



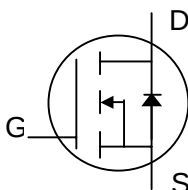
## N-channel Enhancement-mode Power MOSFET

Simple Drive Requirement

Supports 4.5V Logic-level Gate Drive

Low Gate Charge

RoHS-compliant



|              |               |
|--------------|---------------|
| $BV_{DSS}$   | 60V           |
| $R_{DS(ON)}$ | 100m $\Omega$ |
| $I_D$        | 11A           |

### Description

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

The AP9977GH-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 (AP9977GJ-HF-3) is available where a small PCB footprint is required.



### Absolute Maximum Ratings

| Symbol                           | Parameter                             | Rating     | Units               |
|----------------------------------|---------------------------------------|------------|---------------------|
| $V_{DS}$                         | Drain-Source Voltage                  | 60         | V                   |
| $V_{GS}$                         | Gate-Source Voltage                   | $\pm 25$   | V                   |
| $I_D$ at $T_A=25^\circ\text{C}$  | Continuous Drain Current <sup>3</sup> | 11         | A                   |
| $I_D$ at $T_A=100^\circ\text{C}$ | Continuous Drain Current <sup>3</sup> | 6.8        | A                   |
| $I_{DM}$                         | Pulsed Drain Current <sup>1</sup>     | 45         | A                   |
| $P_D$ at $T_A=25^\circ\text{C}$  | Total Power Dissipation               | 21         | W                   |
|                                  | Linear Derating Factor                | 0.17       | W/ $^\circ\text{C}$ |
| $T_{STG}$                        | 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 | Unit               |
|--------|----------------------------------------------------------------------|-------|--------------------|
| Rthj-c | Maximum Thermal Resistance, Junction-case                            | 6     | $^\circ\text{C/W}$ |
| Rthj-a | Maximum Thermal Resistance, Junction-ambient(PCB mount) <sup>3</sup> | 62.5  | $^\circ\text{C/W}$ |
| Rthj-a | Maximum Thermal Resistance, Junction-ambient                         | 110   | $^\circ\text{C/W}$ |

### Ordering Information

AP9977GH-HF-3TR : in RoHS-compliant halogen-free TO-252 shipped on tape and reel (3000 pcs/reel)

AP9977GJ-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                             | $V_{GS}=0V, I_D=250\mu A$                         | 60   | -    | -         | V                     |
| $\Delta BV_{DSS} / \Delta T_j$ | Breakdown Voltage Temperature Coefficient                  | Reference to $25^{\circ}\text{C}, I_D=1\text{mA}$ | -    | 0.04 | -         | V/ $^{\circ}\text{C}$ |
| $R_{DS(ON)}$                   | Static Drain-Source On-Resistance <sup>2</sup>             | $V_{GS}=10V, I_D=5A$                              | -    | -    | 100       | m $\Omega$            |
|                                |                                                            | $V_{GS}=4.5V, I_D=4A$                             | -    | -    | 125       | m $\Omega$            |
| $V_{GS(th)}$                   | Gate Threshold Voltage                                     | $V_{DS}=V_{GS}, I_D=250\mu A$                     | 1    | -    | 3         | V                     |
| $g_{fs}$                       | Forward Transconductance                                   | $V_{DS}=10V, I_D=5A$                              | -    | 7    | -         | S                     |
| $I_{DSS}$                      | Drain-Source Leakage Current                               | $V_{DS}=60V, V_{GS}=0V$                           | -    | -    | 10        | $\mu A$               |
|                                | Drain-Source Leakage Current ( $T_j=125^{\circ}\text{C}$ ) | $V_{DS}=48V, V_{GS}=0V$                           | -    | -    | 250       | $\mu A$               |
| $I_{GSS}$                      | Gate-Source Leakage                                        | $V_{GS}=\pm 25V$                                  | -    | -    | $\pm 100$ | nA                    |
| $Q_g$                          | Total Gate Charge <sup>2</sup>                             | $I_D=5A$                                          | -    | 6    | 10        | nC                    |
| $Q_{gs}$                       | Gate-Source Charge                                         | $V_{DS}=48V$                                      | -    | 2    | -         | nC                    |
| $Q_{gd}$                       | Gate-Drain ("Miller") Charge                               | $V_{GS}=4.5V$                                     | -    | 3    | -         | nC                    |
| $t_{d(on)}$                    | Turn-on Delay Time <sup>2</sup>                            | $V_{DS}=30V$                                      | -    | 6    | -         | ns                    |
| $t_r$                          | Rise Time                                                  | $I_D=5A$                                          | -    | 11   | -         | ns                    |
| $t_{d(off)}$                   | Turn-off Delay Time                                        | $R_G=3.3\Omega, V_{GS}=10V$                       | -    | 14   | -         | ns                    |
| $t_f$                          | Fall Time                                                  | $R_D=6\Omega$                                     | -    | 2    | -         | ns                    |
| $C_{iss}$                      | Input Capacitance                                          | $V_{GS}=0V$                                       | -    | 485  | 780       | pF                    |
| $C_{oss}$                      | Output Capacitance                                         | $V_{DS}=25V$                                      | -    | 55   | -         | pF                    |
| $C_{rss}$                      | Reverse Transfer Capacitance                               | $f=1.0\text{MHz}$                                 | -    | 40   | -         | pF                    |
|                                |                                                            |                                                   |      |      |           |                       |

