



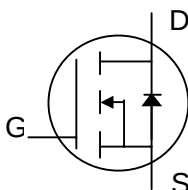
## N-channel Enhancement-mode Power MOSFET

Simple Drive Requirement

100% Avalanche Test

Fast Switching Characteristics

RoHS-compliant, halogen-free

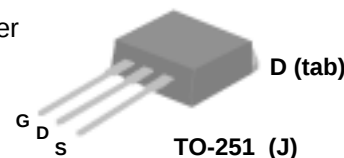


|              |           |
|--------------|-----------|
| $BV_{DSS}$   | 400V      |
| $R_{DS(ON)}$ | $5\Omega$ |
| $I_D$        | 1.6A      |

### Description

Advanced Power MOSFETs from APEC provide the designer with the best combination of fast switching, low on-resistance and cost-effectiveness.

The AP02N40H-HF-3 is in the TO-252 package which is widely preferred for commercial and industrial surface mount applications such as medium-power DC/DC converters. The through-hole TO-251 version (AP02N40J-HF-3) is available where a small PCB footprint is required.



### Absolute Maximum Ratings

| Symbol                           | Parameter                                  | Rating     | Units               |
|----------------------------------|--------------------------------------------|------------|---------------------|
| $V_{DS}$                         | Drain-Source Voltage                       | 400        | V                   |
| $V_{GS}$                         | Gate-Source Voltage                        | $\pm 30$   | V                   |
| $I_D$ at $T_C=25^\circ\text{C}$  | Continuous Drain Current                   | 1.6        | A                   |
| $I_D$ at $T_C=100^\circ\text{C}$ | Continuous Drain Current                   | 1          | A                   |
| $I_{DM}$                         | Pulsed Drain Current <sup>1</sup>          | 3          | A                   |
| $P_D$ at $T_C=25^\circ\text{C}$  | Total Power Dissipation                    | 33         | W                   |
|                                  | Linear Derating Factor                     | 0.26       | W/ $^\circ\text{C}$ |
| $E_{AS}$                         | Single Pulse Avalanche Energy <sup>2</sup> | 5          | mJ                  |
| $I_{AR}$                         | Avalanche Current                          | 1          | A                   |
| $T_{STG}$                        | Storage Temperature Range                  | -55 to 150 | $^\circ\text{C}$    |
| $T_J$                            | Operating Junction Temperature Range       | -55 to 150 | $^\circ\text{C}$    |

### Thermal Data

| Symbol | Parameter                                                             | Value | Units              |
|--------|-----------------------------------------------------------------------|-------|--------------------|
| Rthj-c | Maximum Thermal Resistance, Junction-case                             | 3.8   | $^\circ\text{C/W}$ |
| Rthj-a | Maximum Thermal Resistance, Junction-ambient (PCB mount) <sup>4</sup> | 62.5  | $^\circ\text{C/W}$ |
| Rthj-a | Maximum Thermal Resistance, Junction-ambient                          | 110   | $^\circ\text{C/W}$ |

### Ordering Information

AP02N40H-HF-3TR : in RoHS-compliant halogen-free TO-252 shipped on tape and reel (3000 pcs/reel)

AP02N40J-HF-3TB : in RoHS-compliant halogen-free TO-251 shipped in tubes (80pcs/tube)



