

## NCE Automotive N-Channel Super Trench Power MOSFET

### Description

The NCEAP40T20AGU uses **Super Trench** technology that is uniquely optimized to provide the most efficient high frequency switching performance. Both conduction and switching power losses are minimized due to an extremely low combination of  $R_{DS(on)}$  and  $Q_g$ . This device is ideal for high-frequency switching and synchronous rectification.

### Application

- Automotive application
- DC/DC Converter
- Ideal for high-frequency switching and synchronous rectification

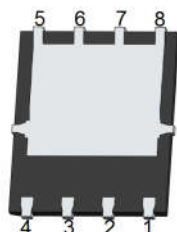
### General Features

- $V_{DS} = 40V, I_D = 300A$  (Silicon Limited)  
 $R_{DS(on)} = 0.95m\Omega$ , typical @  $V_{GS} = 10V$
- Excellent gate charge x  $R_{DS(on)}$  product(FOM)
- Very low on-resistance  $R_{DS(on)}$
- 175 °C operating temperature
- Pb-free lead plating
- 100% UIS tested
- 100%  $\Delta V_{ds}$  tested
- **AEC-Q101 qualified**

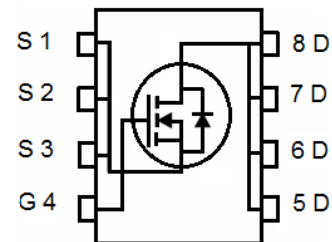
### DFN 5X6



Top View



Bottom View



Schematic Diagram

### Package Marking and Ordering Information

| Device Marking | Device        | Device Package | Reel Size | Tape width | Quantity |
|----------------|---------------|----------------|-----------|------------|----------|
| AP40T20AGU     | NCEAP40T20AGU | DFN5X6-8L      | -         | -          | -        |

### Absolute Maximum Ratings ( $T_c = 25^\circ C$ unless otherwise noted)

| Parameter  | Symbol              | Limit      | Unit |
|--|---------------------|------------|------|
| Drain-Source Voltage   | $V_{DS}$            | 40         | V    |
| Gate-Source Voltage  | $V_{GS}$            | $\pm 20$   | V    |
| Drain Current-Continuous(Silicon Limited) <sup>(Note1)</sup> | $I_D$               | 300        | A    |
| Drain Current-Continuous(Silicon Limited) <sup>(Note1)</sup> | $I_D (100^\circ C)$ | 213        | A    |
| Drain Current-Continuous (Package Limited)                   | $I_D$               | 200        | A    |
| Pulsed Drain Current   | $I_{DM}$            | 800        | A    |
| Maximum Power Dissipation                                    | $P_D$               | 220        | W    |
| Derating factor  |                     | 1.47       | W/°C |
| Single pulse avalanche energy <sup>(Note 2)</sup>            | $E_{AS}$            | 1800       | mJ   |
| Operating Junction and Storage Temperature Range             | $T_J, T_{STG}$      | -55 To 175 | °C   |

### Thermal Characteristic

|                                      |                 |      |      |
|--------------------------------------|-----------------|------|------|
| Thermal Resistance, Junction-to-Case | $R_{\theta JC}$ | 0.68 | °C/W |
|--------------------------------------|-----------------|------|------|

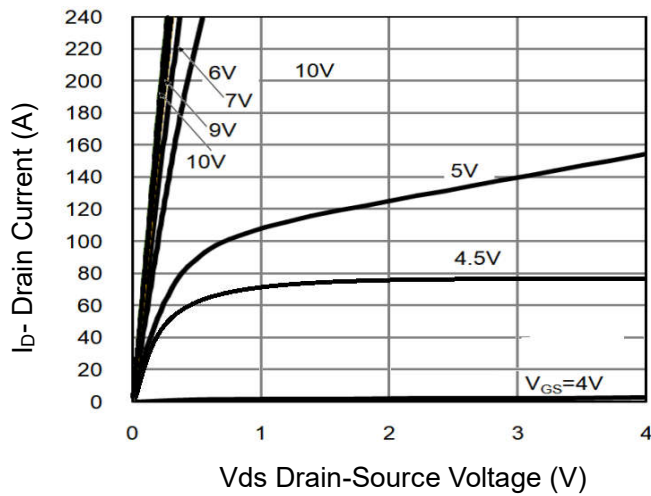
## Electrical Characteristics (T<sub>c</sub>=25°C unless otherwise noted)

