------------------|
| Thermal resistance, channel to ambient<br>( $t = 10\text{s}$ )<br>(Note 2a) | Single-device operation<br>(Note 3a)                  | $R_{th(ch-a)}(1)$ | 83.3 | $^{\circ}\text{C/W}$ |
|                                                                             | Single-device value at<br>dual operation<br>(Note 3b) | $R_{th(ch-a)}(2)$ | 114  |                      |
| Thermal resistance, channel to ambient<br>( $t = 10\text{s}$ )<br>(Note 2b) | Single-device operation<br>(Note 3a)                  | $R_{th(ch-a)}(1)$ | 167  |                      |
|                                                                             | Single-device value at<br>dual operation<br>(Note 3b) | $R_{th(ch-a)}(2)$ | 278  |                      |

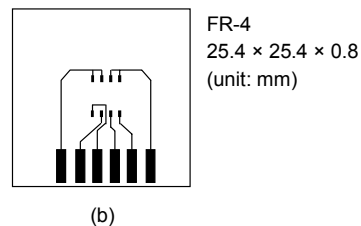
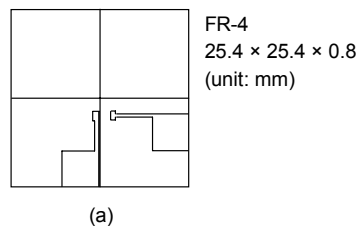
## Marking



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

Note 2:

- a) Device mounted on a glass-epoxy board (a)      b) Device mounted on a glass-epoxy board (b)



Note 3:

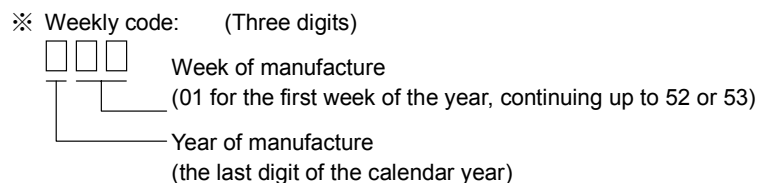
- a) The power dissipation and thermal resistance values shown are for a single device.  
(During single-device operation, power is applied to one device only.)
- b) The power dissipation and thermal resistance values shown are for a single device.  
(During dual operation, power is evenly applied to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

Note 4:

- a)  $V_{DD} = -24\text{ V}$ ,  $T_{ch} = 25^{\circ}\text{C}$  (initial),  $L = 0.5\text{ mH}$ ,  $R_G = 25\ \Omega$ ,  $I_{AR} = -4.5\text{ A}$
- b)  $V_{DD} = 24\text{ V}$ ,  $T_{ch} = 25^{\circ}\text{C}$  (initial),  $L = 0.5\text{ mH}$ ,  $R_G = 25\ \Omega$ ,  $I_{AR} = 6.0\text{ A}$

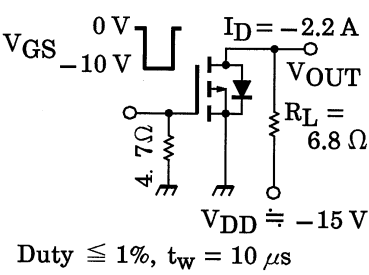
Note 5: Repetitive rating: pulse width limited by maximum channel temperature