**Electrical Specifications at  $T_j=25^{\circ}\text{C}$  (unless otherwise specified)**

| Symbol       | Parameter                                                  | Test Conditions               | Min. | Typ. | Max.      | Units    |
|--------------|------------------------------------------------------------|-------------------------------|------|------|-----------|----------|
| $BV_{DSS}$   | Drain-Source Breakdown Voltage                             | $V_{GS}=0V, I_D=1mA$          | 400  | -    | -         | V        |
| $R_{DS(ON)}$ | Static Drain-Source On-Resistance <sup>3</sup>             | $V_{GS}=10V, I_D=0.7A$        | -    | -    | 5         | $\Omega$ |
| $V_{GS(th)}$ | Gate Threshold Voltage                                     | $V_{DS}=V_{GS}, I_D=250\mu A$ | 2    | -    | 4         | V        |
| $g_{fs}$     | Forward Transconductance                                   | $V_{DS}=10V, I_D=1A$          | -    | 1.5  | -         | S        |
| $I_{DSS}$    | Drain-Source Leakage Current                               | $V_{DS}=400V, V_{GS}=0V$      | -    | -    | 25        | $\mu A$  |
|              | Drain-Source Leakage Current ( $T_j=125^{\circ}\text{C}$ ) | $V_{DS}=320V, V_{GS}=0V$      | -    | -    | 250       | $\mu A$  |
| $I_{GSS}$    | Gate-Source Leakage                                        | $V_{GS}=\pm 30V, V_{DS}=0V$   | -    | -    | $\pm 100$ | nA       |
| $Q_g$        | Total Gate Charge <sup>3</sup>                             | $I_D=1A$                      | -    | 6.4  | 10        | nC       |
| $Q_{gs}$     | Gate-Source Charge                                         | $V_{DS}=320V$                 | -    | 1.2  | -         | nC       |
| $Q_{gd}$     | Gate-Drain ("Miller") Charge                               | $V_{GS}=10V$                  | -    | 3.2  | -         | nC       |
| $t_{d(on)}$  | Turn-on Delay Time <sup>3</sup>                            | $V_{DD}=200V$                 | -    | 8    | -         | ns       |
| $t_r$        | Rise Time                                                  | $I_D=1A$                      | -    | 9    | -         | ns       |
| $t_{d(off)}$ | Turn-off Delay Time                                        | $R_G=50\Omega, V_{GS}=10V$    | -    | 21   | -         | ns       |
| $t_f$        | Fall Time                                                  | $R_D=200\Omega$               | -    | 12   | -         | ns       |
| $C_{iss}$    | Input Capacitance                                          | $V_{GS}=0V$                   | -    | 180  | 300       | pF       |
| $C_{oss}$    | Output Capacitance                                         | $V_{DS}=25V$                  | -    | 22   | -         | pF       |
| $C_{rss}$    | Reverse Transfer Capacitance                               | $f=1.0MHz$                    | -    | 5.6  | -         | pF       |

**Source-Drain Diode**

| Symbol   | Parameter                          | Test Conditions       | Min. | Typ. | Max. | Units |
|----------|------------------------------------|-----------------------|------|------|------|-------|
| $V_{SD}$ | Forward On Voltage <sup>3</sup>    | $I_S=1.6A, V_{GS}=0V$ | -    | -    | 1.5  | V     |
| $t_{rr}$ | Reverse Recovery Time <sup>3</sup> | $I_S=1A, V_{GS}=0V,$  | -    | 150  | -    | ns    |
| $Q_{rr}$ | Reverse Recovery Charge            | $dI/dt=100A/\mu s$    | -    | 680  | -    | nC    |

**Notes:**

1. Pulse width limited by maximum junction temperature
2. Starting  $T_j=25^{\circ}\text{C}$ ,  $V_{DD}=50V$ ,  $L=10mH$ ,  $R_G=25\Omega$
3. Pulse test
4. Surface mounted on 1 in<sup>2</sup> copper pad of FR4 board

THIS PRODUCT IS SENSITIVE TO ELECTROSTATIC DISCHARGE, PLEASE HANDLE WITH CAUTION.

USE OF THIS PRODUCT AS A CRITICAL COMPONENT IN LIFE SUPPORT OR OTHER SIMILAR SYSTEMS IS NOT AUTHORIZED.

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## Typical Electrical Characteristics

