

### FEATURES

- $R_{DS(ON)} < 2.4 \Omega$  @  $V_{GS} = 10V$
- Fast switching capability
- Lead free in compliance with EU RoHS directive.
- Green molding compound

### MECHANICAL DATA

- Case: TO-220, ITO-220, TO-251, TO-252, TO-262, TO-263 Package

### Ordering Information

| Part No. | Package | Packing           |
|----------|---------|-------------------|
| 4N65-TU  | TO-220  | 50pcs / Tube      |
| 4N65F-TU | ITO-220 | 50pcs / Tube      |
| 4N65E-TU | TO-262  | 50pcs / Tube      |
| 4N65D-TU | TO-263  | 50pcs / Tube      |
| 4N65D-TR | TO-263  | 800pcs / 13"Reel  |
| 4N65N-TU | TO-251  | 75pcs / Tube      |
| 4N65M-TU | TO-252  | 75pcs / Tube      |
| 4N65M-TR | TO-252  | 2.5Kpcs / 13"Reel |

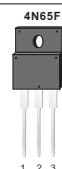
### PRODUCT SUMMARY

| $V_{DS}$ (V) | $R_{DS(on)}$ ( $\Omega$ ) | $I_D$ (A) |
|--------------|---------------------------|-----------|
| 650          | 2.4 @ $V_{GS} = 10V$      | 4         |

TO-220AB



ITO-220AB



TO-263



TO-262  
4N65E



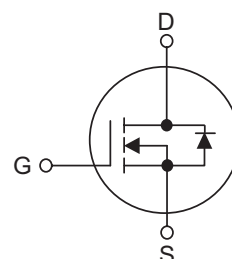
TO-251  
4N65N



TO-252  
4N65M



### Block Diagram



Pin Definition:

1. Gate
2. Drain
3. Source

### ABSOLUTE MAXIMUM RATINGS

( $T_C = 25^\circ C$ , unless otherwise specified)

| PARAMETER                     | SYMBOL               | RATINGS    | UNIT       |
|-------------------------------|----------------------|------------|------------|
| Drain-Source Voltage          | $V_{DS}$             | 650        | V          |
| Gate-Source Voltage           | $V_{GS}$             | $\pm 30$   | V          |
| Continuous Drain Current      | $I_D$                | 4.0        | A          |
| Pulsed Drain Current (Note 2) | $I_{DM}$             | 16         | A          |
| Avalanche Energy              | $E_{AS}$             | 260        | mJ         |
| Power Dissipation             | TO-220/TO-263/TO-262 | 106        | W          |
|                               | ITO-220              | 35         |            |
|                               | TO-251/TO-252        | 50         |            |
| Junction Temperature          | $T_J$                | +150       | $^\circ C$ |
| Storage Temperature           | $T_{STG}$            | -55 ~ +150 | $^\circ C$ |

Notes: 1. Absolute maximum ratings are those values beyond which the device could be permanently damaged.

Absolute maximum ratings are stress ratings only and functional device operation is not implied.

2. Repetitive Rating : Pulse width limited by maximum junction temperature

3.  $L = 30mH$ ,  $I_{AS} = 3.6A$ ,  $V_{DD} = 50V$ ,  $R_G = 25\Omega$ , Starting  $T_J = 25^\circ C$

# 4N65

## 650V N-Channel Power MOSFET

### THERMAL DATA

| PARAMETER           |                                 | SYMBOL        | RATING | UNIT |
|---------------------|---------------------------------|---------------|--------|------|
| Junction to Ambient | TO-220/ITO-220<br>TO-262/TO-263 | $\theta_{JA}$ | 62.5   | C/W  |
|                     | TO-251/TO-252                   |               | 110    |      |
| Junction to Case    | TO-220/TO-263/TO-262            | $\theta_{JC}$ | 2.35   | C/W  |
|                     | ITO-220                         |               | 5.5    |      |
|                     | TO-251/TO-252                   |               | 2.9    |      |

