# NCE Automotive P-Channel Enhancement Mode Power MOSFET

## Description

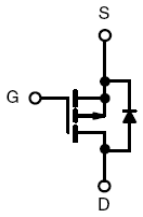
The NCEA60P28AK uses advanced trench technology and design to provide excellent $R_{DS(ON)}$ with low gate charge .This device is well suited for high current load applications.

## General Features

- $V_{DS}$ =-60V,$I_D$ =-28A
  $R_{DS(ON)}$ <48mΩ @ $V_{GS}$=-10V
  $R_{DS(ON)}$ <55mΩ @ $V_{GS}$=-4.5V
- High density cell design for ultra low Rdson
- Fully characterized avalanche voltage and current
- Good stability and uniformity with high $E_{AS}$
- Excellent package for good heat dissipation
- 100% UIS tested
- 100% ΔVds tested
- **AEC-Q101 qualified**

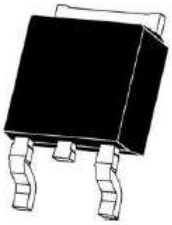
## Application

- Automotive application
- High side switch for full bridge converter
- DC/DC converter for LCD display




**Schematic diagram**


**Marking and pin assignment**



**TO-252 -2Ltop view**

## Package Marking and Ordering Information

| Device Marking | Device | Device Package | Reel Size | Tape width | Quantity |
|---|---|---|---|---|---|
| A60P28AK | NCEA60P28AK | TO-252-2L | - | - | - |

## Absolute Maximum Ratings ($T_C$=25℃unless otherwise noted)

| Parameter | Symbol | Limit | Unit |
|---|---|---|---|
| Drain-Source Voltage | $V_{DS}$ | -60 | V |
| Gate-Source Voltage | $V_{GS}$ | ±20 | V |
| Drain Current-Continuous | $I_D$ | -28 | A |
| | $I_D$ (100℃) | -19.8 | A |
| Pulsed Drain Current | $I_{DM}$ | -112 | A |
| Maximum Power Dissipation | $P_D$ | 80 | W |
| Derating factor | | 0.53 | W/℃ |
| Single pulse avalanche energy (Note 5) | $E_{AS}$ | 100 | mJ |
| Operating Junction and Storage Temperature Range | $T_J$,$T_{STG}$ | -55 To 175 | ℃ |

## Thermal Characteristic

| | | | |
|---|---|---|---|
| Thermal Resistance, Junction-to-Case(Note 2) | $R_{\theta JC}$ | 1.88 | ℃/W |