| Parameter                                     | Symbol              | Condition   | Min | Typ    | Max  | Unit |
|---|---------------------|---|-----|--------|------|------|
| Off Characteristics                           |                     |   |     |        |      |      |
| Drain-Source Breakdown Voltage                | BV <sub>DSS</sub>   | V <sub>GS</sub> =0V I <sub>D</sub> =250μA   | 40  | -      | -    | V    |
| Zero Gate Voltage Drain Current               | I <sub>DSS</sub>    | V <sub>DS</sub> =40V, V <sub>GS</sub> =0V   | -   | -      | 1    | μA   |
| Gate-Body Leakage Current                     | I <sub>GSS</sub>    | V <sub>GS</sub> =±20V, 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    |
| Drain-Source On-State Resistance              | R <sub>DS(ON)</sub> | V <sub>GS</sub> =10V, I <sub>D</sub> =20A   | -   | 0.95   | 1.3  | mΩ   |
| Forward Transconductance                      | g <sub>FS</sub>     | V <sub>DS</sub> =5V, I <sub>D</sub> =20A  |     | 90     | -    | S    |
| Dynamic Characteristics                       |                     |   |     |        |      |      |
| Input Capacitance                             | C <sub>iss</sub>    | V <sub>DS</sub> =20V, V <sub>GS</sub> =0V,<br>F=1.0MHz                                  | -   | 5834.6 | -    | pF   |
| Output Capacitance                            | C <sub>oss</sub>    |   | -   | 2320.5 | -    | pF   |
| Reverse Transfer Capacitance                  | C <sub>rss</sub>    |   | -   | 70     | -    | pF   |
| Switching Characteristics <sup>(Note 1)</sup> |                     |   |     |        |      |      |
| Turn-on Delay Time                            | t <sub>d(on)</sub>  | V <sub>DD</sub> =20V, I <sub>D</sub> =20A<br>V <sub>GS</sub> =10V, R <sub>G</sub> =1.6Ω | -   | 14.5   | -    | nS   |
| Turn-on Rise Time                             | t <sub>r</sub>      |   | -   | 8      | -    | nS   |
| Turn-Off Delay Time                           | t <sub>d(off)</sub> |   | -   | 58     | -    | nS   |
| Turn-Off Fall Time                            | t <sub>f</sub>      |   | -   | 10     | -    | nS   |
| Total Gate Charge                             | Q <sub>g</sub>      | V <sub>DS</sub> =20V, I <sub>D</sub> =20A,<br>V <sub>GS</sub> =10V                      | -   | 91     | -    | nC   |
| Gate-Source Charge                            | Q <sub>gs</sub>     |   | -   | 29.4   | -    | nC   |
| Gate-Drain Charge                             | Q <sub>gd</sub>     |   | -   | 19     | -    | nC   |
| Drain-Source Diode Characteristics            |                     |   |     |        |      |      |
| Diode Forward Voltage                         | V <sub>SD</sub>     | V <sub>GS</sub> =0V, I <sub>S</sub> =20A  | -   | -      | 1.2  | V    |
| Diode Forward Current                         | I <sub>S</sub>      |   | -   | -      | 300  | A    |
| Reverse Recovery Time                         | t <sub>rr</sub>     | T <sub>J</sub> = 25°C, I <sub>F</sub> = I <sub>S</sub>                                  | -   | 35     | -    | nS   |
| Reverse Recovery Charge                       | Q <sub>rr</sub>     | di/dt = 100A/μs   | -   | 120    | -    | nC   |

