NEC

# MOS FIELD EFFECT TRANSISTOR

# NP86N04CHE, NP86N04DHE, NP86N04EHE

## SWITCHING
## N-CHANNEL POWER MOS FET
## INDUSTRIAL USE

### DESCRIPTION

These products are N-channel MOS Field Effect Transistor designed for high current switching applications.

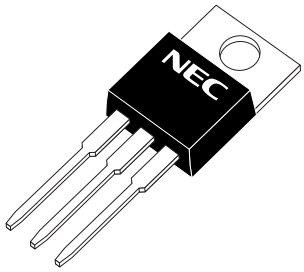
### FEATURES

- Channel temperature 175 degree rated
- Super low on-state resistance
- ★ $R_{DS(on)}$ = 4.4 mΩ MAX. ($V_{GS}$ = 10 V, $I_D$ = 43 A)
- ★ Low $C_{iss}$ : $C_{iss}$ = 5900 pF TYP.
- Built-in gate protection diode

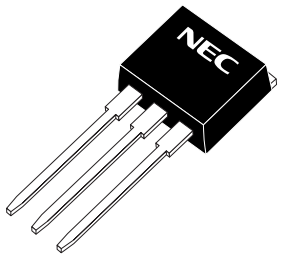
### ORDERING INFORMATION

| PART NUMBER | PACKAGE |
|---|---|
| NP86N04CHE | TO-220AB |
| NP86N04DHE | TO-262 |
| NP86N04EHE | TO-263 |

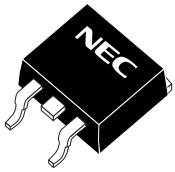
(TO-220AB)




(TO-262)




(TO-263)




### ABSOLUTE MAXIMUM RATINGS ($T_A$ = 25°C)

| | | | | |
|---|---|---|---|---|
| | Drain to Source Voltage | $V_{DSS}$ | 40 | V |
| | Gate to Source Voltage | $V_{GSS}$ | ±20 | V |
| | Drain Current (DC) Note1 | $I_{D(DC)}$ | ±86 | A |
| | Drain Current (Pulse) Note2 | $I_{D(pulse)}$ | ±344 | A |
| | Total Power Dissipation ($T_A$ = 25°C) | $P_T$ | 1.8 | W |
| ★ | Total Power Dissipation ($T_C$ = 25°C) | $P_T$ | 230 | W |
| ★ | Single Avalanche Current Note3 | $I_{AS}$ | 86 / 67 / 24 | A |
| ★ | Single Avalanche Energy Note3 | $E_{AS}$ | 74 / 450 / 580 | mJ |
| | Channel Temperature | $T_{ch}$ | 175 | °C |
| | Storage Temperature | $T_{stg}$ | –55 to +175 | °C |

**Notes 1.** Package Limit = ± 75 A

**2.** PW ≤ 10 μs, Duty cycle ≤ 1 %

**3.** Starting $T_{ch}$ = 25°C, $R_G$ = 25 Ω , $V_{GS}$ = 20 V→0 V

### THERMAL RESISTANCE

| | | | | |
|---|---|---|---|---|
| ★ | Channel to Case | $R_{th(ch-C)}$ | 0.65 | °C/W |
| | Channel to Ambient | $R_{th(ch-A)}$ | 83.3 | °C/W |



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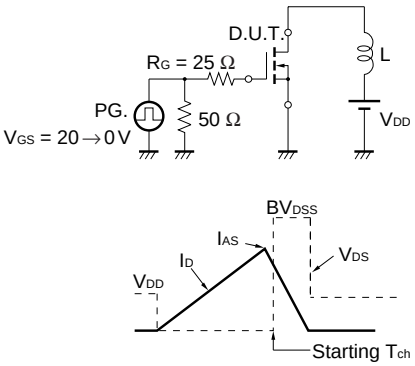
The mark ★ shows major revised points.