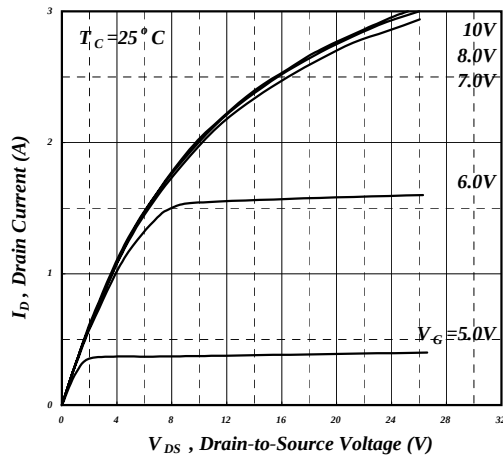


Fig 1. Typical Output Characteristics

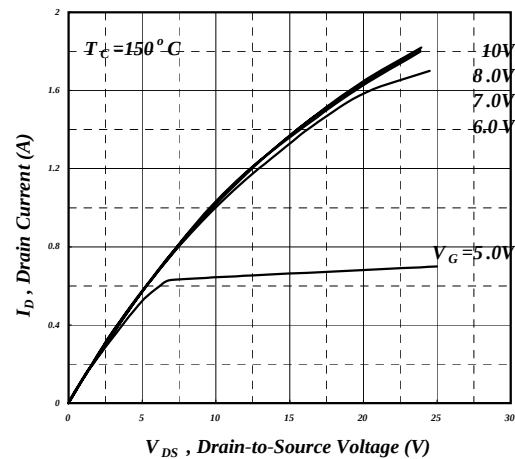


Fig 2. Typical Output Characteristics

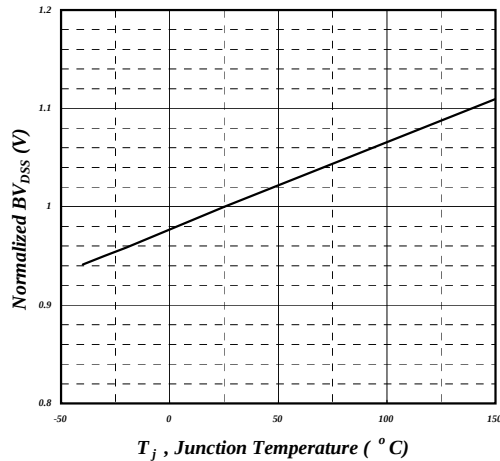


Fig 3. Normalized  $BV_{DSS}$   
vs. Junction Temperature

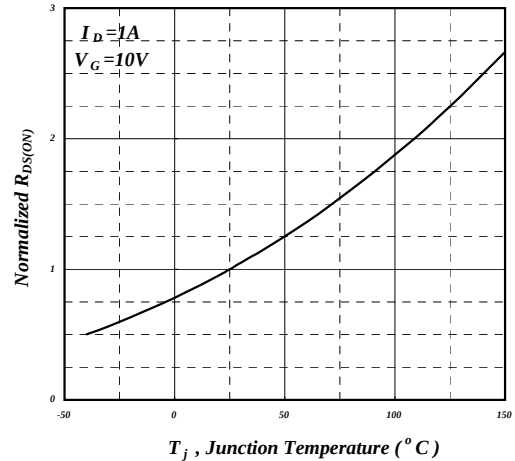


Fig 4. Normalized On-Resistance  
vs. Junction Temperature

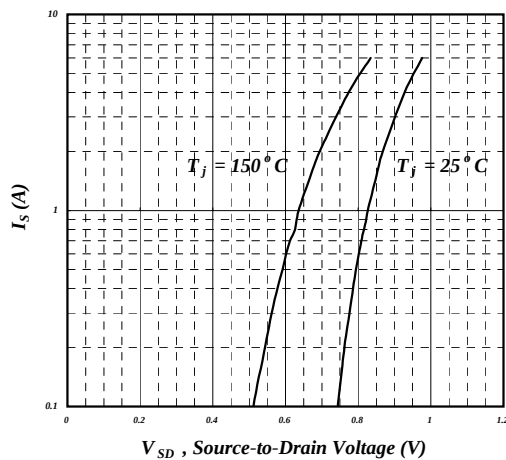


Fig 5. Forward Characteristic of  
Reverse Diode

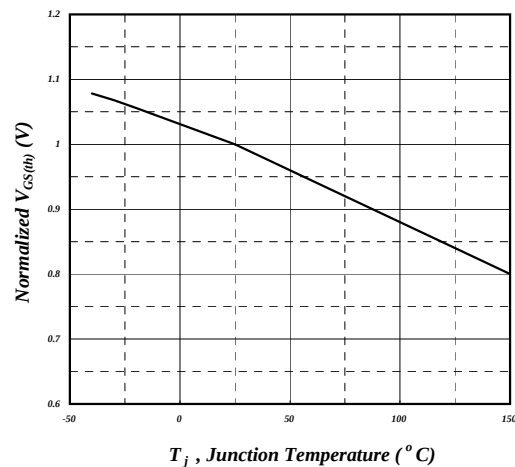


Fig 6. Gate Threshold Voltage vs.  
Junction Temperature



Typical Electrical Characteristics (cont.)