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



## P-ch

## Electrical Characteristics (Ta = 25°C)

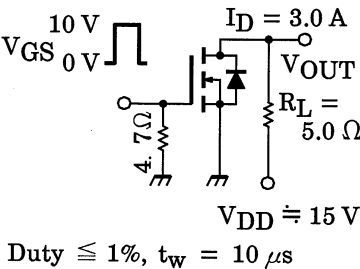
| Characteristics                                 |               | Symbol         | Test Condition                                                                                                                                                                                                                                                                                                                                                                  | Min  | Typ. | Max      | Unit          |
|-------------------------------------------------|---------------|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|----------|---------------|
| Gate leakage current                            |               | $I_{GSS}$      | $V_{GS} = \pm 16 \text{ V}, V_{DS} = 0 \text{ V}$                                                                                                                                                                                                                                                                                                                               | —    | —    | $\pm 10$ | $\mu\text{A}$ |
| Drain cut-OFF current                           |               | $I_{DSS}$      | $V_{DS} = -30 \text{ V}, V_{GS} = 0 \text{ V}$                                                                                                                                                                                                                                                                                                                                  | —    | —    | -10      | $\mu\text{A}$ |
| 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                          |               | $V_{th}$       | $V_{DS} = -10 \text{ V}, I_D = -1 \text{ mA}$                                                                                                                                                                                                                                                                                                                                   | -0.8 | —    | -2.0     | V             |
| Drain-source ON resistance                      |               | $R_{DS(ON)}$   | $V_{GS} = -4.5 \text{ V}, I_D = -2.2 \text{ A}$                                                                                                                                                                                                                                                                                                                                 | —    | 32   | 42       | m $\Omega$    |
|                                                 |               | $R_{DS(ON)}$   | $V_{GS} = -10 \text{ V}, I_D = -2.2 \text{ A}$                                                                                                                                                                                                                                                                                                                                  | —    | 25   | 33       |               |
| Forward transfer admittance                     |               | $ Y_{fs} $     | $V_{DS} = -10 \text{ V}, I_D = -2.2 \text{ A}$                                                                                                                                                                                                                                                                                                                                  | 6    | 12   | —        | S             |
| Input capacitance                               |               | $C_{iss}$      | $V_{DS} = -10 \text{ V}, V_{GS} = 0 \text{ V}, f = 1 \text{ MHz}$                                                                                                                                                                                                                                                                                                               | —    | 1540 | —        | pF            |
| Reverse transfer capacitance                    |               | $C_{rss}$      |                                                                                                                                                                                                                                                                                                                                                                                 | —    | 220  | —        |               |
| Output capacitance                              |               | $C_{oss}$      |                                                                                                                                                                                                                                                                                                                                                                                 | —    | 250  | —        |               |
| Switching time                                  | Rise time     | $t_r$          |  <p><math>V_{GS} = 0 \text{ V}</math><br/><math>V_{GS} = -10 \text{ V}</math><br/><math>I_D = -2.2 \text{ A}</math><br/><math>V_{OUT}</math><br/><math>R_L = 6.8 \Omega</math><br/><math>V_{DD} \approx -15 \text{ V}</math><br/><math>\text{Duty} \leq 1\%, t_w = 10 \mu\text{s}</math></p> | —    | 5.0  | —        | ns            |
|                                                 | Turn-ON time  | $t_{on}$       |                                                                                                                                                                                                                                                                                                                                                                                 | —    | 13   | —        |               |
|                                                 | Fall time     | $t_f$          |                                                                                                                                                                                                                                                                                                                                                                                 | —    | 35   | —        |               |
|                                                 | Turn-OFF time | $t_{off}$      |                                                                                                                                                                                                                                                                                                                                                                                 | —    | 125  | —        |               |
| Total gate charge (Gate-source plus gate-drain) |               | $Q_g$          | $V_{DD} \approx -24 \text{ V}, V_{GS} = -10 \text{ V}, I_D = -4.5 \text{ A}$                                                                                                                                                                                                                                                                                                    | —    | 40   | —        | nC            |
| Gate-source charge 1                            |               | $Q_{gs1}$      |                                                                                                                                                                                                                                                                                                                                                                                 | —    | 4.4  | —        |               |
| Gate-drain (“miller”) charge                    |               | $Q_{gd}$       |                                                                                                                                                                                                                                                                                                                                                                                 | —    | 8.2  | —        |               |

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

| Characteristics       |                | Symbol    | Test Condition                                  | Min | Typ. | Max | Unit |
|-----------------------|----------------|-----------|-------------------------------------------------|-----|------|-----|------|
| Drain reverse current | Pulse (Note 1) | $I_{DRP}$ | —                                               | —   | —    | -18 | A    |
|                       |                | $V_{DSF}$ | $I_{DR} = -4.5 \text{ A}, V_{GS} = 0 \text{ V}$ | —   | —    | 1.2 | V    |