## Electrical Characteristics ($T_C$=25℃unless otherwise noted)

| Parameter | Symbol | Condition | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **Off Characteristics** | | | | | | |
| Drain-Source Breakdown Voltage | $BV_{DSS}$ | $V_{GS}$=0V $I_D$=-250μA | -60 | - | - | V |
| Zero Gate Voltage Drain Current | $I_{DSS}$ | $V_{DS}$=-60V,$V_{GS}$=0V | - | - | -1 | μA |
| Gate-Body Leakage Current | $I_{GSS}$ | $V_{GS}$=±20V,$V_{DS}$=0V | - | - | ±100 | nA |
| **On Characteristics** (Note 3) | | | | | | |
| Gate Threshold Voltage | $V_{GS(th)}$ | $V_{DS}$=$V_{GS}$,$I_D$=-250μA | -1 | -1.5 | -2.0 | V |
| Drain-Source On-State Resistance | $R_{DS(ON)}$ | $V_{GS}$=-10V, $I_D$=-20A | - | 40 | 48 | mΩ |
| | | $V_{GS}$=-4.5V, $I_D$=-20A | - | 48 | 55 | mΩ |
| Forward Transconductance | $g_{FS}$ | $V_{DS}$=-5V,$I_D$=-20A | - | 10 | - | S |
| **Dynamic Characteristics** (Note4) | | | | | | |
| Input Capacitance | $C_{lss}$ | $V_{DS}$=-30V,$V_{GS}$=0V, F=1.0MHz | - | 1630.7 | - | pF |
| Output Capacitance | $C_{oss}$ | | - | 90.6 | - | pF |
| Reverse Transfer Capacitance | $C_{rss}$ | | - | 77.3 | - | pF |
| **Switching Characteristics** (Note 4) | | | | | | |
| Turn-on Delay Time | $t_{d(on)}$ | $V_{DD}$=-30V, $R_L$=1.5Ω, $V_{GS}$=-10V,$R_G$=3Ω | - | 11 | - | nS |
| Turn-on Rise Time | $t_r$ | | - | 14 | - | nS |
| Turn-Off Delay Time | $t_{d(off)}$ | | - | 33 | - | nS |
| Turn-Off Fall Time | $t_f$ | | - | 13 | - | nS |
| Total Gate Charge | $Q_g$ | $V_{DS}$=-30,$I_D$=-20A, $V_{GS}$=-10V | - | 30 | - | nC |
| Gate-Source Charge | $Q_{gs}$ | | - | 3.4 | - | nC |
| Gate-Drain Charge | $Q_{gd}$ | | - | 6.7 | - | nC |
| **Drain-Source Diode Characteristics** | | | | | | |
| Diode Forward Voltage (Note 3) | $V_{SD}$ | $V_{GS}$=0V,$I_S$=-20A | - | - | -1.2 | V |
| Diode Forward Current (Note 2) | $I_S$ | | - | - | -18 | A |
| Reverse Recovery Time | $t_{rr}$ | TJ = 25°C, IF =- 20A di/dt = -100A/μs(Note3) | - | 34 | - | nS |
| Reverse Recovery Charge | Qrr | | - | 37 | - | nC |
| Forward Turn-On Time | $t_{on}$ | Intrinsic turn-on time is negligible (turn-on is dominated by LS+LD) | | | | |

## Notes:

**1.** Repetitive Rating: Pulse width limited by maximum junction temperature.
**2.** Surface Mounted on FR4 Board, t ≤ 10 sec.
**3.** Pulse Test: Pulse Width ≤ 300μs, Duty Cycle ≤ 2%.
**4.** Guaranteed by design, not subject to production
**5.** $E_{AS}$ condition: Tj=25℃,$V_{DD}$=-30V,$V_G$=-10V,L=0.5mH,Rg=25Ω