### ELECTRICAL CHARACTERISTICS (T<sub>C</sub>=25°C, unless otherwise specified)

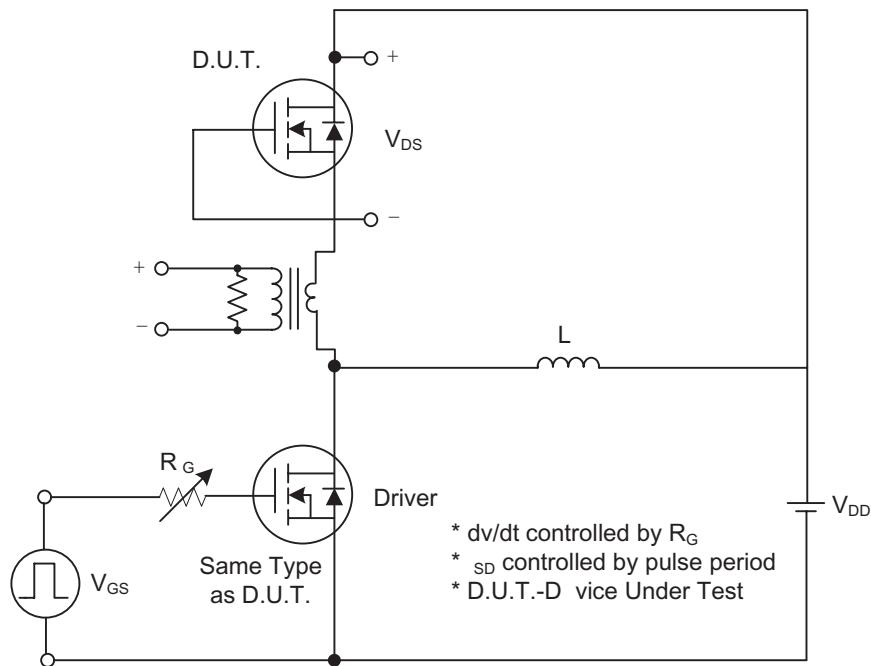
| PARAMETER                                              |         | SYMBOL              | TEST CONDITIONS                                                               | MIN | TYP | MAX  | UNIT |
|--------------------------------------------------------|---------|---------------------|-------------------------------------------------------------------------------|-----|-----|------|------|
| OFF CHARACTERISTICS                                    |         |                     |                                                                               |     |     |      |      |
| Drain-Source Breakdown Voltage                         |         | BV <sub>DSS</sub>   | V <sub>GS</sub> =0V,I <sub>D</sub> =250μA                                     | 650 |     |      | V    |
| Drain-Source Leakage Current                           |         | I <sub>DSS</sub>    | V <sub>DS</sub> =650V,V <sub>GS</sub> =0V                                     |     |     | 1    | μA   |
| Gate- Source Leakage Current                           | Forward | I <sub>GSS</sub>    | V <sub>G</sub> =30V,V <sub>DS</sub> =0V                                       |     |     | 100  | nA   |
|                                                        | Reverse |                     | V <sub>GS</sub> =-30V,V <sub>DS</sub> =0V                                     |     |     | -100 | nA   |
|                                                        |         |                     |                                                                               |     |     |      |      |
| ON CHARACTERISTICS                                     |         |                     |                                                                               |     |     |      |      |
| Gate Threshold Voltage                                 |         | V <sub>GS(TH)</sub> | V <sub>DS</sub> =V <sub>GS</sub> ,I <sub>D</sub> =250μA                       | 2.0 |     | 4.0  | V    |
| Static Drain-Source On-State Resistance                |         | R <sub>DS(ON)</sub> | V <sub>GS</sub> =10V,I <sub>D</sub> =2.0A                                     |     | 2.0 | 2.4  | Ω    |
| DYNAMIC CHARACTERISTICS                                |         |                     |                                                                               |     |     |      |      |
| Input Capacitance                                      |         | C <sub>ISS</sub>    | V <sub>DS</sub> =25V,V <sub>GS</sub> =0V,f=1MHz                               |     | 300 |      | pF   |
| Output Capacitance                                     |         | C <sub>OSS</sub>    |                                                                               |     | 45  |      | pF   |
| Reverse Transfer Capacitance                           |         | C <sub>RSS</sub>    |                                                                               |     | 2   |      | pF   |
| SWITCHING CHARACTERISTICS                              |         |                     |                                                                               |     |     |      |      |
| Turn-On Delay Time                                     |         | t <sub>D(ON)</sub>  | V <sub>DD</sub> =325V,I <sub>D</sub> =4.0A,<br>R <sub>G</sub> =25Ω(Note1, 2)  |     | 45  |      | ns   |
| Turn-On Rise Time                                      |         | t <sub>r</sub>      |                                                                               |     | 100 |      | ns   |
| Turn-Off Delay Time                                    |         | t <sub>D(OFF)</sub> |                                                                               |     | 200 |      | ns   |
| Turn-Off Fall Time                                     |         | t <sub>f</sub>      |                                                                               |     | 130 |      | ns   |
| Total Gate Charge                                      |         | Q <sub>G</sub>      | V <sub>DS</sub> =520V,I <sub>D</sub> =4.0A,<br>V <sub>GS</sub> =10V(Note1, 2) |     | 100 |      | nC   |
| Gate-Source Charge                                     |         | Q <sub>GS</sub>     |                                                                               |     | 17  |      | nC   |
| Gate-Drain Charge                                      |         | Q <sub>GD</sub>     |                                                                               |     | 20  |      | nC   |
| DRAIN-SOURCE DIODE CHARACTERISTICS AND MAXIMUM RATINGS |         |                     |                                                                               |     |     |      |      |
| Drain-Source Diode Forward Voltage                     |         | V <sub>SD</sub>     | V <sub>GS</sub> =0V, I <sub>S</sub> =4A                                       |     |     | 1.4  | V    |
| Maximum Continuous Drain-Source Diode Forward Current  |         | I <sub>S</sub>      |                                                                               |     |     | 4.0  | A    |
| Maximum Pulsed Drain-Source Diode Forward Current      |         | I <sub>SM</sub>     |                                                                               |     |     | 16   | A    |
| Reverse Recovery Time                                  |         | t <sub>rr</sub>     | V <sub>GS</sub> =0V, I <sub>S</sub> =4A                                       |     | 260 |      | ns   |
| Reverse Recovery Charge                                |         | Q <sub>RR</sub>     | dlF/dt=100A/μs (Note 1)                                                       |     | 2.5 |      | μC   |