**Source-Drain Diode**

| Symbol   | Parameter                          | Test Conditions     | Min. | Typ. | Max. | Units |
|----------|------------------------------------|---------------------|------|------|------|-------|
| $V_{SD}$ | Forward On Voltage <sup>2</sup>    | $I_S=5A, V_{GS}=0V$ | -    | -    | 1.2  | V     |
| $t_{rr}$ | Reverse Recovery Time <sup>2</sup> | $I_S=5A, V_{GS}=0V$ | -    | 23   | -    | ns    |
| $Q_{rr}$ | Reverse Recovery Charge            | $dI/dt=100A/\mu s$  | -    | 28   | -    | nC    |

**Notes:**

1. Pulse width limited by safe operating area
2. Pulse test - pulse width  $\leq 300\mu s$ , duty cycle  $\leq 2\%$
3. 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.

APEC DOES NOT ASSUME ANY LIABILITY ARISING OUT OF THE APPLICATION OR USE OF ANY PRODUCT OR CIRCUIT DESCRIBED HEREIN; NEITHER DOES IT CONVEY ANY LICENSE UNDER ITS PATENT RIGHTS, NOR THE RIGHTS OF OTHERS.

APEC RESERVES THE RIGHT TO MAKE CHANGES WITHOUT FURTHER NOTICE TO ANY PRODUCTS HEREIN TO IMPROVE RELIABILITY, FUNCTION OR DESIGN.



