

## Description

The DIODES™ AP22980 is a single channel high side power switch with slew rate control, tri-state soft-start and active output discharge path in compact size.

The AP22980 contains an N-channel MOSFET that supports 6A of maximum continuous current and operates over an input range of 0.285V to 5.5V. The wide input voltage range and high current capability enable the device to be used in various systems and applications. The AP22980 has ultra-low ON-resistance of typical 5.1mΩ, which can minimize the voltage drop and power loss.

Low quiescent supply current of typical 60μA makes it ideal for system where standby power consumption is a concern.

The AP22980 offers multiple VOUT slew rates by tri-state logic input of SS pin, which does not require external component.

The AP22980 has 50Ω on-chip resistor for quick output discharge when switch is disabled to avoid unknown state caused by floating condition to downstream load.

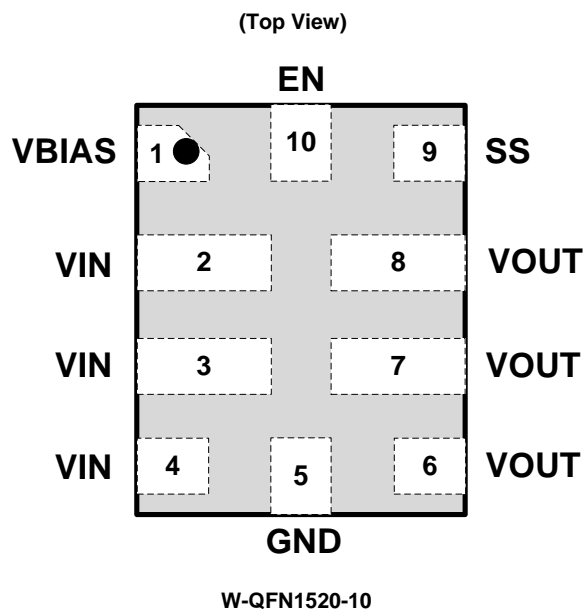
Over temperature protection circuitry is triggered if the junction temperature exceeds +150°C, thereby protecting the AP22980 and downstream circuit from potential damage.

The AP22980 is available in compact W-QFN1520-10 package.

## Applications

- Solid state drives (SSD)
- Laptops, desktops
- Tablet PCs
- Servers

## Pin Assignments

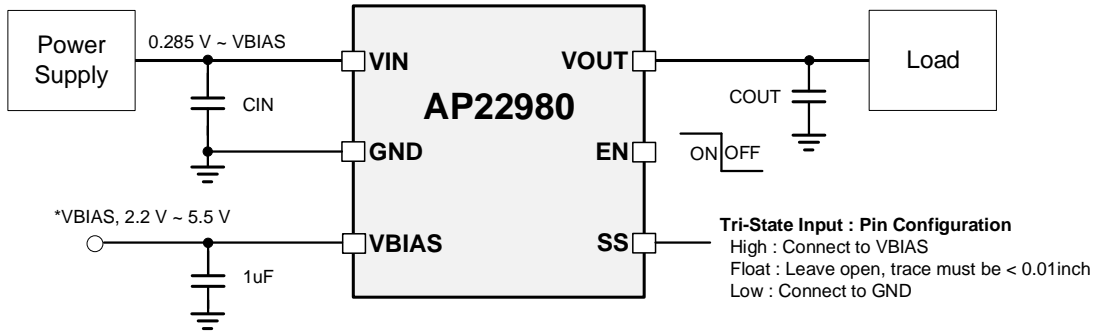


## Features

- Integrated Single Channel Load Switch
- 0.285V to VBIAS (up to 5.5V) Input Voltage Range
- 2.2V to 5.5V VBIAS Voltage Range
- Low R<sub>ON</sub> of Typ. 5.1mΩ (V<sub>BIAS</sub> = 5V)
- 6A Maximum Continuous Current
- Low Quiescent Current of Typ. 60μA.
- Tri-State Slew Rate Control at V<sub>IN</sub> = 3.3V
  - 15mV/μs (V<sub>SS</sub> = Floating)
  - 2mV/μs (V<sub>SS</sub> = HIGH)
  - 1mV/μs (V<sub>SS</sub> = LOW)
- Quick Output Discharge (QOD)
- Low Voltage Logic Enable
  - 1.2V/1.8V/2.5V/3.3V Logic Compatible
- Active HIGH Operation
- Thermal Shutdown
- ESD Protection: 2kV of HBM and 1kV of CDM
- Smaller Form Factor Package W-QFN1520-10
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1&2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**
- **For automotive applications requiring specific change control (i.e. parts qualified to AEC-Q100/101/104/200, PPAP capable, and manufactured in IATF 16949 certified facilities), please [contact us](https://www.diodes.com/quality/product-definitions/) or your local Diodes representative.**

Notes: 1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant.  
 2. See <https://www.diodes.com/quality/lead-free/> for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.  
 3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.