## N-ch

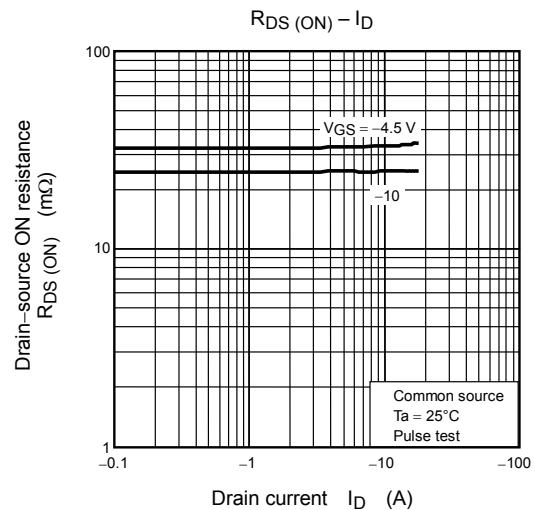
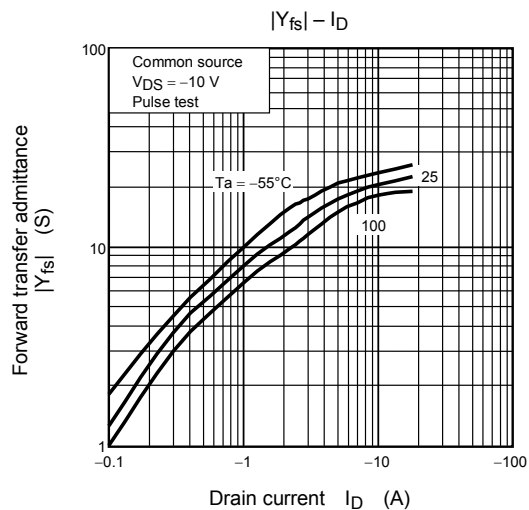
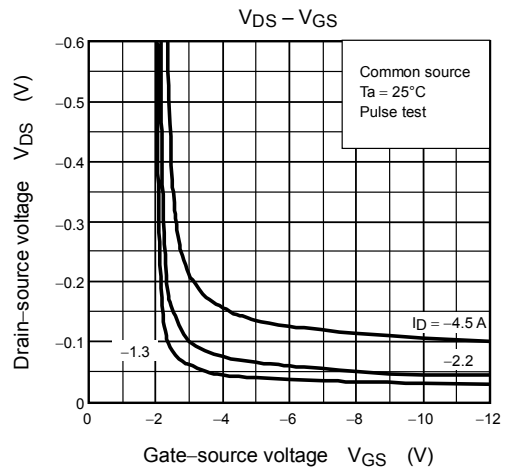
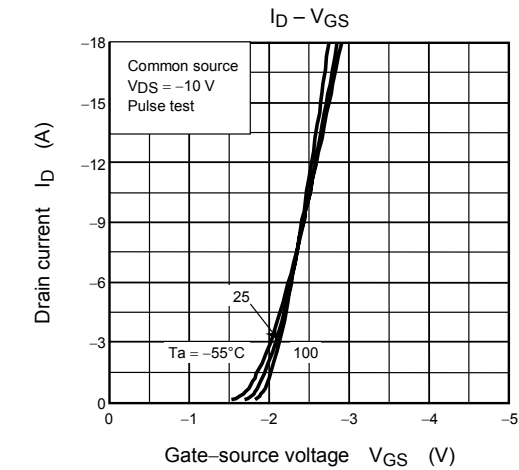
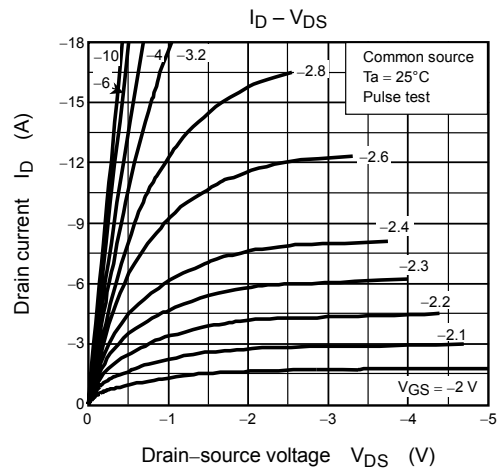
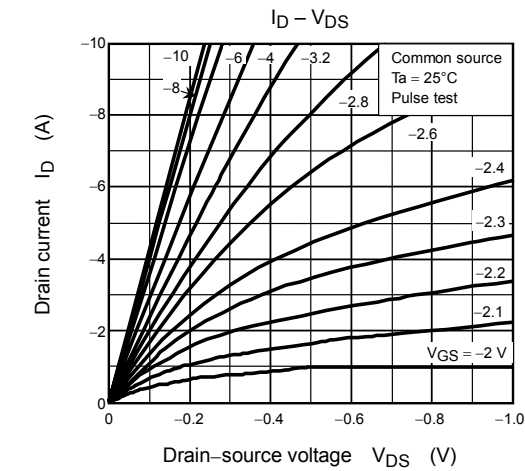
## Electrical Characteristics (Ta = 25°C)