## Typical Electrical Characteristics

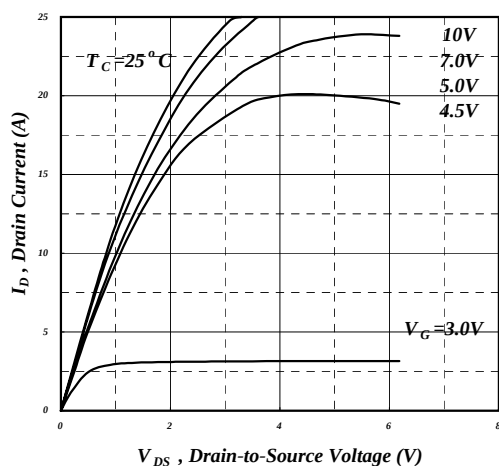


Fig 1. Typical Output Characteristics

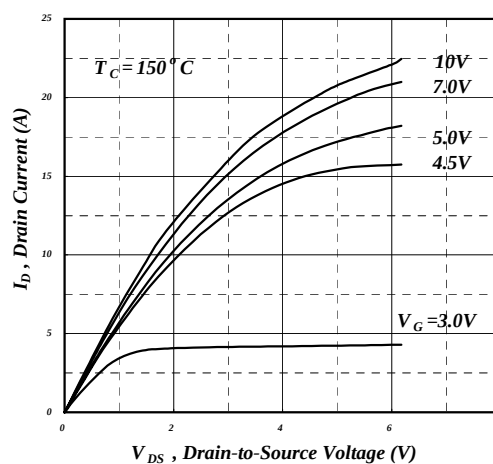


Fig 2. Typical Output Characteristics

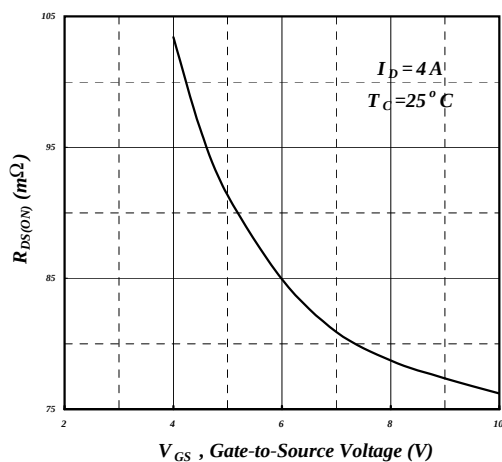


Fig 3. On-Resistance vs. Gate Voltage

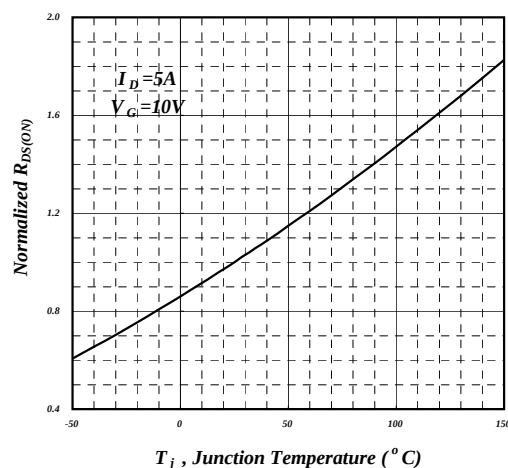


Fig 4. Normalized On-Resistance  
vs. Junction Temperature

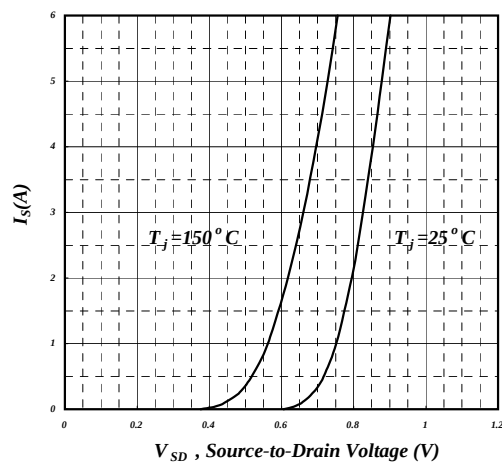


Fig 5. Forward Characteristic of  
Reverse Diode

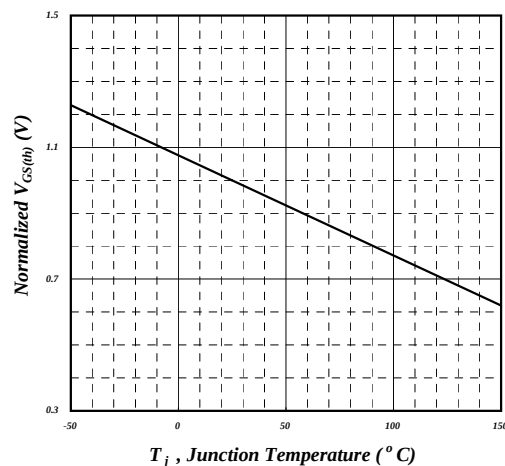


Fig 6. Gate Threshold Voltage vs.  
Junction Temperature



Typical Electrical Characteristics (cont.)