**Typical Applications Circuit**

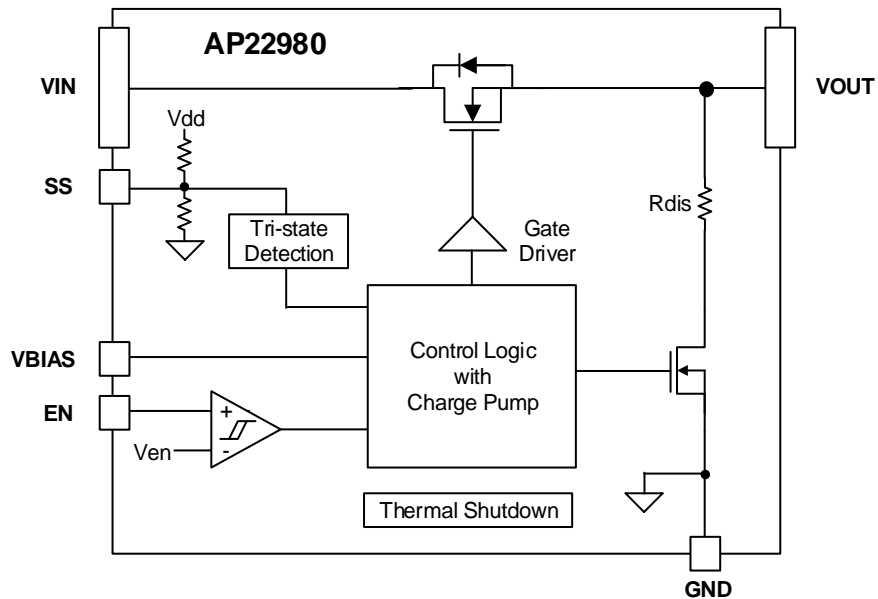


\* If  $V_{IN}$  is higher than 2.2V then VBIAS pin can be connected to VIN.

**Pin Descriptions**

| Pin Name | Pin Number | Function   |
|----------|------------|--|
| VBIAS    | 1          | VBIAS Input. Power supply to the device.               |
| VIN      | 2, 3, 4    | Power Switch Input. Place bypass capacitor to GND.     |
| GND      | 5          | Ground   |
| VOUT     | 6, 7, 8    | Power Switch Output. Place bypass capacitor to GND.    |
| SS       | 9          | Tri-State Slew Rate Control Input (HIGH/Floating/LOW). |
| EN       | 10         | Active HIGH Enable Input. Do not leave floating.       |

**Functional Block Diagram**



### Absolute Maximum Ratings (@ $T_A = +25^\circ\text{C}$ , unless otherwise specified.) (Note 4)

| Symbol               | Parameter  | Ratings     | Unit               |
|----------------------|--|-------------|--------------------|
| ESD HBM              | Human Body ESD Protection                          | $\pm 2$     | kV                 |
| ESD CDM              | Charged Device Model ESD Protection                | $\pm 1$     | V                  |
| $V_{IN}$             | Input Voltage at $V_{IN}$ Pin                      | -0.3 to +6  | V                  |
| $V_{BIAS}$           | Bias Supply Voltage                                | -0.3 to +6  | V                  |
| $V_{OUT}$            | Output Voltage at $V_{OUT}$ Pin                    | -0.3 to +6  | V                  |
| $V_{EN}, V_{SS}$     | Voltage at EN and SS Pins                          | -0.3 to +6  | V                  |
| $I_L$                | Load Current                                       | 6           | A                  |
| $T_{J(max)}$         | Maximum Junction Temperature                       | +150        | $^\circ\text{C}$   |
| $T_{STG}$            | Storage Temperature                                | -65 to +150 | $^\circ\text{C}$   |
| $P_D$                | Power Dissipation (Note 5)                         | 1.57        | W                  |
| $R_{\theta JA}$      | Junction-to-Ambient Thermal Resistance (Note 5)    | 79.5        | $^\circ\text{C/W}$ |
| $R_{\theta JC(top)}$ | Junction-to-Case (Top) Thermal Resistance (Note 5) | 8.5         | $^\circ\text{C/W}$ |

- Notes:
- Stresses greater than those listed under *Absolute Maximum Ratings* can cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions* is not implied. Exposure to *Absolute Maximum Ratings* for extended periods can affect device reliability.
  - $R_{\theta JA}$  and  $R_{\theta JC}$  are measured at  $T_A = +25^\circ\text{C}$  on a high effective thermal conductivity four-layer test board per JEDEC 51-7.

### Recommended Operating Conditions (@ $T_A = +25^\circ\text{C}$ , unless otherwise specified.) (Note 6)

| Symbol           | Parameter                     | Min   | Max        | Unit             |
|------------------|-------------------------------|-------|------------|------------------|
| $V_{IN}$         | Input Voltage                 | 0.285 | $V_{BIAS}$ | V                |
| $V_{BIAS}$       | Bias Supply Voltage           | 2.2   | 5.5        | V                |
| $V_{EN}, V_{SS}$ | Enable and Soft-Start Voltage | 0     | 5.5        | V                |
| $V_{OUT}$        | Output Voltage                | —     | $V_{IN}$   | V                |
| $C_{IN}$         | Input Bypass Capacitor        | 1     | —          | $\mu\text{F}$    |
| $C_{OUT}$        | Output Bypass Capacitor       | 0.1   | 94         | $\mu\text{F}$    |
| $T_A$            | Operating Ambient Temperature | -40   | +105       | $^\circ\text{C}$ |

- Note: 6. Refer to the *Typical Application Circuit*.

**Electrical Characteristics** ( $T_J = -40^{\circ}\text{C}$  to  $+105^{\circ}\text{C}$ ,  $V_{IN} = 0.285\text{V}$  to  $5.5\text{V}$ ,  $V_{BIAS} = 5.5\text{V}$ ,  $C_{IN} = 1\mu\text{F}$ ,  $C_L = 1\mu\text{F}$ ,  $V_{EN} = 3.3\text{V}$  and  $V_{SS} = \text{Floating}$ , typical values are at  $T_A = +25^{\circ}\text{C}$ , unless otherwise specified.)