| Characteristics                                 |               | Symbol         | Test Condition                                                                                                                                                                                                                                                         | Min | Typ. | Max      | Unit          |
|-------------------------------------------------|---------------|----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|------|----------|---------------|
| Gate leakage current                            |               | $I_{GSS}$      | $V_{GS} = \pm 16 \text{ V}, V_{DS} = 0 \text{ V}$                                                                                                                                                                                                                      | —   | —    | $\pm 10$ | $\mu\text{A}$ |
| Drain cut-OFF current                           |               | $I_{DSS}$      | $V_{DS} = 30 \text{ V}, V_{GS} = 0 \text{ V}$                                                                                                                                                                                                                          | —   | —    | 10       | $\mu\text{A}$ |
| 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                          |               | $V_{th}$       | $V_{DS} = 10 \text{ V}, I_D = 1 \text{ mA}$                                                                                                                                                                                                                            | 1.3 | —    | 2.5      | V             |
| Drain-source ON resistance                      |               | $R_{DS(ON)}$   | $V_{GS} = 4.5 \text{ V}, I_D = 3 \text{ A}$                                                                                                                                                                                                                            | —   | 25   | 33       | m $\Omega$    |
|                                                 |               | $R_{DS(ON)}$   | $V_{GS} = 10 \text{ V}, I_D = 3 \text{ A}$                                                                                                                                                                                                                             | —   | 20   | 26       |               |
| Forward transfer admittance                     |               | $ Y_{fs} $     | $V_{DS} = 10 \text{ V}, I_D = 3 \text{ A}$                                                                                                                                                                                                                             | 7   | 14   | —        | S             |
| Input capacitance                               |               | $C_{iss}$      | $V_{DS} = 10 \text{ V}, V_{GS} = 0 \text{ V}, f = 1 \text{ MHz}$                                                                                                                                                                                                       | —   | 1240 | —        | pF            |
| Reverse transfer capacitance                    |               | $C_{rss}$      |                                                                                                                                                                                                                                                                        | —   | 180  | —        |               |
| Output capacitance                              |               | $C_{oss}$      |                                                                                                                                                                                                                                                                        | —   | 230  | —        |               |
| Switching time                                  | Rise time     | $t_r$          |  <p><math>I_D = 3.0 \text{ A}</math><br/><math>R_L = 5.0 \Omega</math><br/><math>V_{DD} \approx 15 \text{ V}</math><br/><math>\text{Duty} \leq 1\%, t_w = 10 \mu\text{s}</math></p> | —   | 4.5  | —        | ns            |
|                                                 | Turn-ON time  | $t_{on}$       |                                                                                                                                                                                                                                                                        | —   | 12.5 | —        |               |
|                                                 | Fall time     | $t_f$          |                                                                                                                                                                                                                                                                        | —   | 6.6  | —        |               |
|                                                 | Turn-OFF time | $t_{off}$      |                                                                                                                                                                                                                                                                        | —   | 33   | —        |               |
| Total gate charge (Gate-source plus gate-drain) |               | $Q_g$          | $V_{DD} \approx 24 \text{ V}, V_{GS} = 10 \text{ V}, I_D = 6 \text{ A}$                                                                                                                                                                                                | —   | 27   | —        | nC            |
| Gate-source charge 1                            |               | $Q_{gs1}$      |                                                                                                                                                                                                                                                                        | —   | 3.9  | —        |               |
| Gate-drain ("miller") charge                    |               | $Q_{gd}$       |                                                                                                                                                                                                                                                                        | —   | 7.0  | —        |               |