Notes: 1. Pulse Test: Pulse width ≤300μs, Duty cycle ≤2%.  
2. Essentially independent of operating temperature.

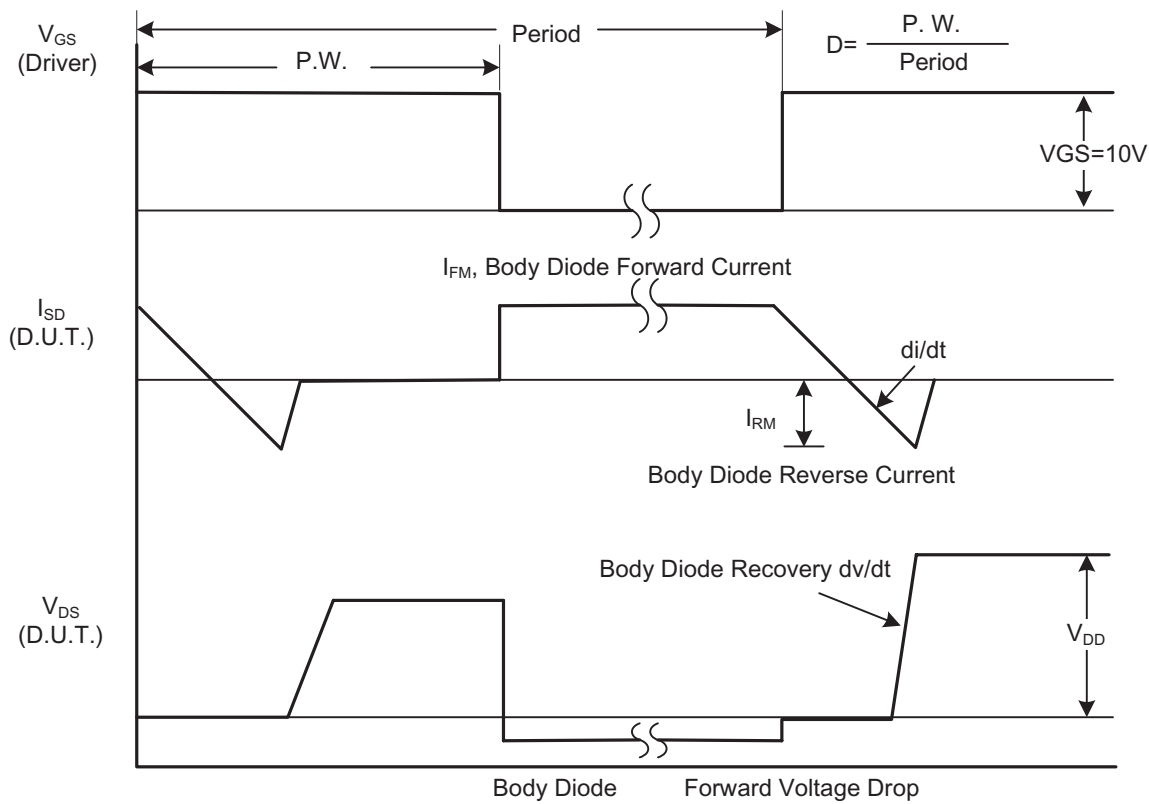
# 4N65

## 650V N-Channel Power MOSFET

### TEST CIRCUITS AND WAVEFORMS



Peak Diode Recovery dv/dt Test Circuit

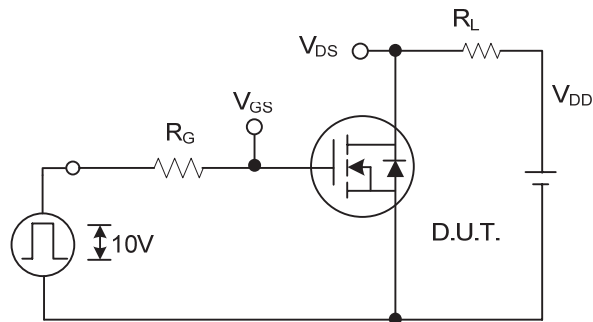


Peak Diode Recovery dv/dt Waveforms

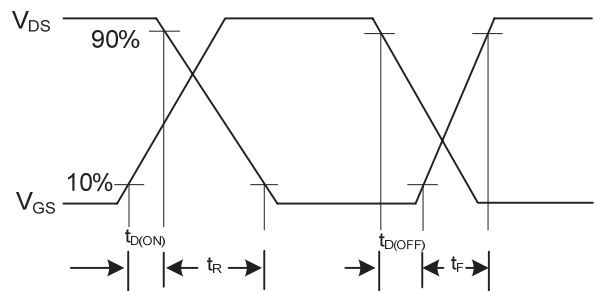
# 4N65

## 650V N-Channel Power MOSFET

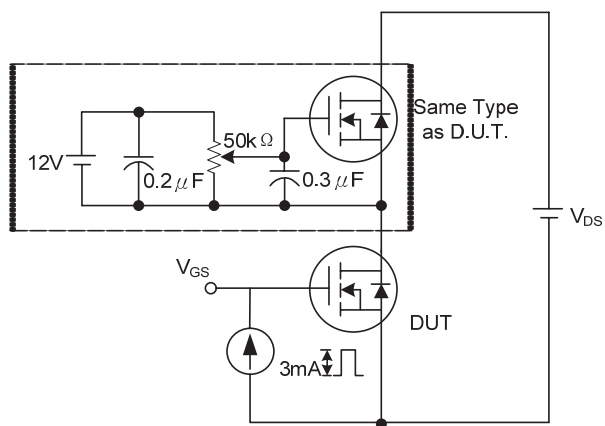
### TEST CIRCUITS AND WAVEFORMS(Cont.)