| Symbol                   | Parameter                      | Test Conditions   | Min.                     | Typ. | Max. | Unit |    |
|--------------------------|--------------------------------|---|--------------------------|------|------|------|----|
| <b>Device</b>            |                                |   |                          |      |      |      |    |
| I <sub>BIAS_Q</sub>      | VBIAS Quiescent Current        | V <sub>EN</sub> = V <sub>IN</sub> = V <sub>BIAS</sub> = 5V, I <sub>OUT</sub> = 0A                   | —                        | 60   | —    | μA   |    |
| I <sub>BIAS_OFF</sub>    | VBIAS OFF Supply Current       | V <sub>EN</sub> = 0V, V <sub>OUT</sub> = 0V   | —                        | —    | 3.5  | μA   |    |
| I <sub>IN_SD</sub>       | Input Shutdown Leakage         | V <sub>EN</sub> = 0V<br>V <sub>OUT</sub> = 0V<br>T <sub>A</sub> = -40°C to +85°C                    | V <sub>IN</sub> = 5V     | —    | 0.03 | 2.0  | μA |
|                          |                                |   | V <sub>IN</sub> = 3.3V   | —    | 0.03 | 1.5  | μA |
|                          |                                |   | V <sub>IN</sub> = 1.8V   | —    | 0.02 | 1.2  | μA |
|                          |                                |   | V <sub>IN</sub> = 1.125V | —    | 0.01 | 1.1  | μA |
|                          |                                |   | V <sub>IN</sub> = 0.5V   | —    | 0.01 | 1.0  | μA |
|                          |                                | V <sub>EN</sub> = 0V<br>V <sub>OUT</sub> = 0V<br>T <sub>A</sub> = -40°C to +105°C                   | V <sub>IN</sub> = 5V     | —    | —    | 6.0  | μA |
|                          |                                |   | V <sub>IN</sub> = 3.3V   | —    | —    | 5.0  | μA |
|                          |                                |   | V <sub>IN</sub> = 1.8V   | —    | —    | 4.0  | μA |
|                          |                                |   | V <sub>IN</sub> = 1.125V | —    | —    | 3.5  | μA |
|                          |                                |   | V <sub>IN</sub> = 0.5V   | —    | —    | 3.0  | μA |
| I <sub>LEAK_EN</sub>     | EN Input Leakage               | V <sub>EN</sub> = 5.5V  | —                        | —    | 0.1  | μA   |    |
| V <sub>ENR</sub>         | EN Rise Threshold              | EN Rise   | 0.8                      | 0.9  | 1.0  | V    |    |
| V <sub>ENF</sub>         | EN Fall Threshold              | EN Fall   | 0.6                      | 0.7  | 0.8  | V    |    |
| t <sub>EN_DEG</sub>      | EN Deglitch Time (Note 7)      | —   | 1                        | 1.3  | —    | μs   |    |
| V <sub>SSH</sub>         | SS Logic HIGH Voltage (Note 7) | Logic Input HIGH  | 1.05                     | —    | —    | V    |    |
| V <sub>SSL</sub>         | SS Logic LOW Voltage (Note 7)  | Logic Input LOW   | —                        | —    | 0.5  | V    |    |
| R <sub>DIS</sub>         | Output Discharge Resistance    | V <sub>EN</sub> = 0V, I <sub>DIS</sub> = 10mA   | 40                       | 50   | 60   | Ω    |    |
| T <sub>SDN</sub>         | Thermal Shutdown (Note 8)      | Threshold   | —                        | +150 | —    | °C   |    |
|                          |                                | Hysteresis  | —                        | +25  | —    | °C   |    |
| <b>Power Switch</b>      |                                |   |                          |      |      |      |    |
| R <sub>ON</sub>          | ON Resistance                  | V <sub>EN</sub> = V <sub>BIAS</sub><br>I <sub>OUT</sub> = 200mA<br>T <sub>A</sub> = +25°C           | V <sub>IN</sub> = 5V     | —    | 5.1  | —    | mΩ |
|                          |                                |   | V <sub>IN</sub> = 3.3V   | —    | 5.2  | —    | mΩ |
|                          |                                |   | V <sub>IN</sub> = 1.8V   | —    | 5.2  | —    | mΩ |
|                          |                                |   | V <sub>IN</sub> = 1.125V | —    | 5.2  | —    | mΩ |
|                          |                                |   | V <sub>IN</sub> = 0.285V | —    | 5.2  | —    | mΩ |
|                          |                                | V <sub>EN</sub> = V <sub>BIAS</sub><br>I <sub>OUT</sub> = 200mA<br>T <sub>A</sub> = -40°C to +105°C | V <sub>IN</sub> = 5V     | —    | 5.1  | 7.5  | mΩ |
|                          |                                |   | V <sub>IN</sub> = 3.3V   | —    | 5.2  | 7.8  | mΩ |
|                          |                                |   | V <sub>IN</sub> = 1.8V   | —    | 5.2  | 7.8  | mΩ |
|                          |                                |   | V <sub>IN</sub> = 1.125V | —    | 5.2  | 7.8  | mΩ |
|                          |                                |   | V <sub>IN</sub> = 0.285V | —    | 5.2  | 7.8  | mΩ |
|                          |                                | V <sub>IN</sub> = 2.0V<br>I <sub>OUT</sub> = 200mA<br>T <sub>A</sub> = +25°C                        | V <sub>BIAS</sub> = 5V   | —    | 5.1  | —    | mΩ |
|                          |                                |   | V <sub>BIAS</sub> = 3.3V | —    | 5.2  | —    | mΩ |
|                          |                                |   | V <sub>BIAS</sub> = 2.5V | —    | 5.3  | —    | mΩ |
|                          |                                |   | V <sub>BIAS</sub> = 2.2V | —    | 5.4  | —    | mΩ |
|                          |                                | V <sub>IN</sub> = 2.0V<br>I <sub>OUT</sub> = 200mA<br>T <sub>A</sub> = -40°C to +105°C              | V <sub>BIAS</sub> = 5V   | —    | 5.1  | 7.5  | mΩ |
|                          |                                |   | V <sub>BIAS</sub> = 3.3V | —    | 5.2  | 7.8  | mΩ |
| V <sub>BIAS</sub> = 2.5V | —                              |   | 5.3                      | 8.0  | mΩ   |      |    |
| V <sub>BIAS</sub> = 2.2V | —                              |   | 5.4                      | 8.0  | mΩ   |      |    |

Notes: 7. Parameter guaranteed by design.  
8. Parameter guaranteed by design and characterization.