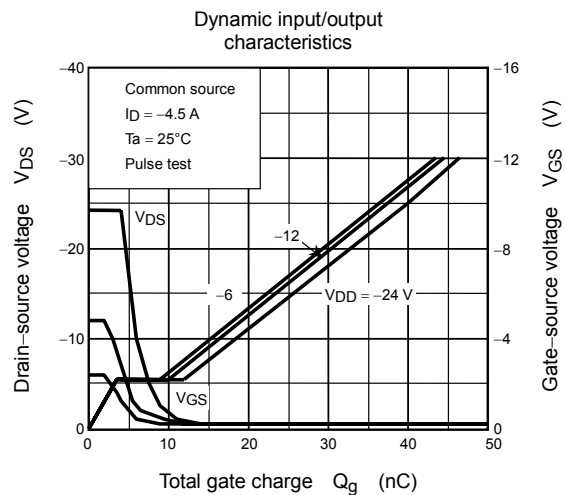
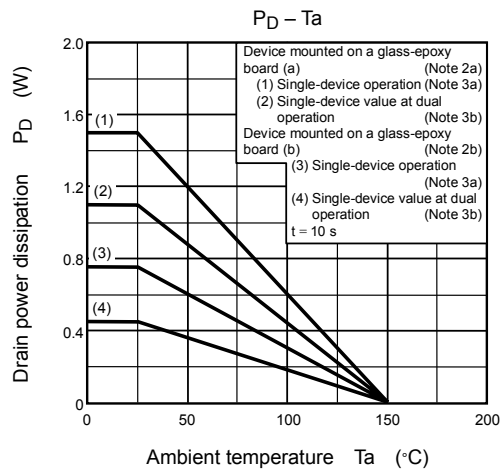
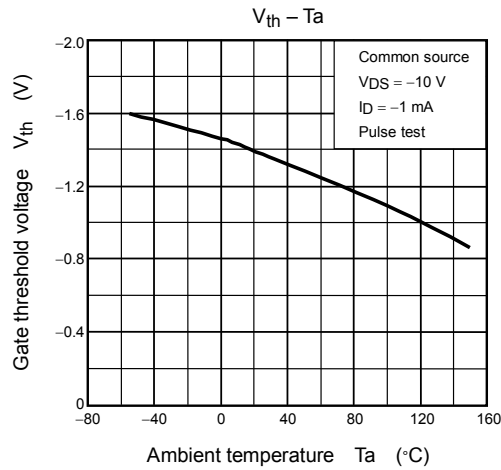
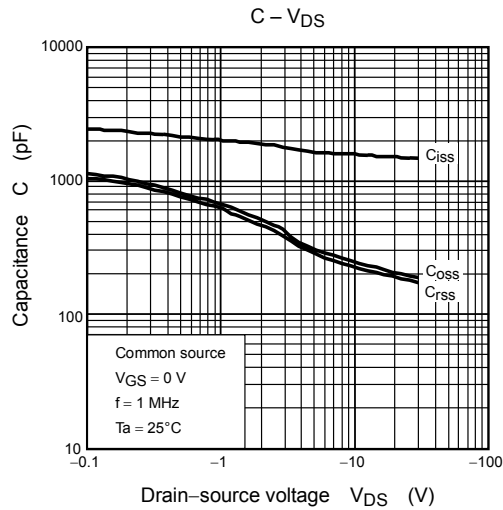
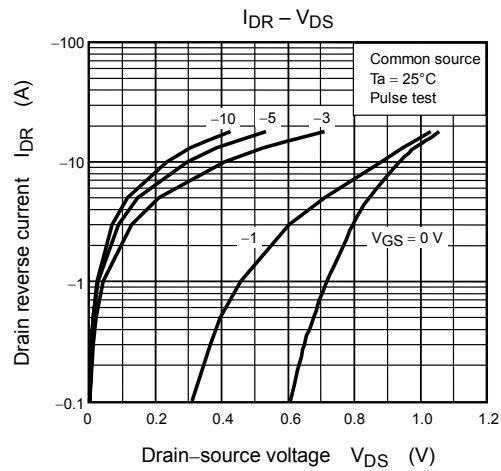
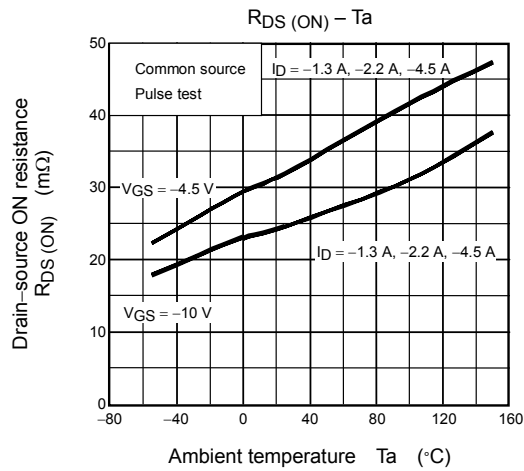
## Source-Drain Ratings and Characteristics (Ta = 25°C)

| Characteristics       |                | Symbol    | Test Condition                               | Min | Typ. | Max  | Unit |
|-----------------------|----------------|-----------|----------------------------------------------|-----|------|------|------|
| Drain reverse current | Pulse (Note 1) | $I_{DRP}$ | —                                            | —   | —    | 24   | A    |
|                       |                | $V_{DSF}$ | $I_{DR} = 6 \text{ A}, V_{GS} = 0 \text{ V}$ | —   | —    | -1.2 | V    |