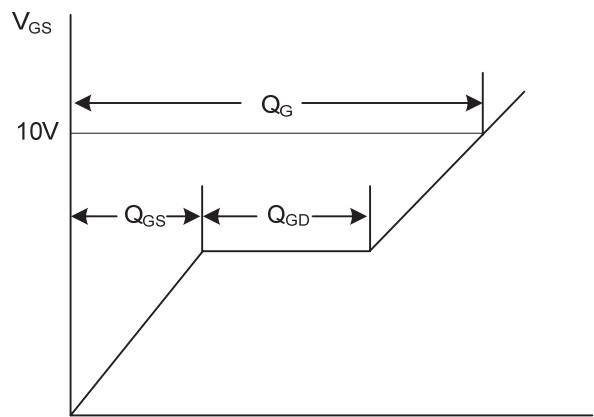
Switching Test Circuit



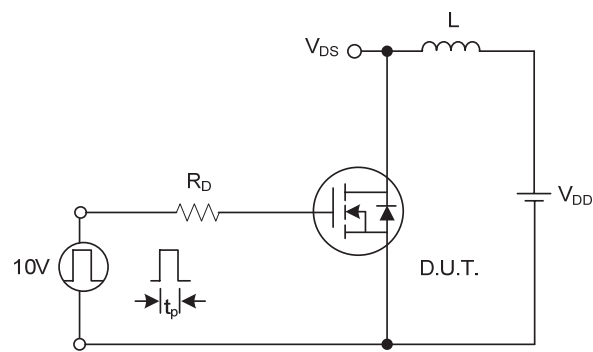
Switching Waveforms



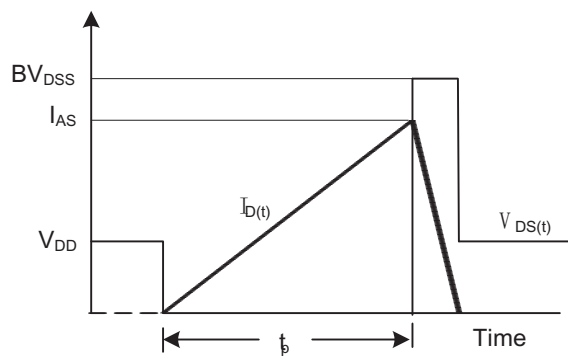
Gate Charge Test Circuit



Charge  
Gate Charge Waveform



Unclamped Inductive Switching Test Circuit