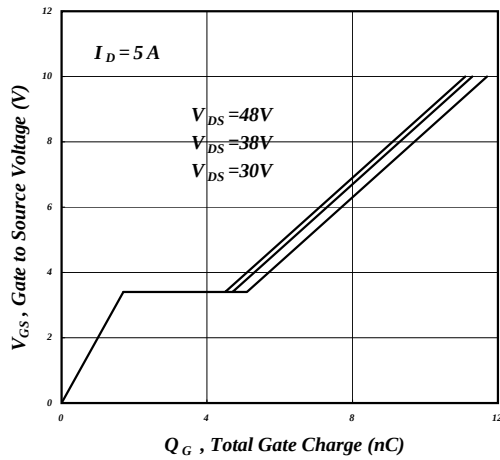


Fig 7. Gate Charge Characteristics

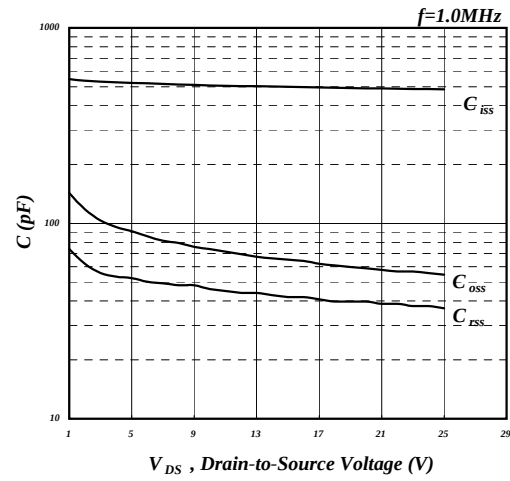


Fig 8. Typical Capacitance Characteristics

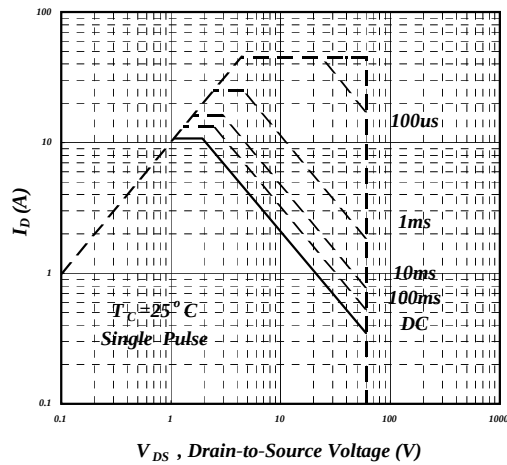


Fig 9. Maximum Safe Operating Area

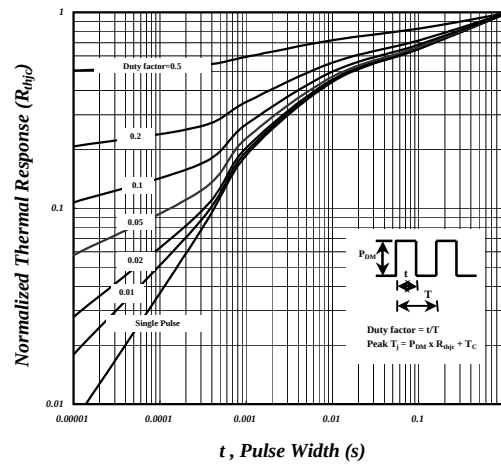


Fig 10. Effective Transient Thermal Impedance

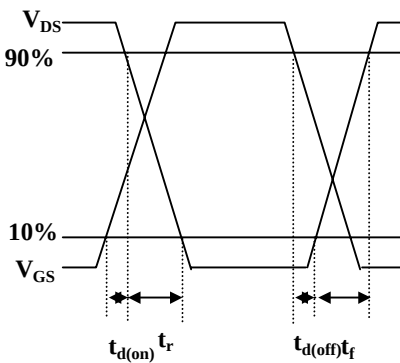


Fig 11. Switching Time Waveforms

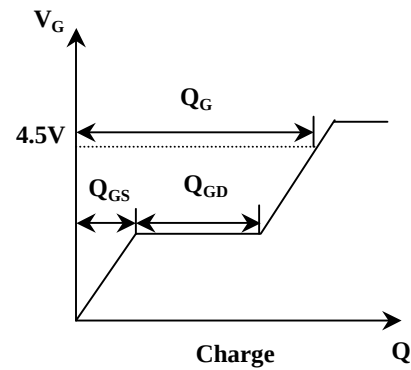
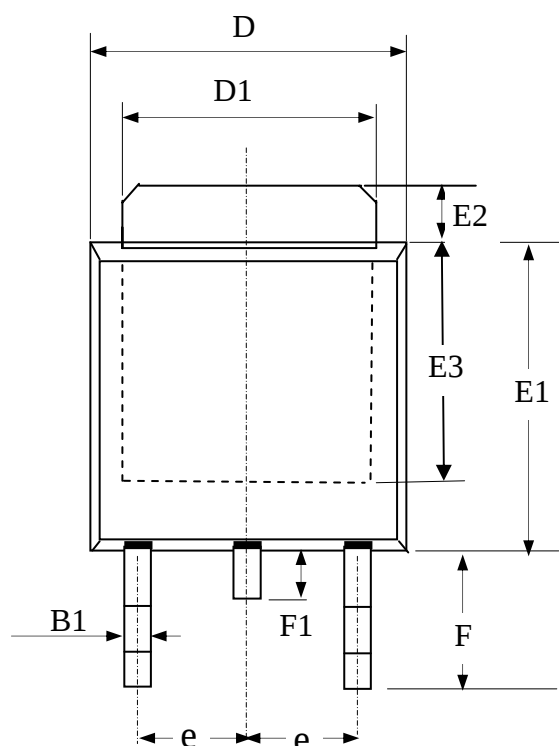