## Typical Electrical and Thermal Characteristics (Curves)

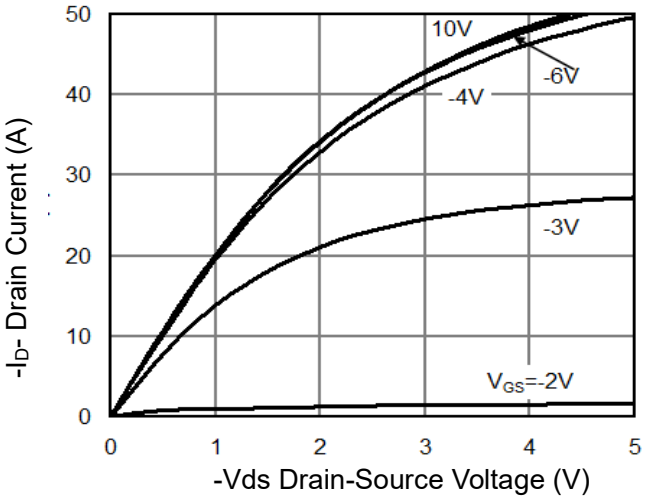



**Figure 1 Output Characteristics**

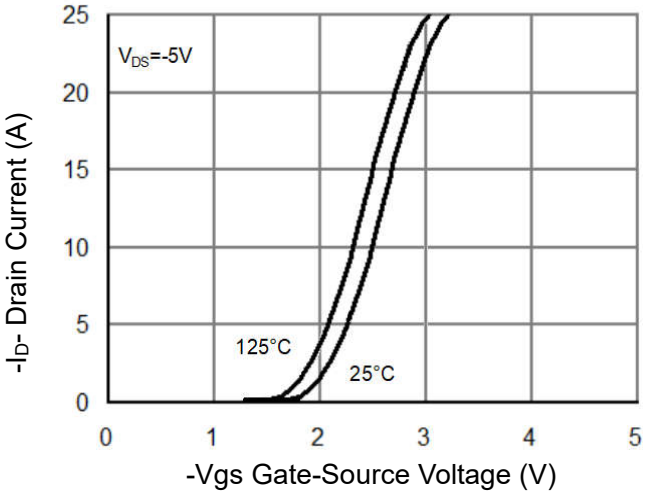



**Figure 2 Transfer Characteristics**

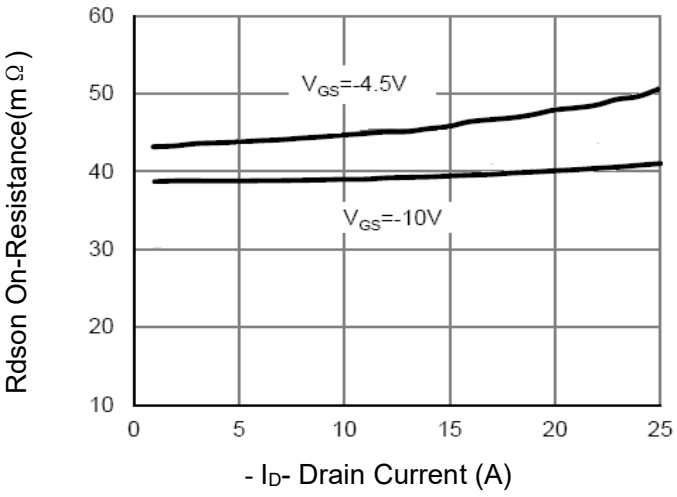



**Figure 3 Rdson- Drain Current**

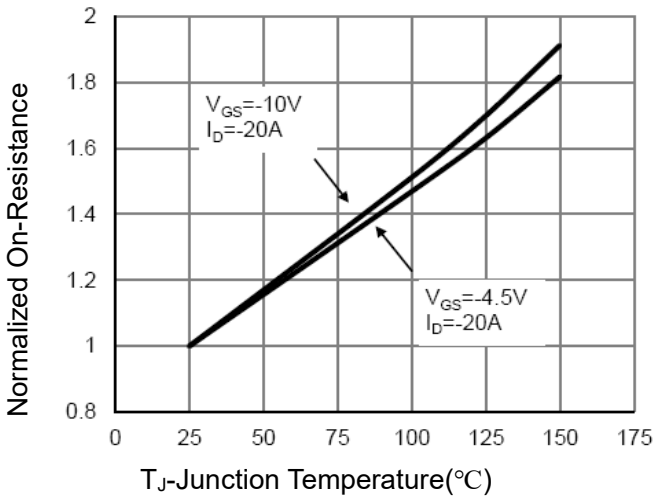