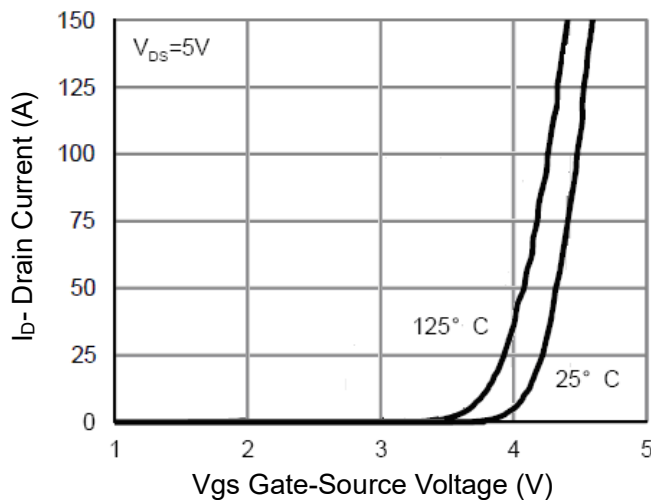
### Notes:

1. Defined by design. Not Subject to production test
2. EAS condition : T<sub>J</sub>=25°C, V<sub>DD</sub>=20V, V<sub>G</sub>=10V, L=0.5mH, R<sub>G</sub>=25Ω
3. These curves are based on the junction-to-case thermal impedance which is measured with the device mounted to a large heatsink, assuming a maximum junction temperature of T<sub>J</sub>(MAX)=175°C. The SOA curve provides a single pulse rating.

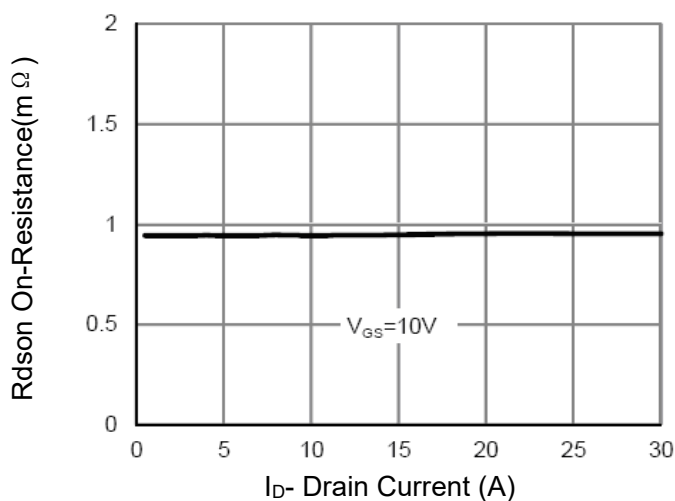
## Typical Electrical and Thermal Characteristics