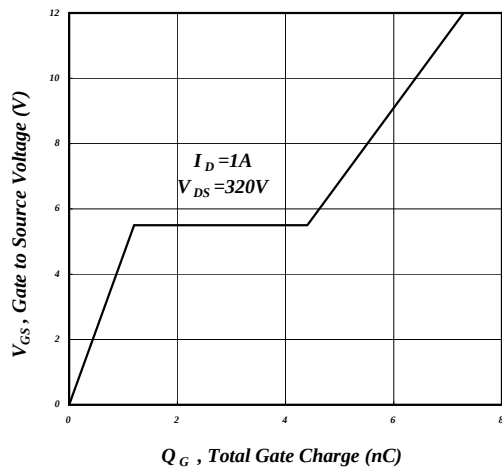


Fig 7. Gate Charge Characteristics

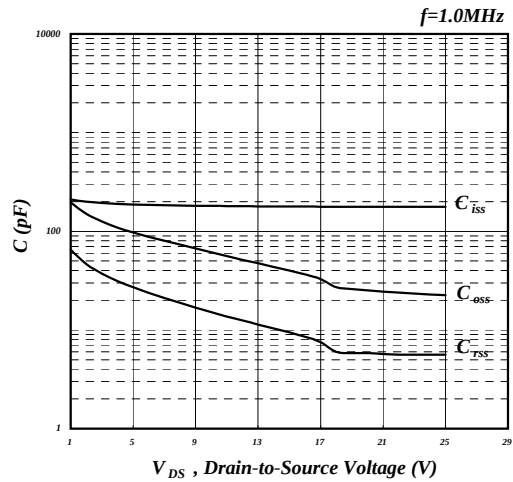


Fig 8. Typical Capacitance Characteristics

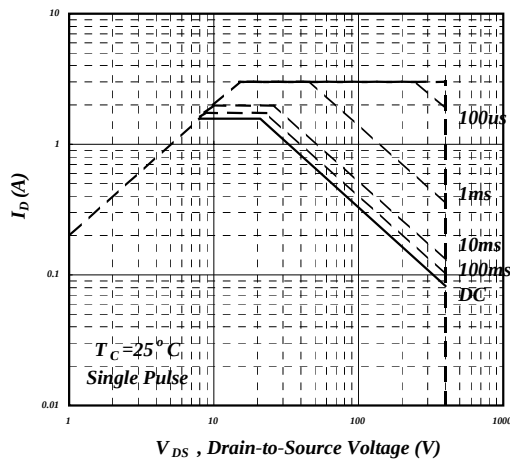


Fig 9. Maximum Safe Operating Area

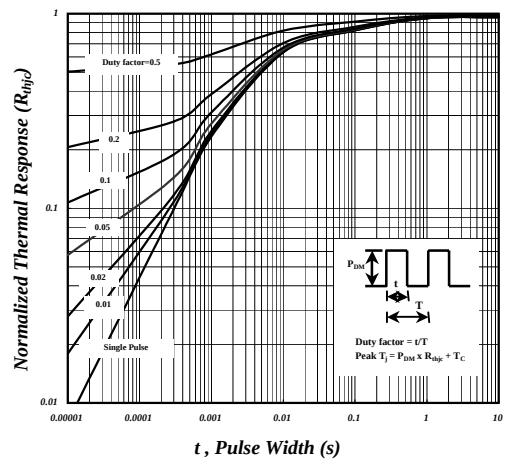


Fig 10. Effective Transient Thermal Impedance

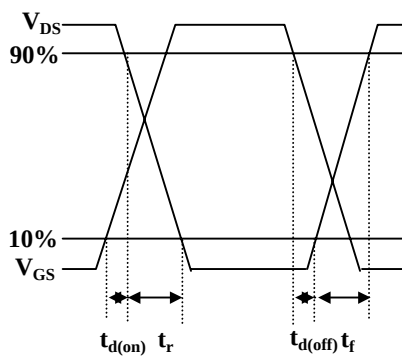


Fig 11. Switching Time Waveform

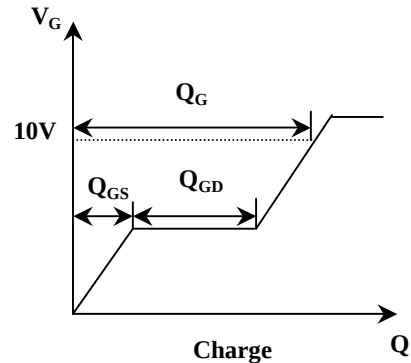
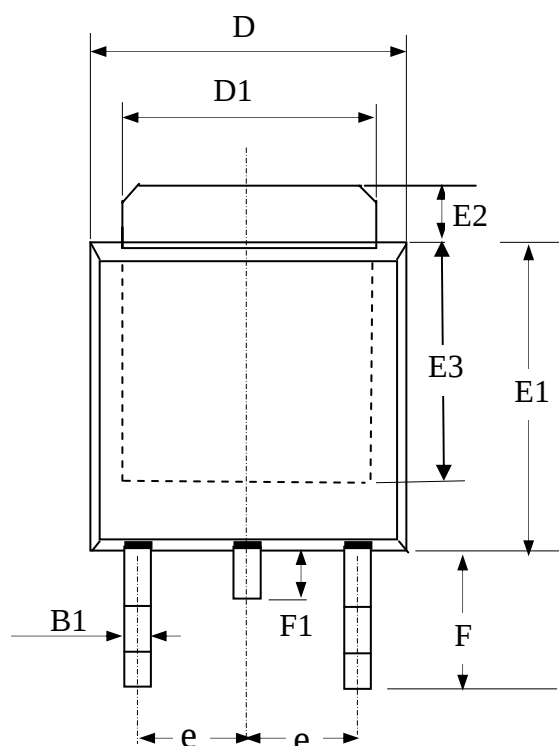


Fig 12. Gate Charge Waveform

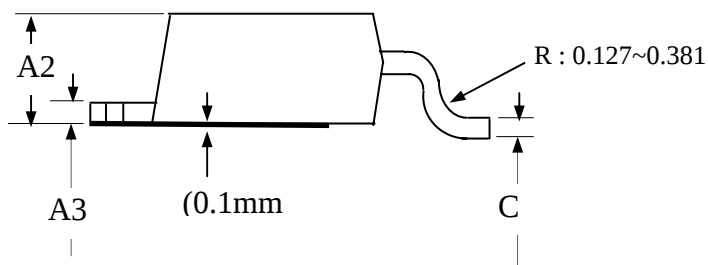


## Package Dimensions: TO-252



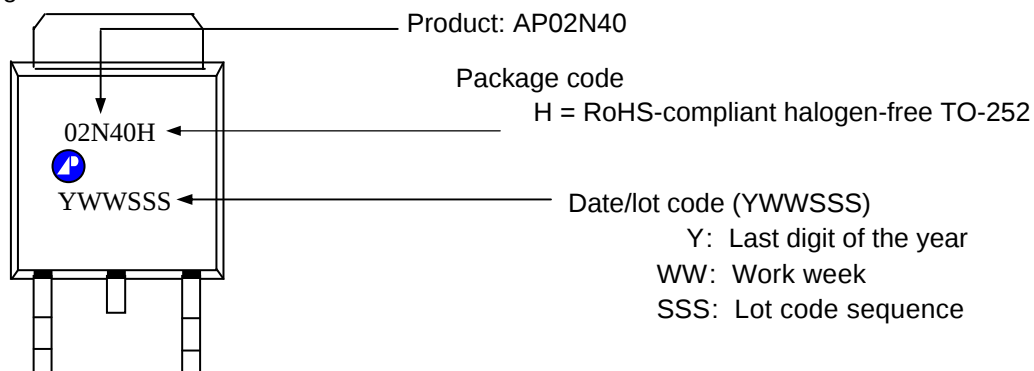
| SYMBOLS | Millimeters |      |      |
|---------|-------------|------|------|
|         | MIN         | NOM  | MAX  |
| A2      | 1.80        | 2.30 | 2.80 |
| A3      | 0.40        | 0.50 | 0.60 |
| B1      | 0.40        | 0.70 | 1.00 |
| D       | 6.00        | 6.50 | 7.00 |
| D1      | 4.80        | 5.35 | 5.90 |
| E3      | 3.50        | 4.00 | 4.50 |
| F       | 2.20        | 2.63 | 3.05 |
| F1      | 0.50        | 0.85 | 1.20 |
| E1      | 5.10        | 5.70 | 6.30 |
| E2      | 0.50        | 1.10 | 1.80 |
| e       | --          | 2.30 | --   |
| C       | 0.35        | 0.50 | 0.65 |