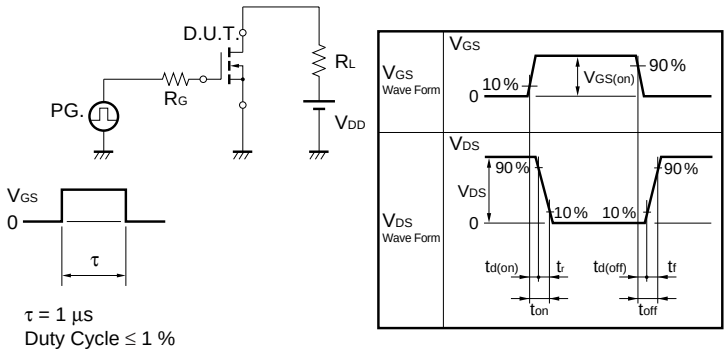
## ★ ELECTRICAL CHARACTERISTICS ($T_A$ = 25 °C)

| CHARACTERISTICS | SYMBOL | TEST CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| Drain to Source On-state Resistance | $R_{DS(on)}$ | $V_{GS}$ = 10 V, $I_D$ = 43 A | | 3.5 | 4.4 | mΩ |
| Gate to Source Cut-off Voltage | $V_{GS(off)}$ | $V_{DS}$ = 10 V, $I_D$ = 250 μA | 2.0 | 3.0 | 4.0 | V |
| Forward Transfer Admittance | $\|y_{fs}\|$ | $V_{DS}$ = 10 V, $I_D$ = 43 A | 29 | 57 | | S |
| Drain Leakage Current | $I_{DSS}$ | $V_{DS}$ = 40 V, $V_{GS}$ = 0 V | | | 10 | μA |
| Gate to Source Leakage Current | $I_{GSS}$ | $V_{GS}$ = ±20 V, $V_{DS}$ = 0 V | | | ±10 | μA |
| Input Capacitance | $C_{iss}$ | $V_{DS}$ = 25 V, $V_{GS}$ = 0 V, f = 1 MHz | | 5900 | 8900 | pF |
| Output Capacitance | $C_{oss}$ | | | 1200 | 1800 | pF |
| Reverse Transfer Capacitance | $C_{rss}$ | | | 530 | 960 | pF |
| Turn-on Delay Time | $t_{d(on)}$ | $I_D$ = 43 A, $V_{GS(on)}$ = 10 V, $V_{DD}$ = 20 V, | | 32 | 71 | ns |
| Rise Time | $t_r$ | $R_G$ = 1 Ω | | 24 | 59 | ns |
| Turn-off Delay Time | $t_{d(off)}$ | | | 110 | 220 | ns |
| Fall Time | $t_f$ | | | 33 | 82 | ns |
| Total Gate Charge | $Q_G$ | $I_D$ = 86 A, $V_{DD}$ = 32 V, $V_{GS}$ = 10 V | | 110 | 170 | nC |
| Gate to Source Charge | $Q_{GS}$ | | | 22 | | nC |
| Gate to Drain Charge | $Q_{GD}$ | | | 36 | | nC |
| Body Diode Forward Voltage | $V_{F(S-D)}$ | $I_F$ = 86 A, $V_{GS}$ = 0 V | | 0.93 | | V |
| Reverse Recovery Time | $t_{rr}$ | $I_F$ = 86A, $V_{GS}$ = 0 V, di/dt = 100A/μs | | 70 | | ns |
| Reverse Recovery Charge | $Q_{rr}$ | | | 125 | | nC |