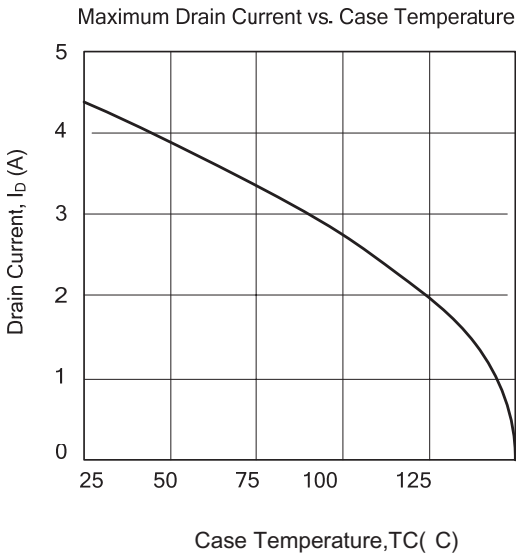
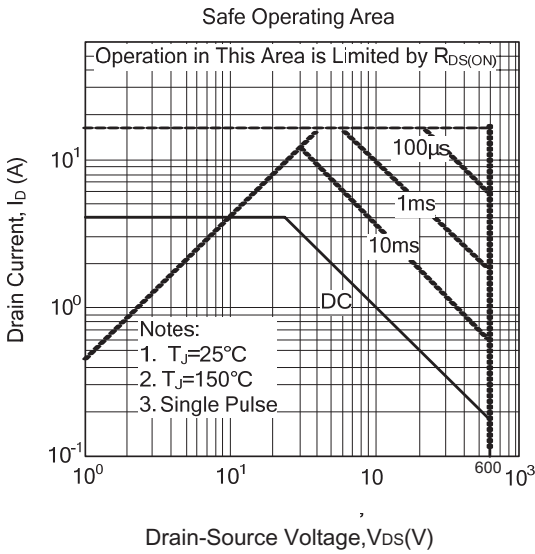
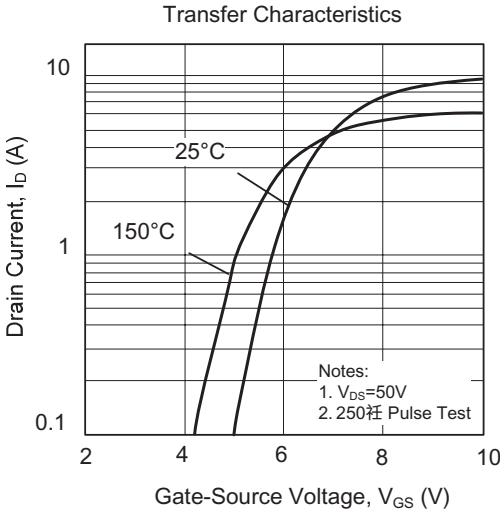
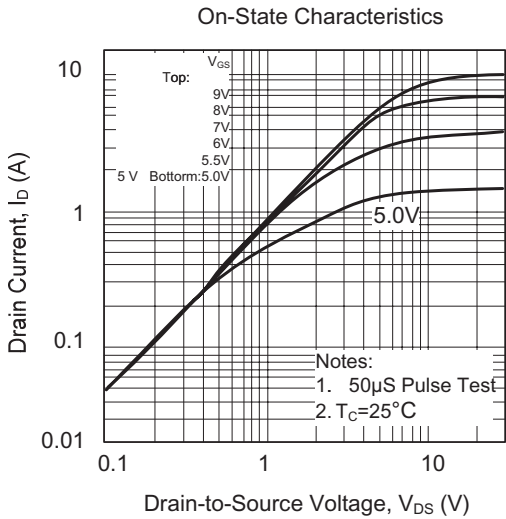
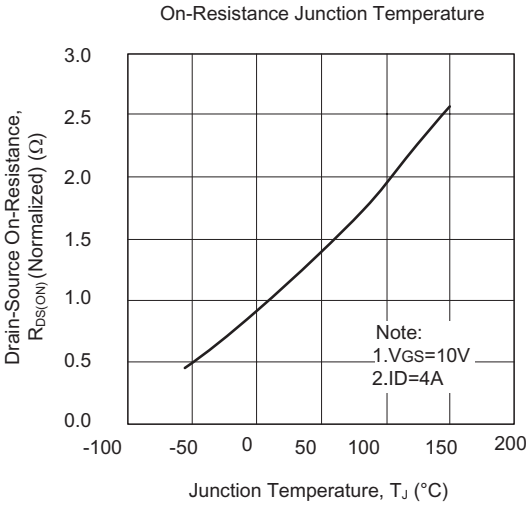
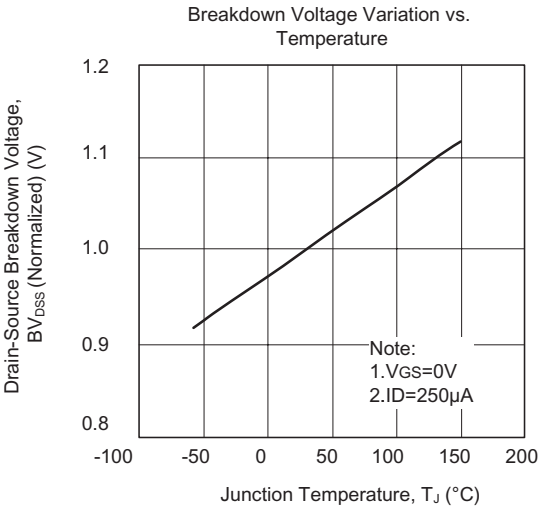