**Figure 4 Rdson-Junction Temperature**

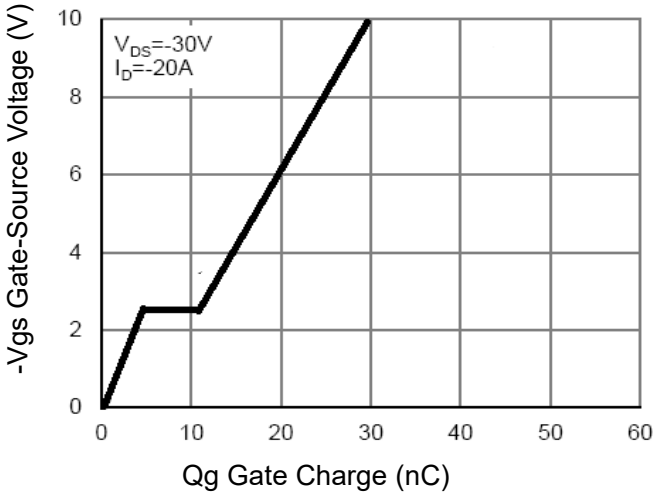



**Figure 5 Gate Charge**

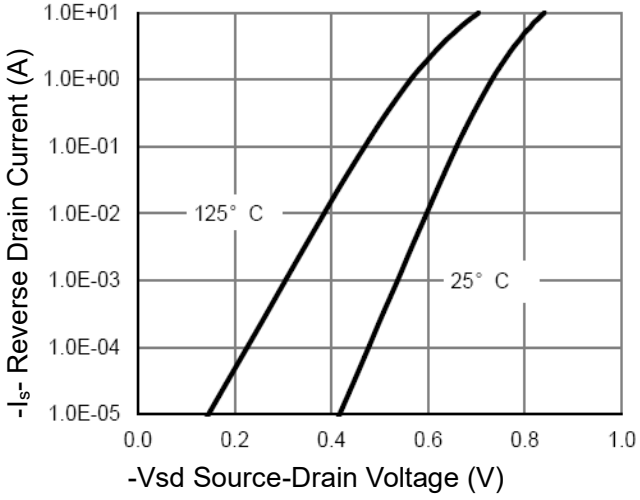



**Figure 6 Source- Drain Diode Forward**

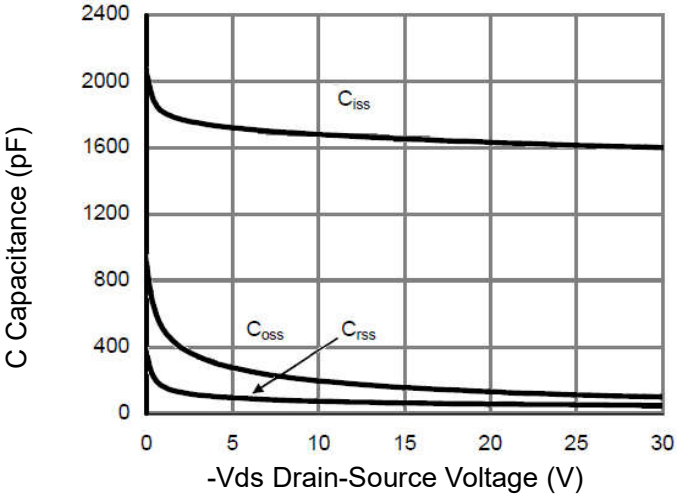