1. All dimensions are in millimeters.
2. Dimensions do not include mold protrusions.



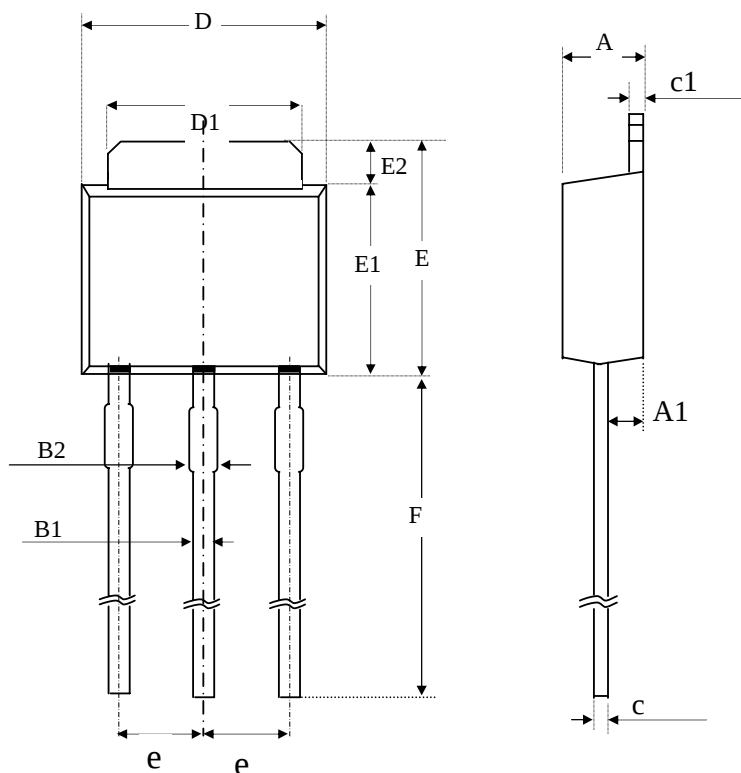
## Marking Information:

### Laser Marking





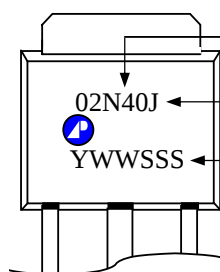
## Package Dimensions: TO-251



| SYMBOLS | Millimeters |      |      |
|---------|-------------|------|------|
|         | MIN         | NOM  | MAX  |
| A       | 2.20        | 2.30 | 2.40 |
| A1      | 0.90        | 1.20 | 1.50 |
| B1      | 0.40        | 0.60 | 0.80 |
| B2      | 0.60        | 0.85 | 1.05 |
| c       | 0.40        | 0.50 | 0.60 |
| c1      | 0.40        | 0.50 | 0.60 |
| D       | 6.40        | 6.60 | 6.80 |
| D1      | 4.80        | 5.20 | 5.50 |
| E       | 6.70        | 7.00 | 7.30 |
| E1      | 5.40        | 5.60 | 5.80 |
| E2      | 1.30        | 1.50 | 1.70 |
| e       | ----        | 2.30 | ---- |
| F       | 7.00        | 8.30 | 9.60 |

1. All dimensions are in millimeters.
2. Dimensions do not include mold protrusions.

## Marking Information:



Product: AP02N40

Package Code

J = RoHS-compliant halogen-free TO-251

Date Code (YWWSSS)

Y : Last digit of the year

WW : Work week

SSS : Lot code sequence