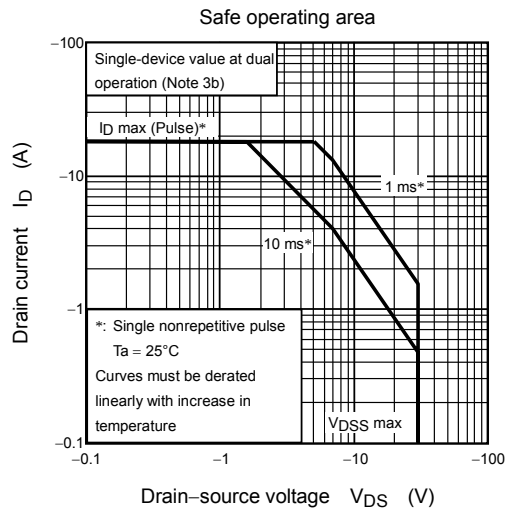
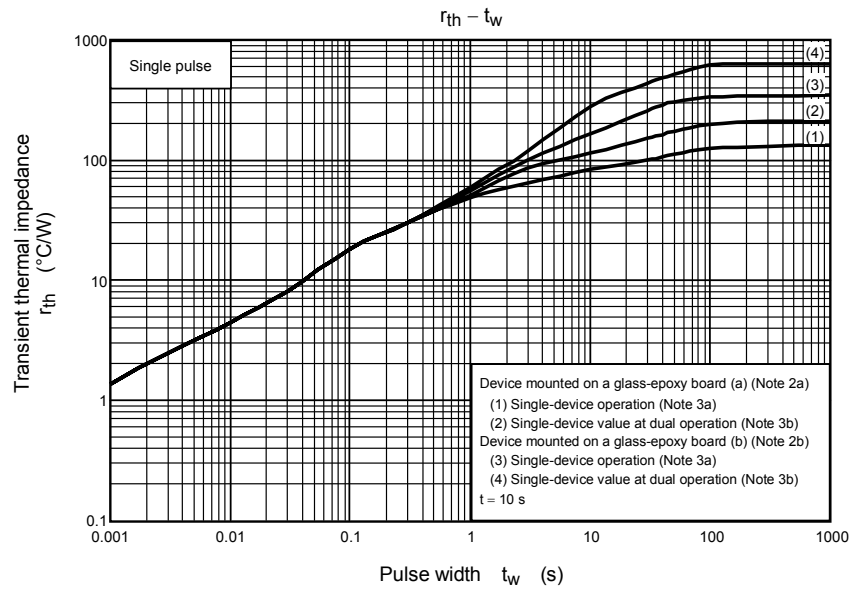
## P-ch



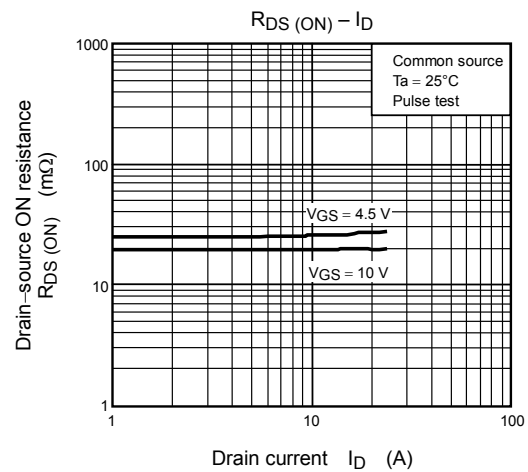
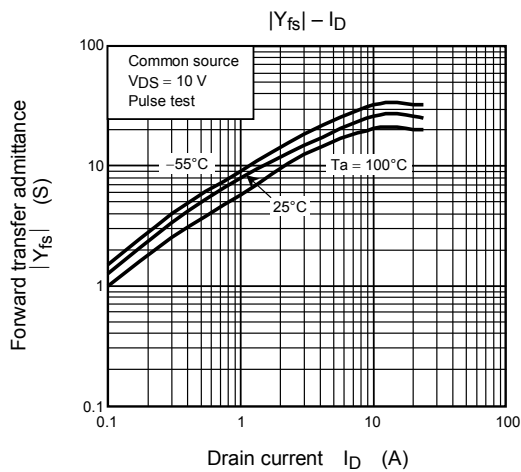
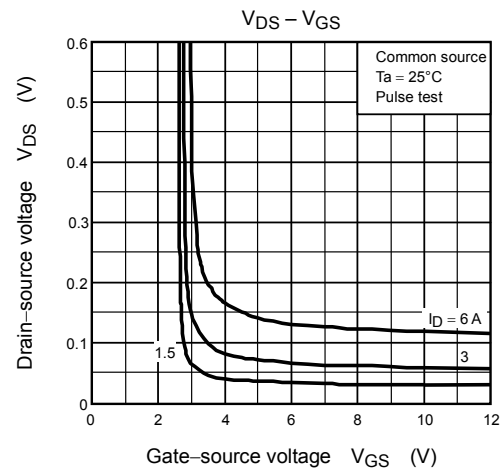
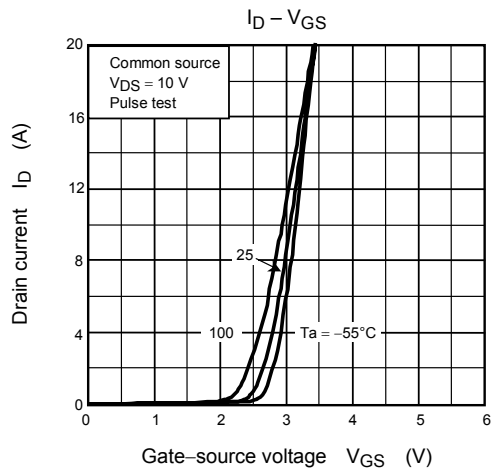
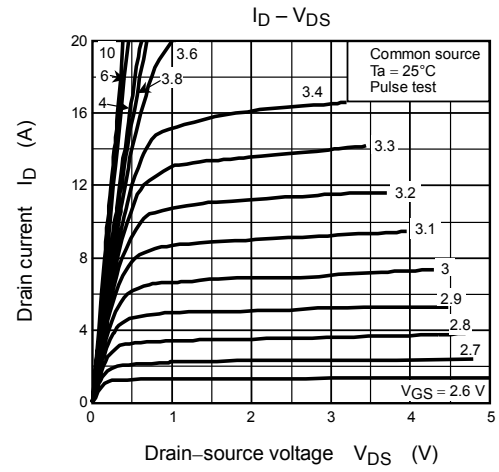
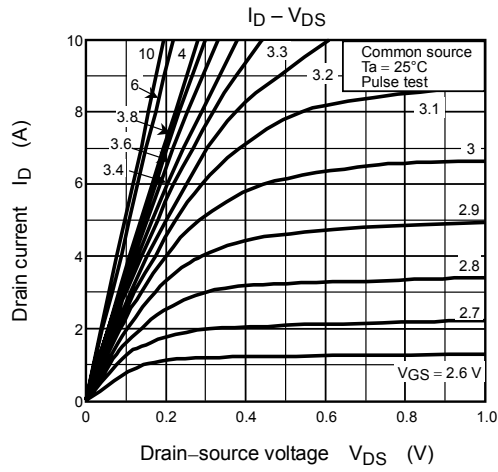
## P-ch