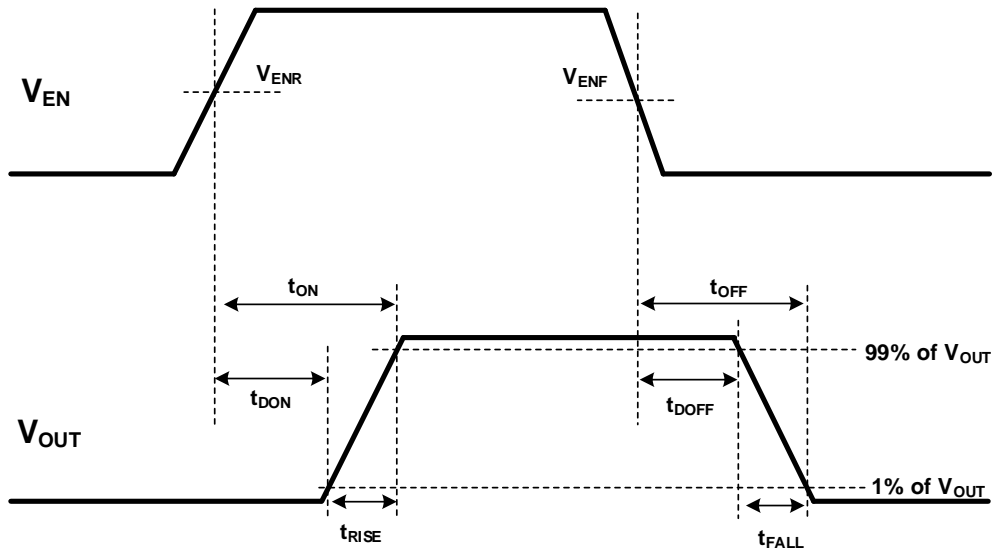
**Switching Characteristics** ( $T_J = -40^\circ\text{C}$  to  $+105^\circ\text{C}$ ,  $V_{IN} = 0.285\text{V}$  to  $5.5\text{V}$ ,  $V_{BIAS} = 5.5\text{V}$ ,  $C_{IN} = 1\mu\text{F}$ ,  $C_L = 0.1\mu\text{F}$ ,  $V_{EN} = 5\text{V}$  and  $V_{SS} = \text{Floating}$ , typical values are at  $T_A = +25^\circ\text{C}$ , unless otherwise specified.)