Fig 12. Gate Charge Waveform

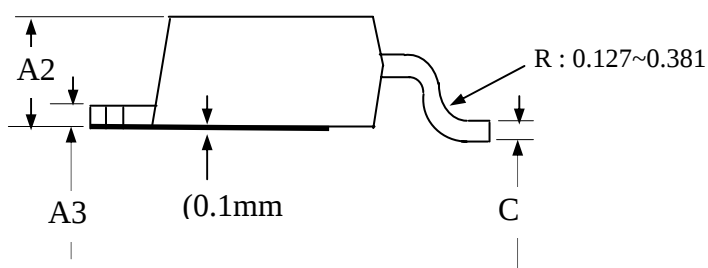


## Package Dimensions: TO-252



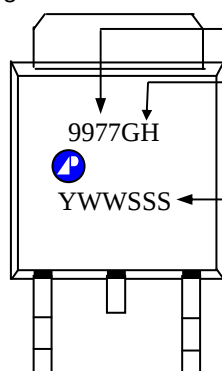
| SYMBOLS | Millimeters |      |      |
|---------|-------------|------|------|
|         | MIN         | NOM  | MAX  |
| A2      | 1.80        | 2.30 | 2.80 |
| A3      | 0.40        | 0.50 | 0.60 |
| B1      | 0.40        | 0.70 | 1.00 |
| D       | 6.00        | 6.50 | 7.00 |
| D1      | 4.80        | 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: TO-252

Laser Marking



Product: AP9977

Package code

GH = RoHS-compliant halogen-free TO-252

Date/lot code (YWWSSS)

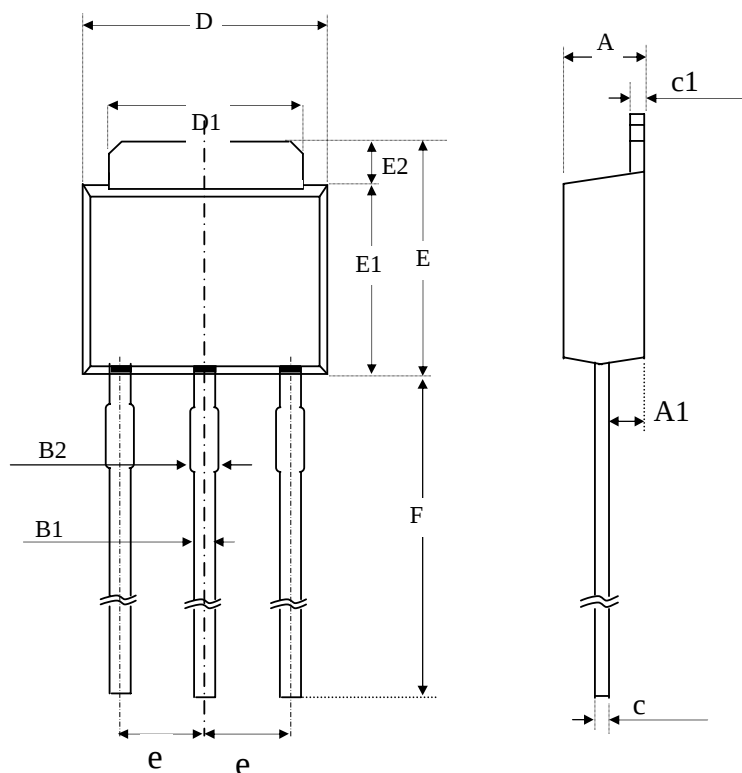
Y: Last digit of the year

WW: Work week

SSS: Lot code sequence



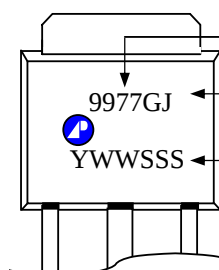
## Package Dimensions: TO-251



| 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: AP9977

Package Code

9977GJ

GJ = RoHS-compliant halogen-free TO-251

YWWSSS

Date Code (YWWSSS)

Y : Last digit of the year

WW : Work week

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