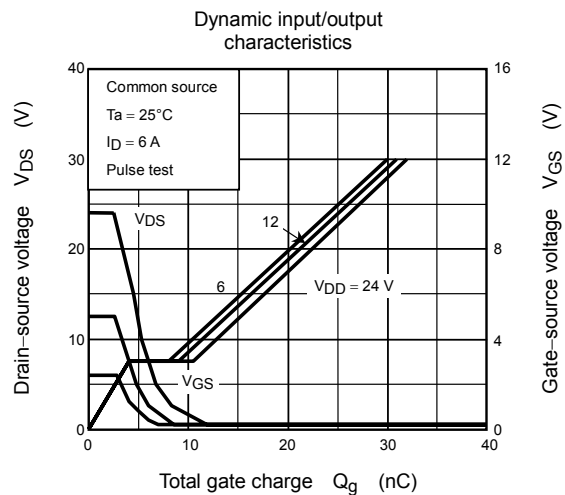
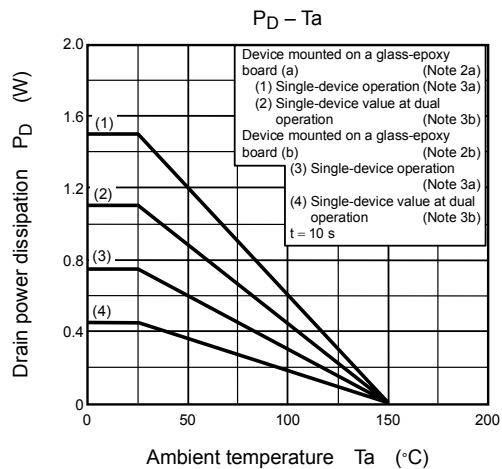
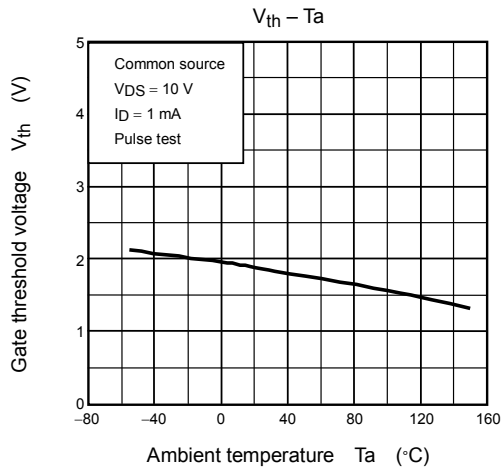
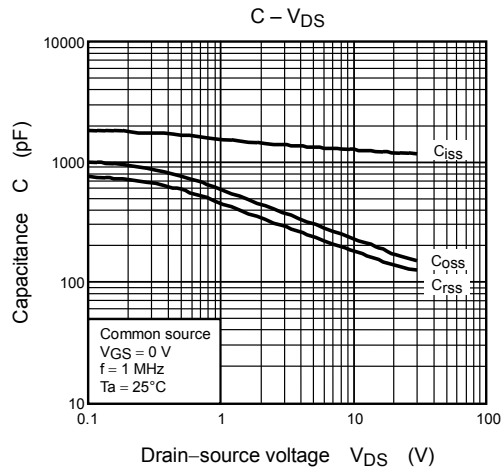
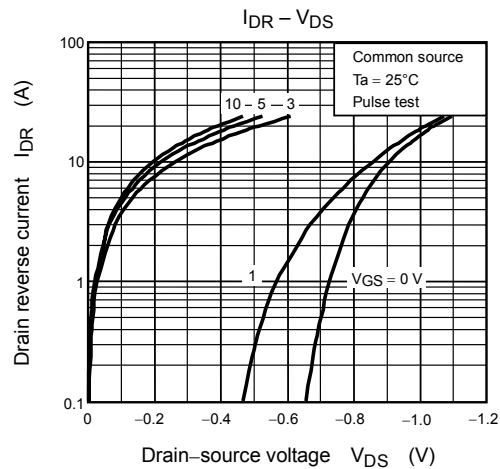
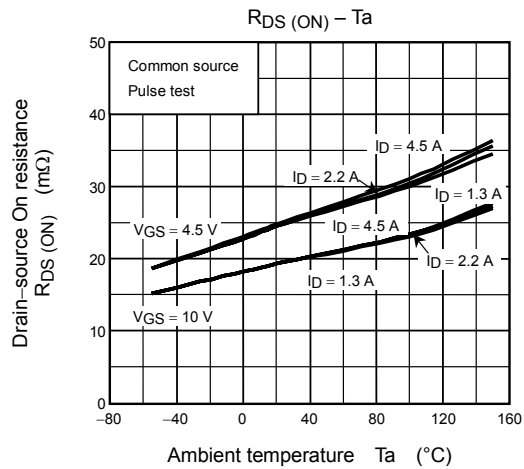