| Symbol   | Parameter                                     | Test Conditions                                     | Min. | Typ. | Max.          | Unit                    |
|--|---|---|------|------|---------------|-------------------------|
| <b>Tri-State Slew Rate with SS Pin</b>   |   |   |      |      |               |                         |
| $t_{DON}$  | ON Delay Time                                 | —   | —    | 25   | 50            | $\mu\text{s}$           |
| SR   | Output Slew Rate<br>(1% to 90% of $V_{OUT}$ ) | $V_{IN} = 3.3\text{V}$ , $V_{SS} = \text{Floating}$ | —    | 15   | —             | $\text{mV}/\mu\text{s}$ |
|  |   | $V_{IN} = 3.3\text{V}$ , $V_{SS} = \text{HIGH}$     | —    | 2    | —             | $\text{mV}/\mu\text{s}$ |
|  |   | $V_{IN} = 3.3\text{V}$ , $V_{SS} = \text{LOW}$      | —    | 1    | —             | $\text{mV}/\mu\text{s}$ |
| $t_{DOFF}$   | OFF Delay Time                                | —   | —    | 7    | $\mu\text{s}$ |                         |
| $t_{FALL\_4.7\mu\text{F}}$   | Output Fall Time                              | $R_L = 100\Omega$ , $C_L = 4.7\mu\text{F}$          | —    | 90   | —             | $\mu\text{s}$           |
| <b><math>V_{IN} = 5\text{V}</math>, <math>V_{EN} = V_{BIAS} = 5\text{V}</math>, <math>V_{SS} = 3.3\text{V}</math>, <math>T_A = +25^\circ\text{C}</math> (Unless otherwise noted)</b>         |   |   |      |      |               |                         |
| $t_{DON}$  | ON Delay Time                                 | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$          | —    | 25   | —             | $\mu\text{s}$           |
| $t_{RISE}$   | Output Rise Time                              | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$          | —    | 2550 | —             | $\mu\text{s}$           |
| $t_{ON}$   | Output Turn ON Time                           | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$          | —    | 2575 | —             | $\mu\text{s}$           |
| $t_{DOFF}$   | OFF Delay Time                                | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$          | —    | 3.5  | —             | $\mu\text{s}$           |
| $t_{FALL}$   | Output Fall Time                              | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$          | —    | 5.3  | —             | $\mu\text{s}$           |
| $t_{OFF}$  | Output Turn OFF Time                          | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$          | —    | 8.8  | —             | $\mu\text{s}$           |
| <b><math>V_{IN} = 5\text{V}</math>, <math>V_{EN} = V_{BIAS} = 5\text{V}</math>, <math>V_{SS} = 0\text{V}</math>, <math>T_A = +25^\circ\text{C}</math> (Unless otherwise noted)</b>           |   |   |      |      |               |                         |
| $t_{DON}$  | ON Delay Time                                 | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$          | —    | 30   | —             | $\mu\text{s}$           |
| $t_{RISE}$   | Output Rise Time                              | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$          | —    | 5000 | —             | $\mu\text{s}$           |
| $t_{ON}$   | Output Turn ON Time                           | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$          | —    | 5030 | —             | $\mu\text{s}$           |
| $t_{DOFF}$   | OFF Delay Time                                | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$          | —    | 3.5  | —             | $\mu\text{s}$           |
| $t_{FALL}$   | Output Fall Time                              | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$          | —    | 5.0  | —             | $\mu\text{s}$           |
| $t_{OFF}$  | Output Turn OFF Time                          | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$          | —    | 8.5  | —             | $\mu\text{s}$           |
| <b><math>V_{IN} = 5\text{V}</math>, <math>V_{EN} = V_{BIAS} = 5\text{V}</math>, <math>V_{SS} = \text{Floating}</math>, <math>T_A = +25^\circ\text{C}</math> (Unless otherwise noted)</b>     |   |   |      |      |               |                         |
| $t_{DON}$  | ON Delay Time                                 | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$          | —    | 20   | —             | $\mu\text{s}$           |
| $t_{RISE}$   | Output Rise Time                              | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$          | —    | 350  | —             | $\mu\text{s}$           |
| $t_{ON}$   | Output Turn ON Time                           | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$          | —    | 370  | —             | $\mu\text{s}$           |
| $t_{DOFF}$   | OFF Delay Time                                | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$          | —    | 3.5  | —             | $\mu\text{s}$           |
| $t_{FALL}$   | Output Fall Time                              | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$          | —    | 5.0  | —             | $\mu\text{s}$           |
| $t_{OFF}$  | Output Turn OFF Time                          | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$          | —    | 8.5  | —             | $\mu\text{s}$           |
| <b><math>V_{IN} = 0.285\text{V}</math>, <math>V_{EN} = V_{BIAS} = 5\text{V}</math>, <math>V_{SS} = 3.3\text{V}</math>, <math>T_A = +25^\circ\text{C}</math> (Unless otherwise noted)</b>     |   |   |      |      |               |                         |
| $t_{DON}$  | ON Delay Time                                 | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$          | —    | 30   | —             | $\mu\text{s}$           |
| $t_{RISE}$   | Output Rise Time                              | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$          | —    | 350  | —             | $\mu\text{s}$           |
| $t_{ON}$   | Output Turn ON Time                           | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$          | —    | 380  | —             | $\mu\text{s}$           |
| $t_{DOFF}$   | OFF Delay Time                                | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$          | —    | 6    | —             | $\mu\text{s}$           |
| $t_{FALL}$   | Output Fall Time                              | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$          | —    | 12   | —             | $\mu\text{s}$           |
| $t_{OFF}$  | Output Turn OFF Time                          | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$          | —    | 18   | —             | $\mu\text{s}$           |
| <b><math>V_{IN} = 0.285\text{V}</math>, <math>V_{EN} = V_{BIAS} = 5\text{V}</math>, <math>V_{SS} = 0\text{V}</math>, <math>T_A = +25^\circ\text{C}</math> (Unless otherwise noted)</b>       |   |   |      |      |               |                         |
| $t_{DON}$  | ON Delay Time                                 | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$          | —    | 30   | —             | $\mu\text{s}$           |
| $t_{RISE}$   | Output Rise Time                              | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$          | —    | 650  | —             | $\mu\text{s}$           |
| $t_{ON}$   | Output Turn ON Time                           | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$          | —    | 680  | —             | $\mu\text{s}$           |
| $t_{DOFF}$   | OFF Delay Time                                | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$          | —    | 6    | —             | $\mu\text{s}$           |
| $t_{FALL}$   | Output Fall Time                              | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$          | —    | 12   | —             | $\mu\text{s}$           |
| $t_{OFF}$  | Output Turn OFF Time                          | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$          | —    | 18   | —             | $\mu\text{s}$           |
| <b><math>V_{IN} = 0.285\text{V}</math>, <math>V_{EN} = V_{BIAS} = 5\text{V}</math>, <math>V_{SS} = \text{Floating}</math>, <math>T_A = +25^\circ\text{C}</math> (Unless otherwise noted)</b> |   |   |      |      |               |                         |
| $t_{DON}$  | ON Delay Time                                 | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$          | —    | 20   | —             | $\mu\text{s}$           |
| $t_{RISE}$   | Output Rise Time                              | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$          | —    | 40   | —             | $\mu\text{s}$           |
| $t_{ON}$   | Output Turn ON Time                           | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$          | —    | 60   | —             | $\mu\text{s}$           |
| $t_{DOFF}$   | OFF Delay Time                                | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$          | —    | 6    | —             | $\mu\text{s}$           |
| $t_{FALL}$   | Output Fall Time                              | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$          | —    | 12   | —             | $\mu\text{s}$           |
| $t_{OFF}$  | Output Turn OFF Time                          | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$          | —    | 18   | —             | $\mu\text{s}$           |