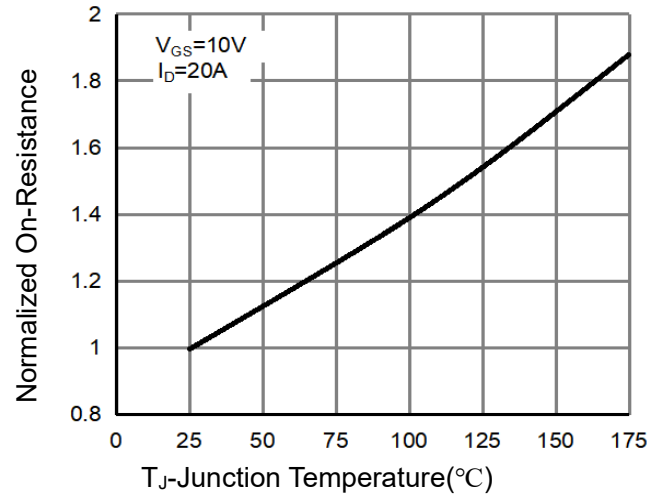
**Figure 1 Output Characteristics**



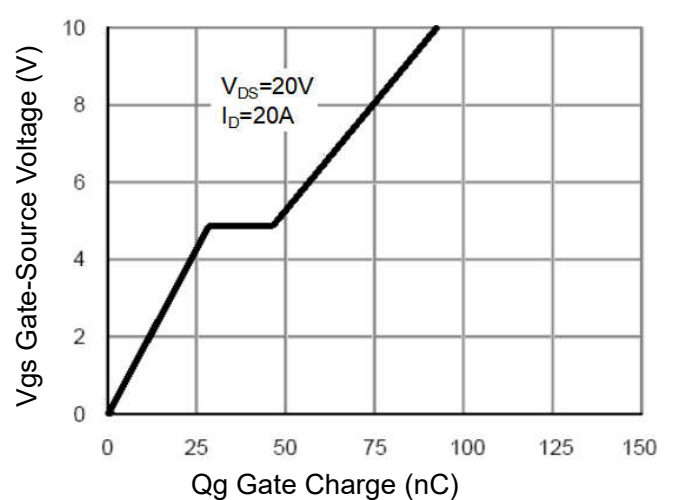
**Figure 2 Transfer Characteristics**



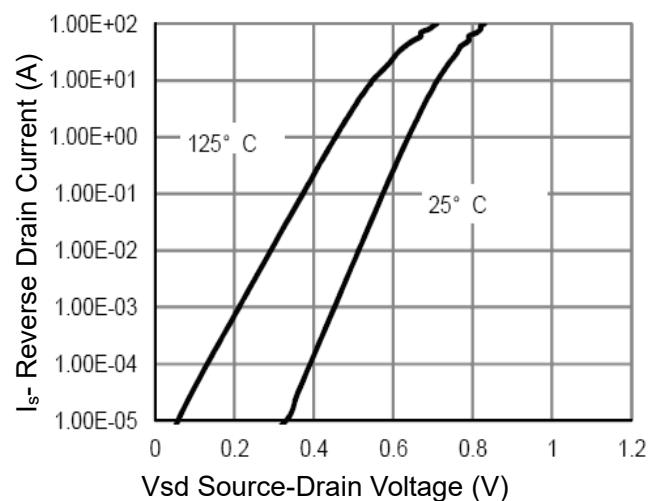
**Figure 3 Rdson- Drain Current**