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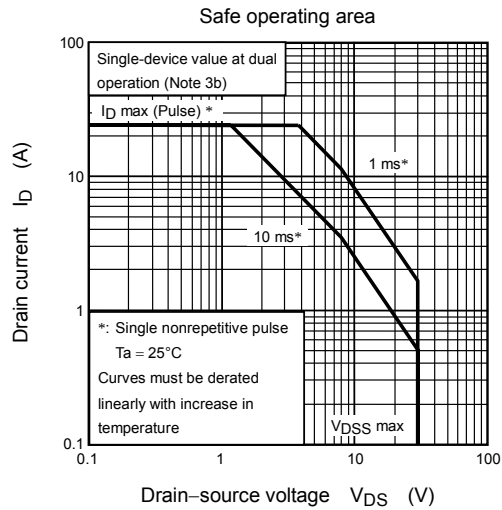
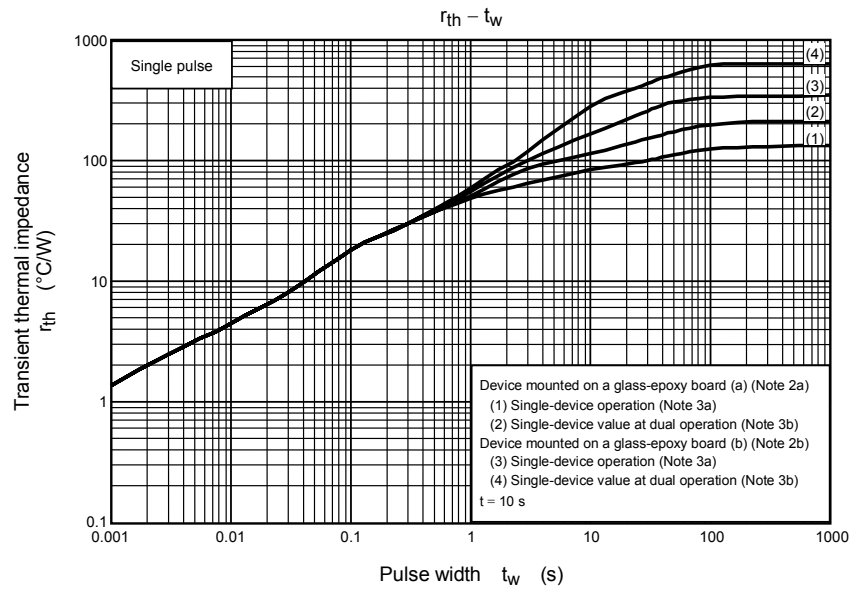
## N-ch



## N-ch



N-ch



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