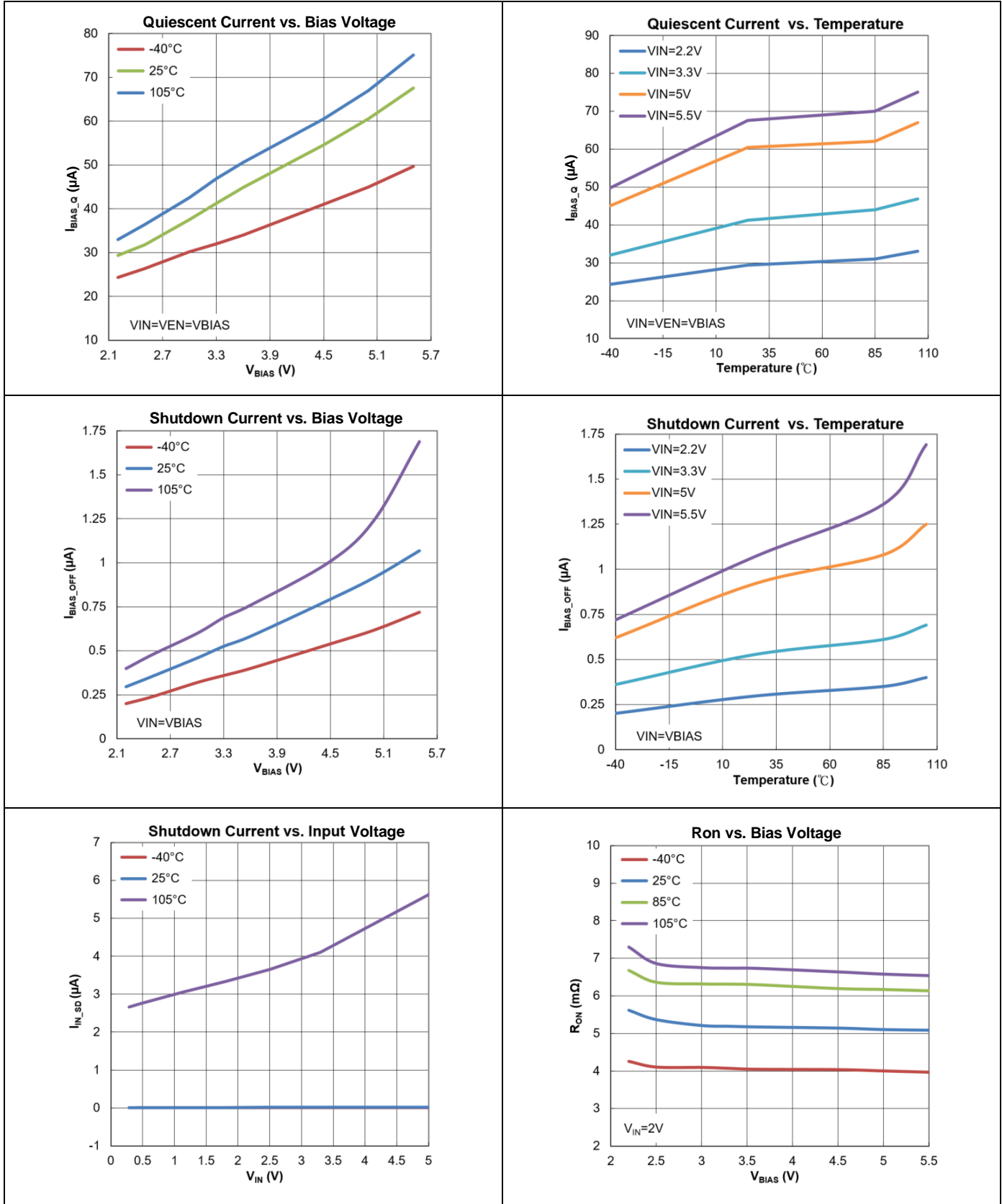
**Switching Characteristics** ( $T_J = -40^{\circ}\text{C}$  to  $+105^{\circ}\text{C}$ ,  $V_{IN} = 0.285\text{V}$  to  $2.2\text{V}$ ,  $V_{BIAS} = 2.2\text{V}$ ,  $C_{IN} = 1\mu\text{F}$ ,  $C_L = 0.1\mu\text{F}$ ,  $V_{EN} = 2.2\text{V}$  and  $V_{SS} = \text{Floating}$ , typical values are at  $T_A = +25^{\circ}\text{C}$ , unless otherwise specified.)