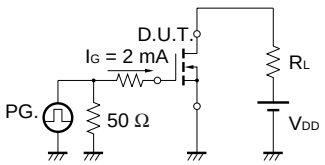
**TEST CIRCUIT 1 AVALANCHE CAPABILITY**




**TEST CIRCUIT 2 SWITCHING TIME**

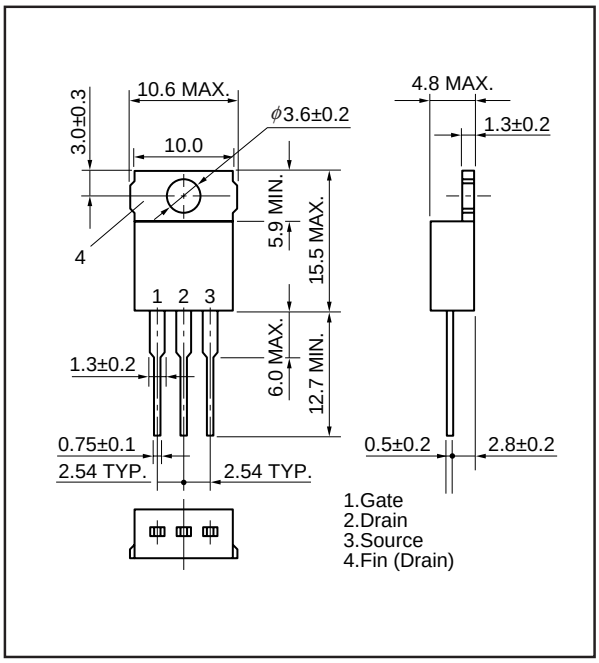



**TEST CIRCUIT 3 GATE CHARGE**

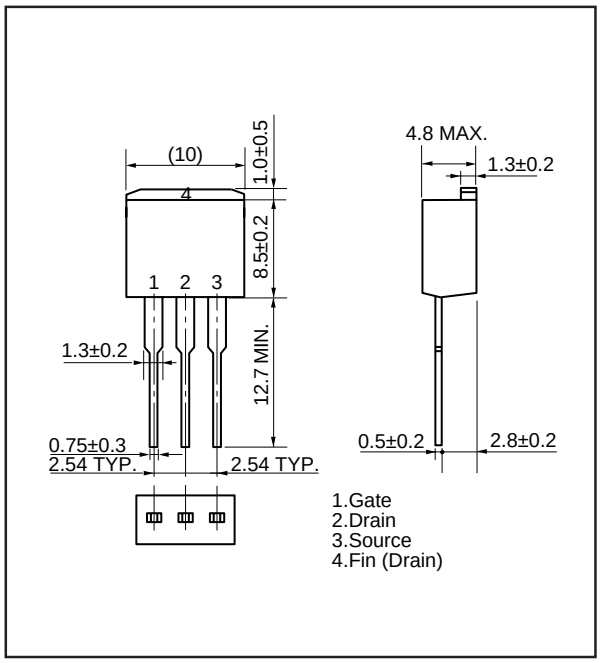


## PACKAGE DRAWINGS (Unit: mm)

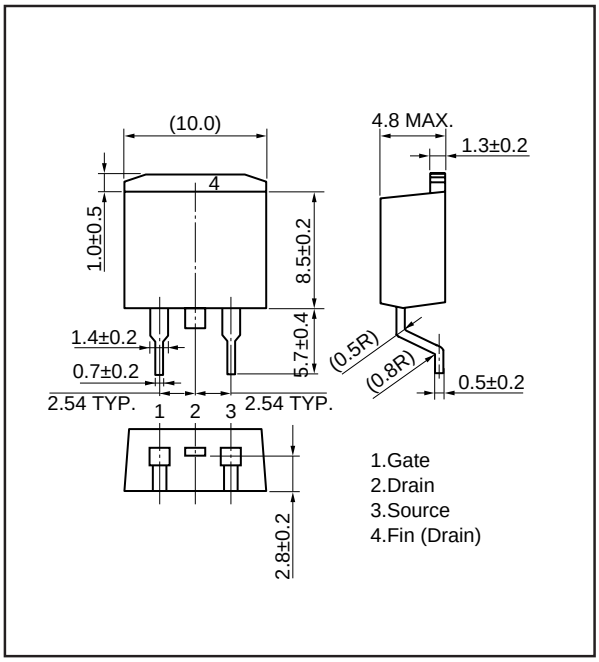
1) TO-220AB (MP-25)



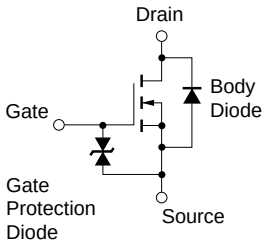

2) TO-262 (MP-25 Fin Cut)




3) TO-263 (MP-25ZJ)




**EQUIVALENT CIRCUIT**




**Remark** The diode connected between the gate and source of the transistor serves as a protector against ESD. When this device actually used, an additional protection circuit is externally required if a voltage exceeding the rated voltage may be applied to this device.

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