Unclamped Inductive Switching Waveforms

# 4N65

## 650V N-Channel Power MOSFET

### TYPICAL CHARACTERISTICS

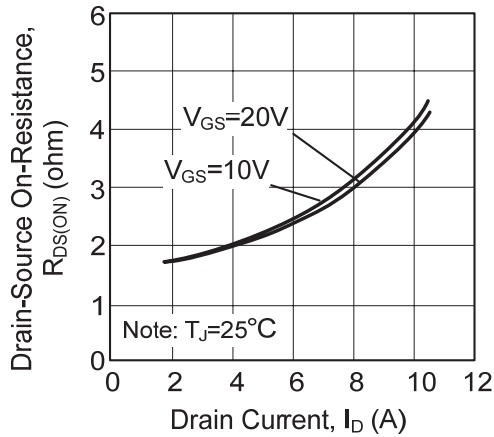


# 4N65

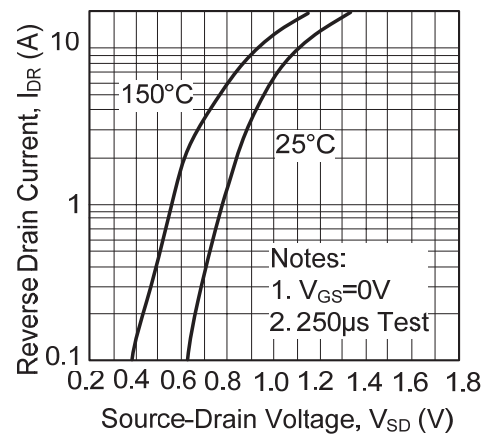
## 650V N-Channel Power MOSFET

### TYPICAL CHARACTERISTICS

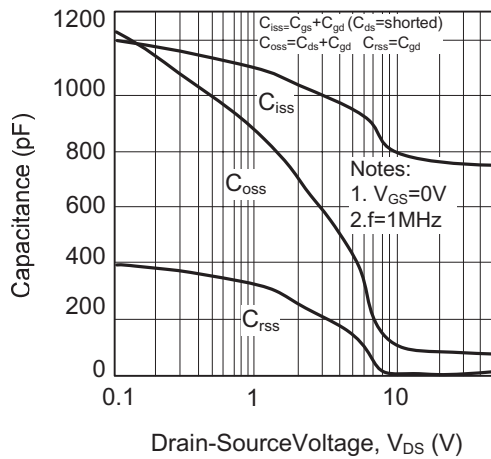
On-Resistance Variation vs. Drain Current and Gate Voltage