**Figure 7 Capacitance vs Vds**

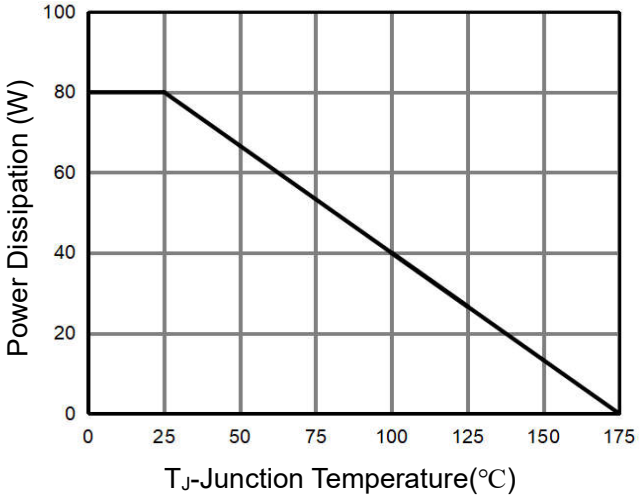



**Figure 9 Power De-rating**

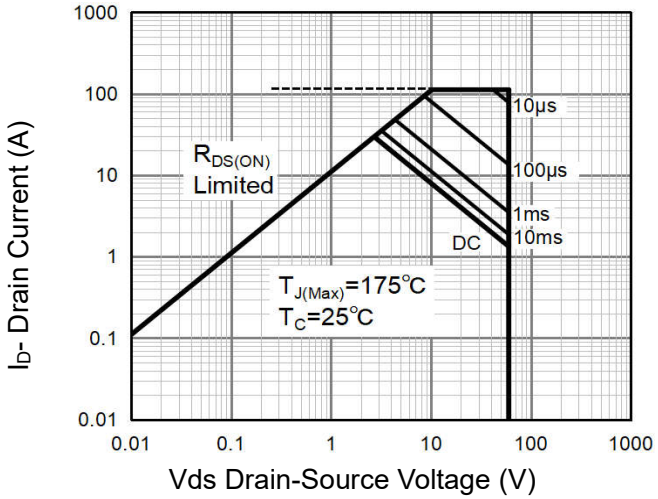



**Figure 8 Safe Operation Area**

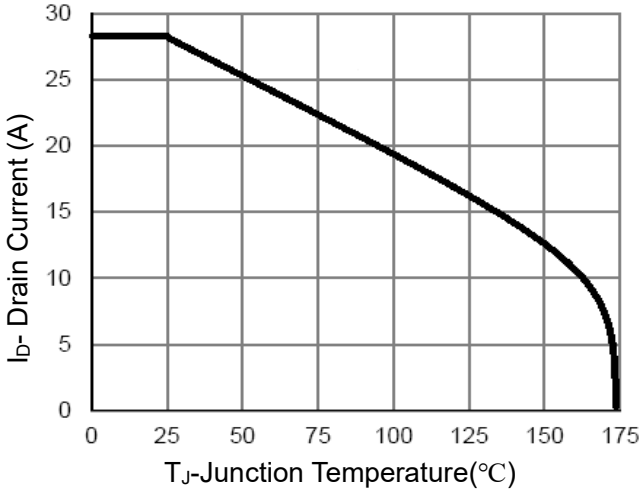



**Figure 10 ID Current De-rating**

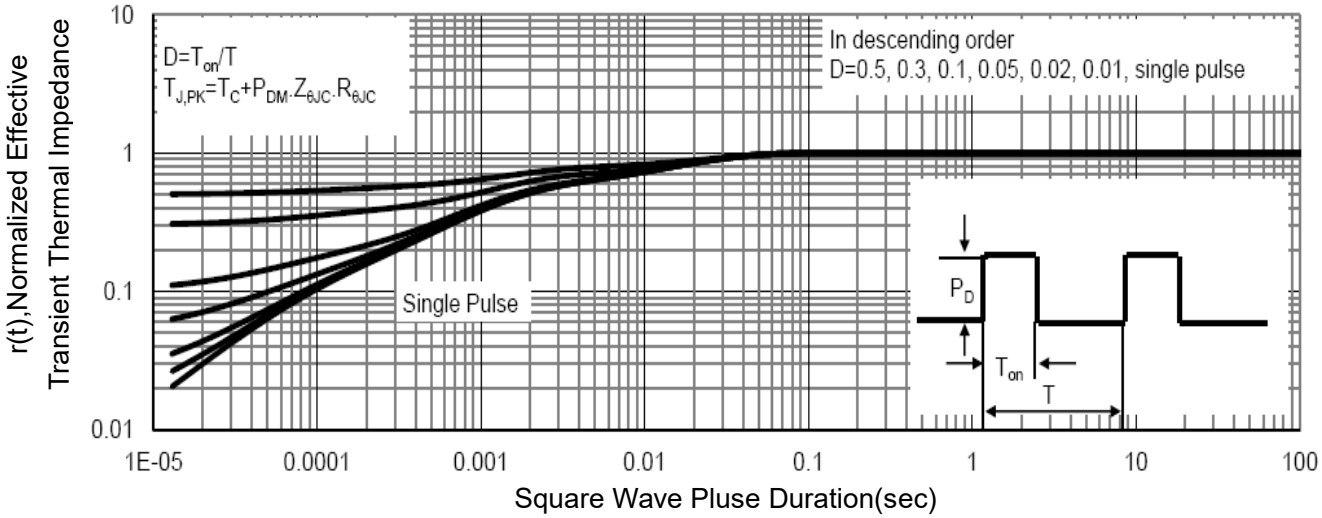
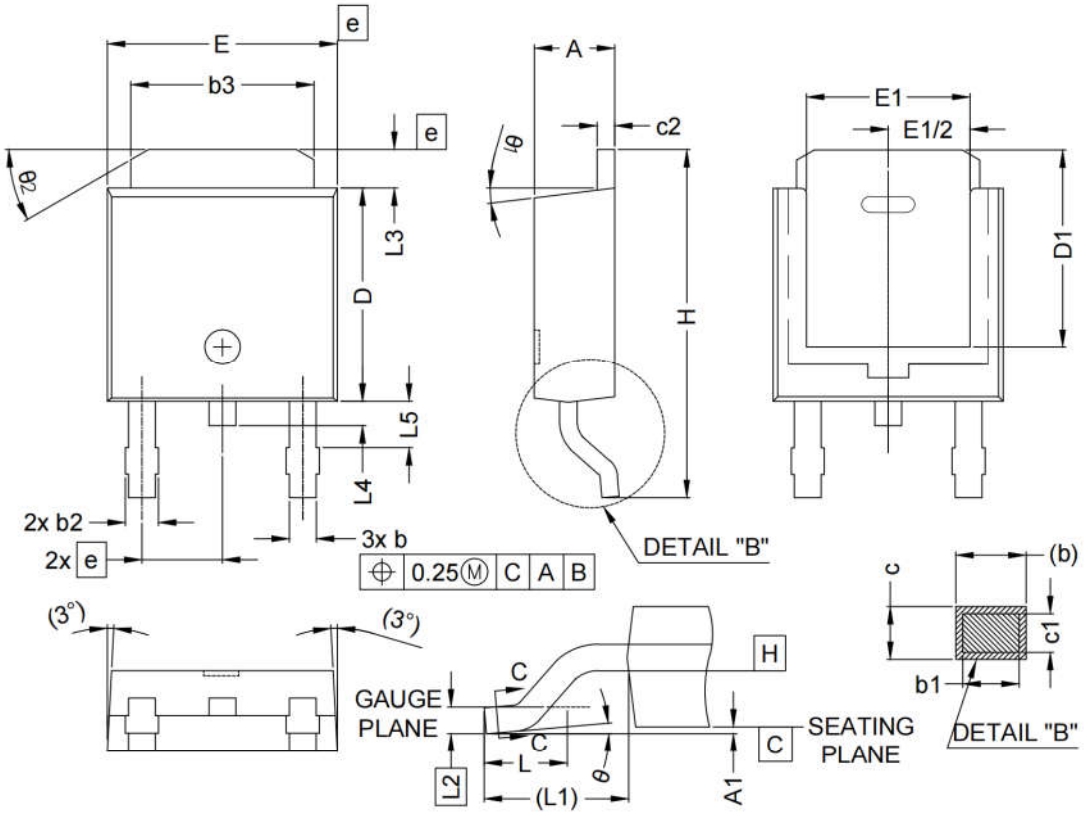