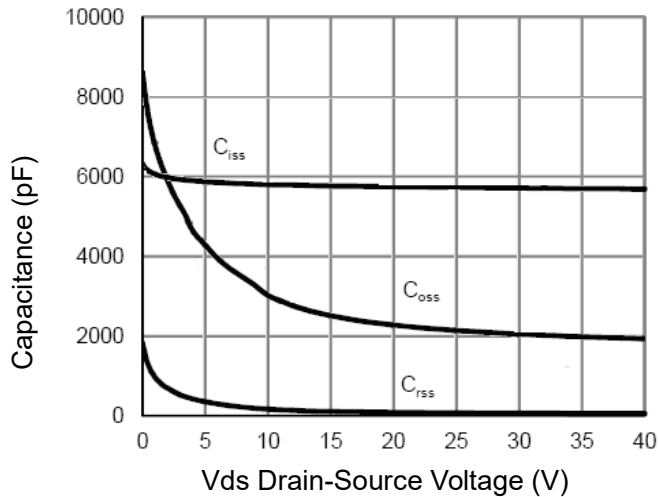
**Figure 4 Rdson-Junction Temperature**



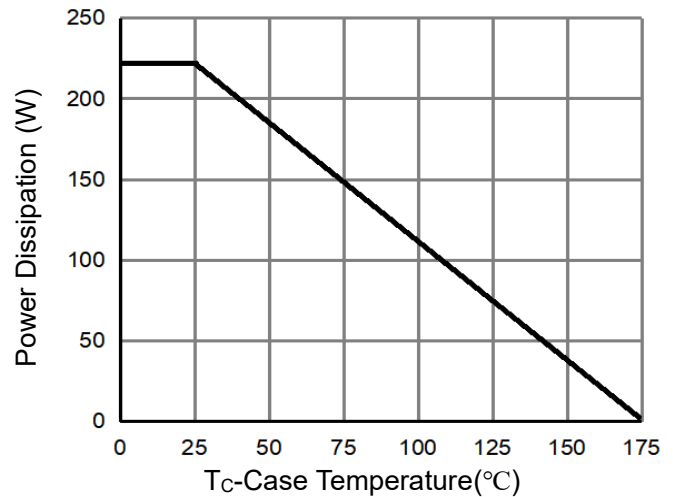
**Figure 5 Gate Charge**



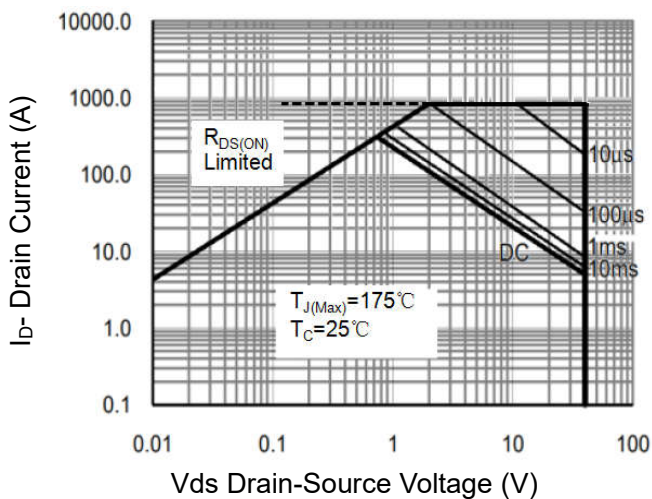
**Figure 6 Source- Drain Diode Forward**