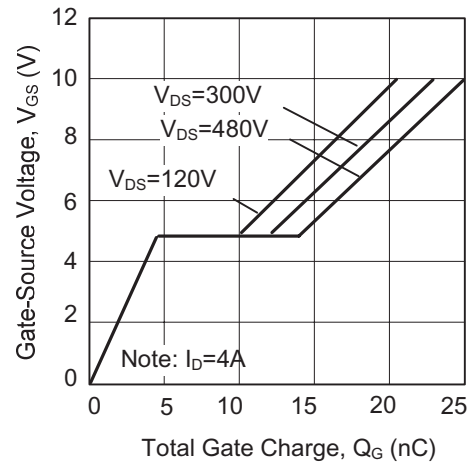
On State Current vs. Allowable Case Temperature



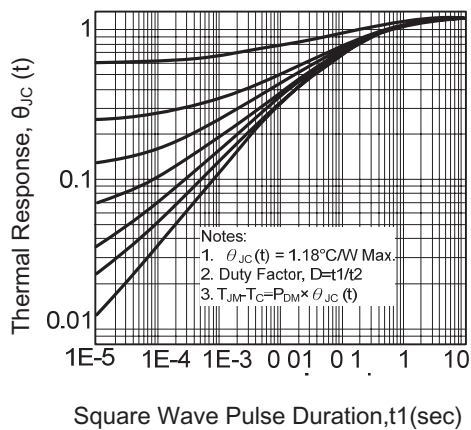
Capacitance Characteristics (Non-Repetitive)