**Figure 11 Normalized Maximum Transient Thermal Impedance**

## TO-252 Package Information




| SYMBOL | MIN. | MAX. | SYMBOL | MIN. | MAX. | SYMBOL | MIN. | MAX. |
|---|---|---|---|---|---|---|---|---|
| A | 2.18 | 2.39 | E | 6.35 | 6.73 | θ1 | 0° | 15° |
| A1 | - | 0.13 | E1 | 4.32 | - | θ2 | 25° | 35° |
| b | 0.65 | 0.89 | e | 2.29 BSC | | | | |
| b1 | 0.64 | 0.79 | H | 9.94 | 10.34 | | | |
| b2 | 0.76 | 1.13 | L | 1.50 | 1.78 | | | |
| b3 | 4.95 | 5.46 | L1 | 2.74 REF | | | | |
| c | 0.46 | 0.61 | L2 | 0.51 BSC | | | | |
| c1 | 0.41 | 0.56 | L3 | 0.89 | 1.27 | | | |
| c2 | 0.46 | 0.60 | L4 | - | 1.02 | | | |
| D | 5.97 | 6.22 | L5 | 1.14 | 1.49 | | | |
| D1 | 5.21 | - | θ | 0° | 10° | | | |

NOTE ; 1.0 DIMENSIONING & TOLERANCEING CONFIRM TO ASME Y14.5M-1994.
2.0 ALL DIMENSIONS ARE IN MILLIMETERS. ANGLES ARE IN DEGREES.
3.0 HEAT SINK SIDE FLASH IS MAX. 0.8mm.
4.0 RADIUS ON TERMINAL IS OPTIONAL.

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