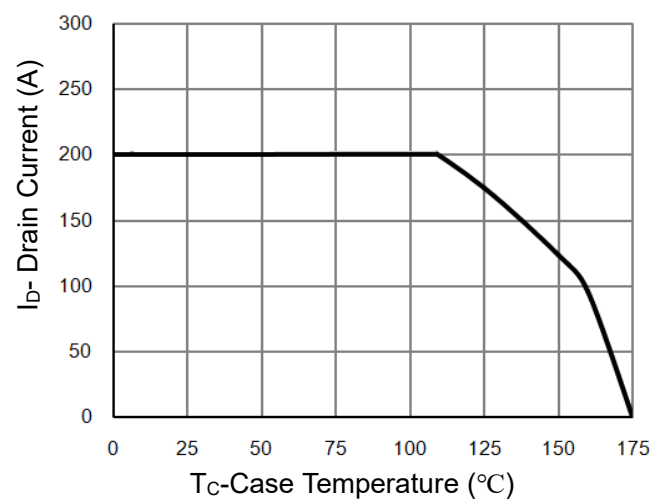
**Figure 7 Capacitance vs Vds**



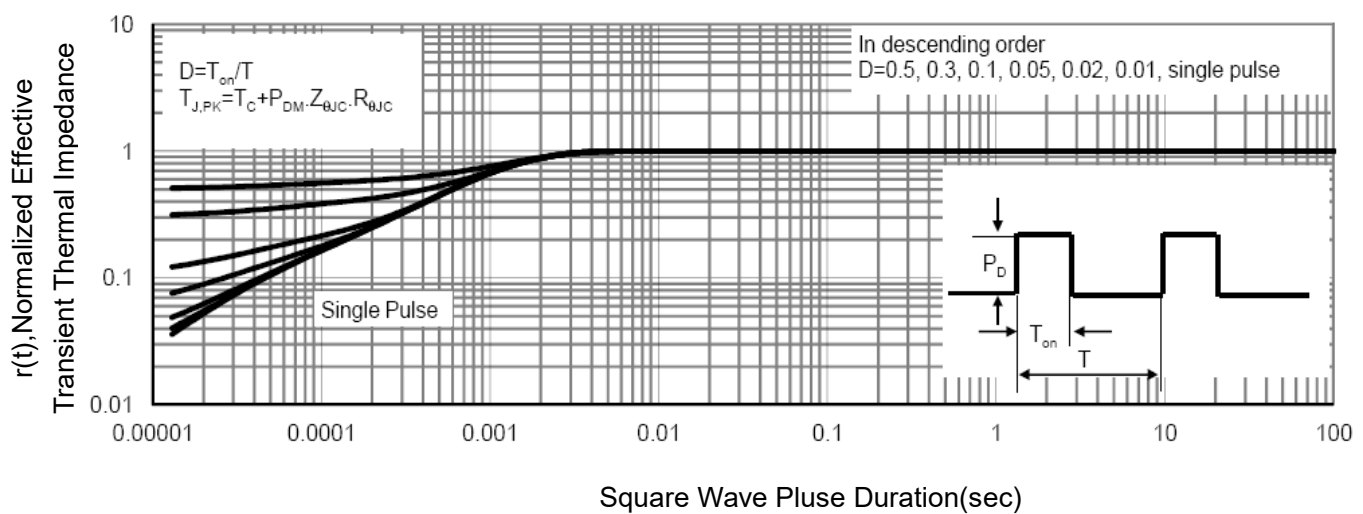
**Figure 9 Power De-rating**



**Figure 8 Safe Operation Area** (Note 3)

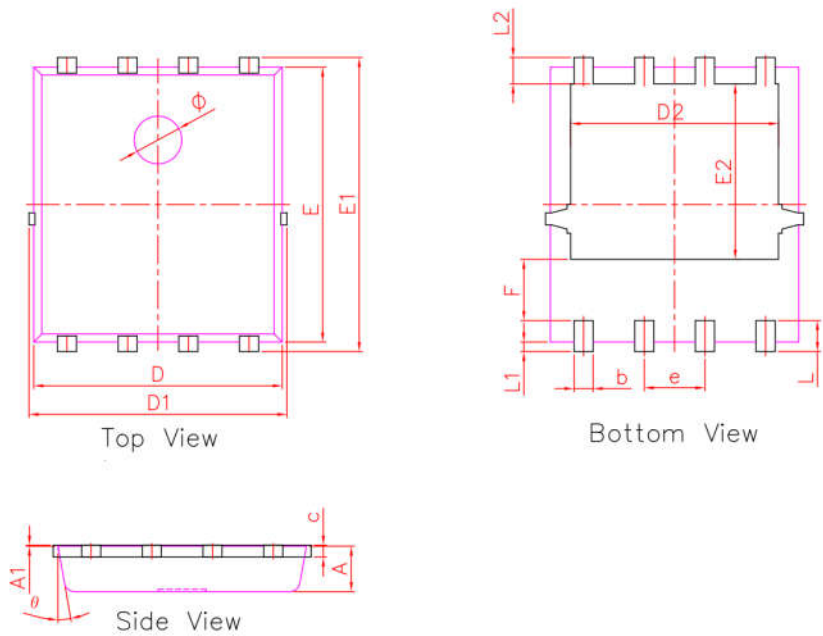


**Figure 10 Current De-rating**



**Figure 11 Normalized Maximum Transient Thermal Impedance**

DFN5X6-8L Package Information



| PDFN5X6-8L                    |          |      |      |
|-------------------------------|----------|------|------|
| DIM.                          | MIN.     | NOM. | MAX. |
| A                             | 0.90     | 0.95 | 1.00 |
| A1                            | 0.00     | 0.02 | 0.05 |
| b                             | 0.35     | 0.40 | 0.50 |
| c                             | 0.20     | 0.25 | 0.30 |
| D                             | 5.10     | 5.20 | 5.30 |
| D1                            | 5.10     | 5.40 | 5.50 |
| D2                            | 4.25     | 4.35 | 4.45 |
| e                             | 1.27 BSC |      |      |
| E                             | 5.70     | 5.75 | 5.80 |
| E1                            | 6.00     | 6.15 | 6.30 |
| E2                            | 3.57     | 3.67 | 3.77 |
| F                             | 1.18     | 1.28 | 1.38 |
| L                             | 0.55     | 0.65 | 0.75 |
| L1                            | 0.15     | 0.20 | 0.25 |
| L2                            | 0.45     | 0.55 | 0.65 |
| Φ                             | 0.90     | 1.00 | 1.10 |
| Θ                             | 8°       | 10°  | 12°  |
| All dimensions in millimeters |          |      |      |

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