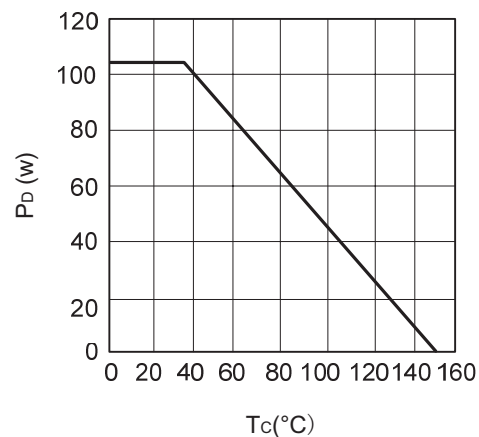
Gate Charge Characteristics



Transient Thermal Response Curve



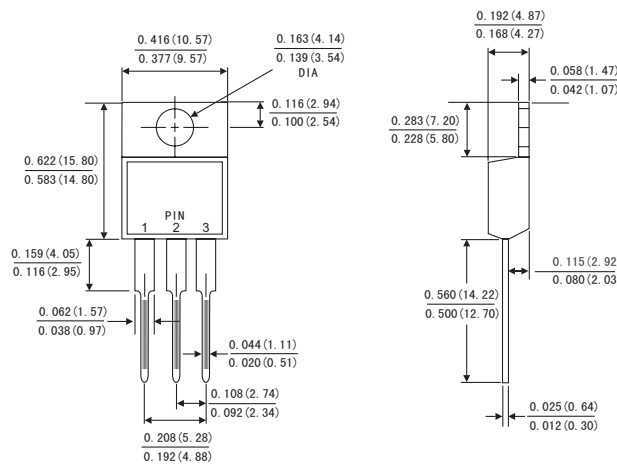
Power Dissipation



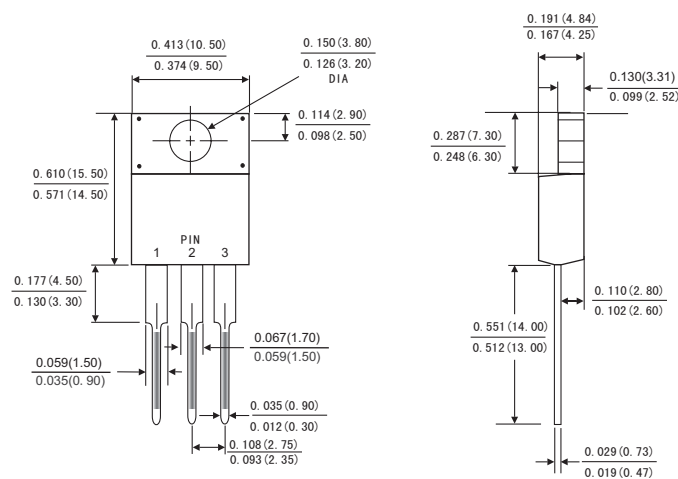
# 4N65

## 650V N-Channel Power MOSFET

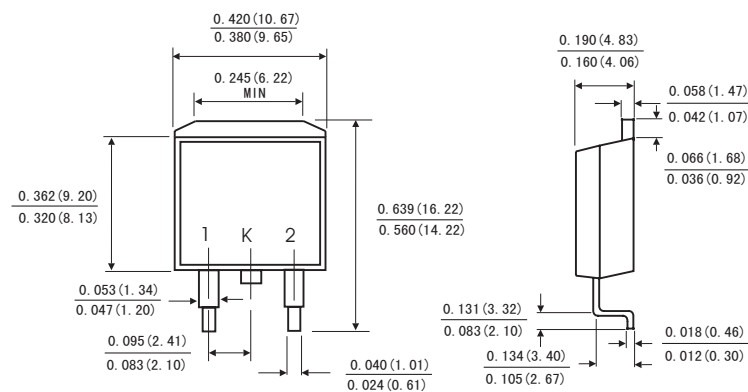
### TO-220AB



### ITO-220AB



### TO-263



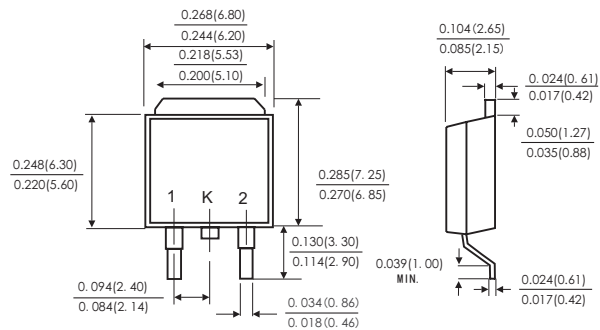
Dimensions in inches and (millimeters)

# 4N65

## 650V N-Channel Power MOSFET

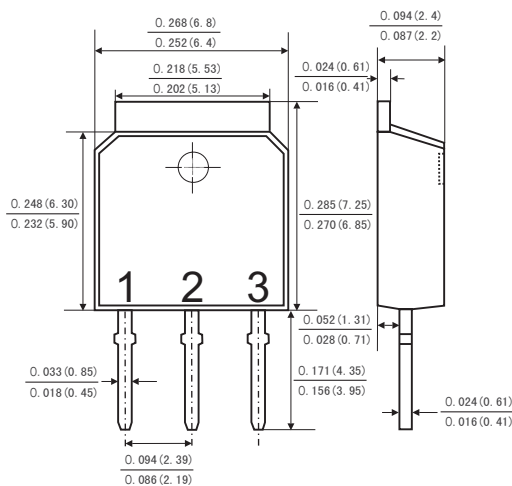
### TO-252

(DPAK)



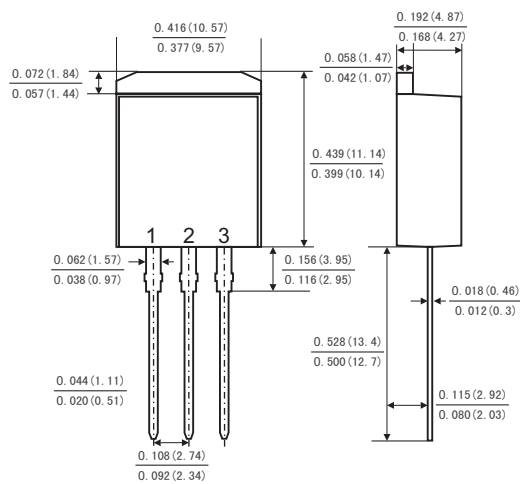
Dimensions in inches and (millimeters)

### TO-251



Dimensions in inches and (millimeters)

### TO-262



Dimensions in inches and (millimeters)