| Symbol   | Parameter            | Test Conditions                            | Min. | Typ. | Max. | Unit          |
|--|----------------------|--|------|------|------|---------------|
| <b><math>V_{IN} = 1.8\text{V}</math>, <math>V_{EN} = V_{BIAS} = 2.2\text{V}</math>, <math>V_{SS} = 3.3\text{V}</math>, <math>T_A = +25^{\circ}\text{C}</math> (Unless otherwise noted)</b>       |                      |  |      |      |      |               |
| $t_{DON}$  | ON Delay Time        | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$ | —    | 35   | —    | $\mu\text{s}$ |
| $t_{RISE}$   | Output Rise Time     | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$ | —    | 1500 | —    | $\mu\text{s}$ |
| $t_{ON}$   | Output Turn ON Time  | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$ | —    | 1535 | —    | $\mu\text{s}$ |
| $t_{DOFF}$   | OFF Delay Time       | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$ | —    | 4    | —    | $\mu\text{s}$ |
| $t_{FALL}$   | Output Fall Time     | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$ | —    | 6.0  | —    | $\mu\text{s}$ |
| $t_{OFF}$  | Output Turn OFF Time | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$ | —    | 10   | —    | $\mu\text{s}$ |
| <b><math>V_{IN} = 1.8\text{V}</math>, <math>V_{EN} = V_{BIAS} = 2.2\text{V}</math>, <math>V_{SS} = 0\text{V}</math>, <math>T_A = +25^{\circ}\text{C}</math> (Unless otherwise noted)</b>         |                      |  |      |      |      |               |
| $t_{DON}$  | ON Delay Time        | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$ | —    | 35   | —    | $\mu\text{s}$ |
| $t_{RISE}$   | Output Rise Time     | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$ | —    | 3100 | —    | $\mu\text{s}$ |
| $t_{ON}$   | Output Turn ON Time  | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$ | —    | 3135 | —    | $\mu\text{s}$ |
| $t_{DOFF}$   | OFF Delay Time       | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$ | —    | 4.0  | —    | $\mu\text{s}$ |
| $t_{FALL}$   | Output Fall Time     | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$ | —    | 5.5  | —    | $\mu\text{s}$ |
| $t_{OFF}$  | Output Turn OFF Time | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$ | —    | 9.5  | —    | $\mu\text{s}$ |
| <b><math>V_{IN} = 1.8\text{V}</math>, <math>V_{EN} = V_{BIAS} = 2.2\text{V}</math>, <math>V_{SS} = \text{Floating}</math>, <math>T_A = +25^{\circ}\text{C}</math> (Unless otherwise noted)</b>   |                      |  |      |      |      |               |
| $t_{DON}$  | ON Delay Time        | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$ | —    | 20   | —    | $\mu\text{s}$ |
| $t_{RISE}$   | Output Rise Time     | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$ | —    | 270  | —    | $\mu\text{s}$ |
| $t_{ON}$   | Output Turn ON Time  | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$ | —    | 290  | —    | $\mu\text{s}$ |
| $t_{DOFF}$   | OFF Delay Time       | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$ | —    | 4.0  | —    | $\mu\text{s}$ |
| $t_{FALL}$   | Output Fall Time     | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$ | —    | 6.0  | —    | $\mu\text{s}$ |
| $t_{OFF}$  | Output Turn OFF Time | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$ | —    | 10   | —    | $\mu\text{s}$ |
| <b><math>V_{IN} = 0.285\text{V}</math>, <math>V_{EN} = V_{BIAS} = 2.2\text{V}</math>, <math>V_{SS} = 3.3\text{V}</math>, <math>T_A = +25^{\circ}\text{C}</math> (Unless otherwise noted)</b>     |                      |  |      |      |      |               |
| $t_{DON}$  | ON Delay Time        | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$ | —    | 30   | —    | $\mu\text{s}$ |
| $t_{RISE}$   | Output Rise Time     | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$ | —    | 430  | —    | $\mu\text{s}$ |
| $t_{ON}$   | Output Turn ON Time  | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$ | —    | 460  | —    | $\mu\text{s}$ |
| $t_{DOFF}$   | OFF Delay Time       | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$ | —    | 5.5  | —    | $\mu\text{s}$ |
| $t_{FALL}$   | Output Fall Time     | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$ | —    | 6.5  | —    | $\mu\text{s}$ |
| $t_{OFF}$  | Output Turn OFF Time | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$ | —    | 12.0 | —    | $\mu\text{s}$ |
| <b><math>V_{IN} = 0.285\text{V}</math>, <math>V_{EN} = V_{BIAS} = 2.2\text{V}</math>, <math>V_{SS} = 0\text{V}</math>, <math>T_A = +25^{\circ}\text{C}</math> (Unless otherwise noted)</b>       |                      |  |      |      |      |               |
| $t_{DON}$  | ON Delay Time        | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$ | —    | 30   | —    | $\mu\text{s}$ |
| $t_{RISE}$   | Output Rise Time     | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$ | —    | 750  | —    | $\mu\text{s}$ |
| $t_{ON}$   | Output Turn ON Time  | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$ | —    | 780  | —    | $\mu\text{s}$ |
| $t_{DOFF}$   | OFF Delay Time       | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$ | —    | 5.5  | —    | $\mu\text{s}$ |
| $t_{FALL}$   | Output Fall Time     | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$ | —    | 6.5  | —    | $\mu\text{s}$ |
| $t_{OFF}$  | Output Turn OFF Time | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$ | —    | 12.0 | —    | $\mu\text{s}$ |
| <b><math>V_{IN} = 0.285\text{V}</math>, <math>V_{EN} = V_{BIAS} = 2.2\text{V}</math>, <math>V_{SS} = \text{Floating}</math>, <math>T_A = +25^{\circ}\text{C}</math> (Unless otherwise noted)</b> |                      |  |      |      |      |               |
| $t_{DON}$  | ON Delay Time        | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$ | —    | 20   | —    | $\mu\text{s}$ |
| $t_{RISE}$   | Output Rise Time     | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$ | —    | 70   | —    | $\mu\text{s}$ |
| $t_{ON}$   | Output Turn ON Time  | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$ | —    | 90   | —    | $\mu\text{s}$ |
| $t_{DOFF}$   | OFF Delay Time       | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$ | —    | 5.5  | —    | $\mu\text{s}$ |
| $t_{FALL}$   | Output Fall Time     | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$ | —    | 6.5  | —    | $\mu\text{s}$ |
| $t_{OFF}$  | Output Turn OFF Time | $R_L = 100\Omega$ , $C_L = 0.1\mu\text{F}$ | —    | 12.0 | —    | $\mu\text{s}$ |

**Typical  $t_{DON}/t_{RISE}/t_{ON}/t_{DOFF}/t_{FALL}/t_{OFF}$  Waveforms**

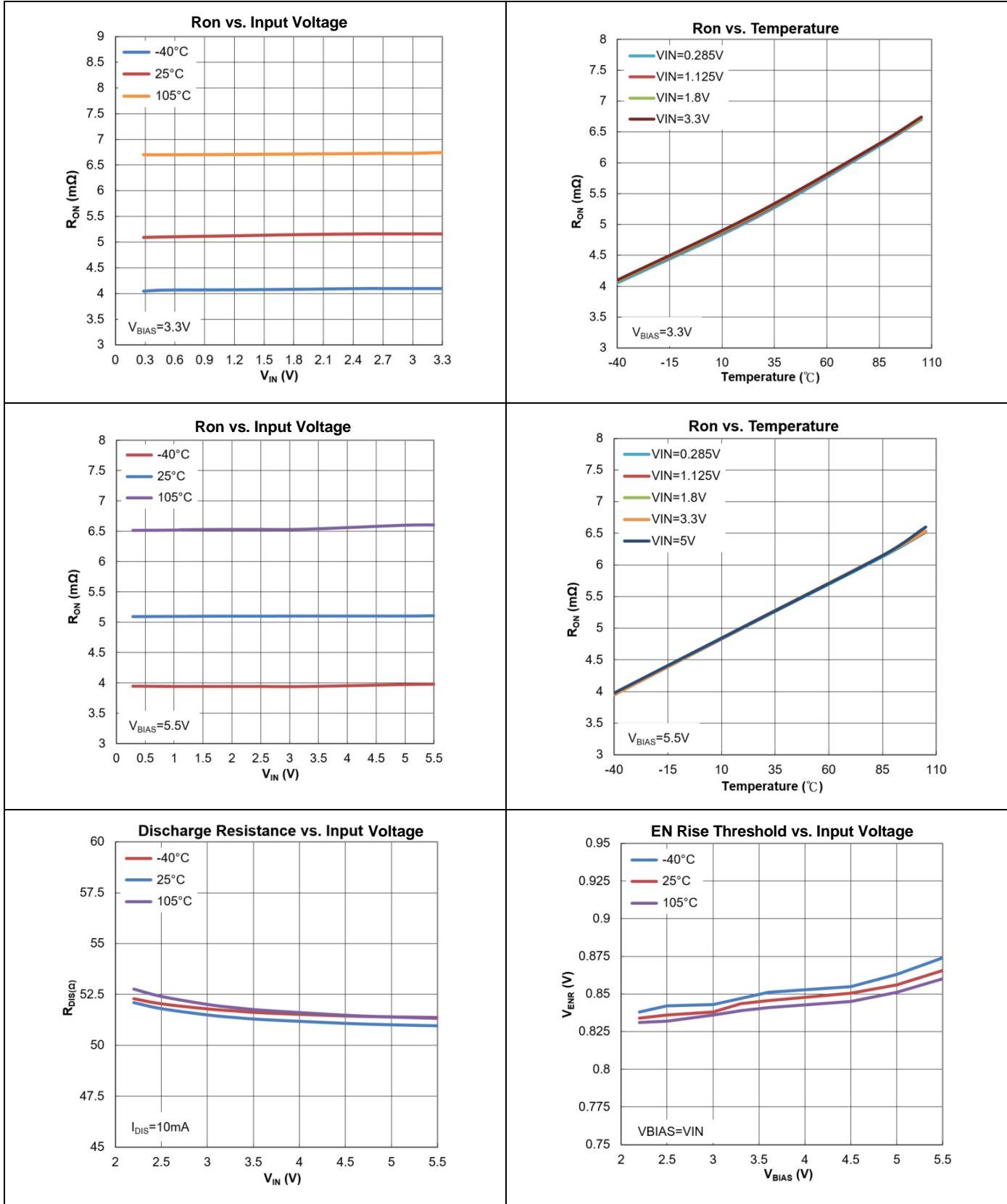


**Typical Performance Characteristics**

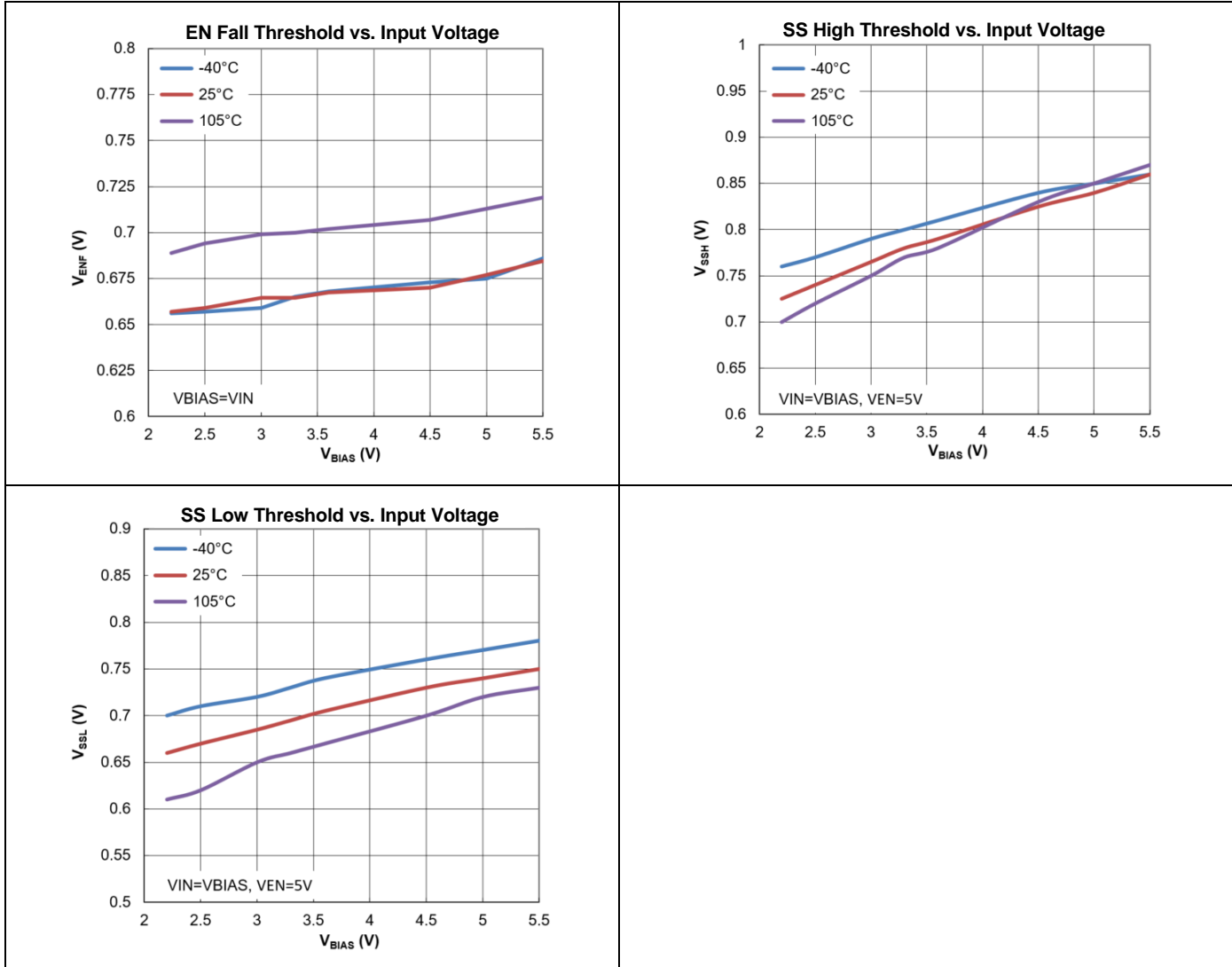




**Typical Performance Characteristics** (continued)



**Typical Performance Characteristics** (continued)



## Application Information

### ENABLE/DISABLE CONTROL

The EN pin controls the state of the power switch. AP22980 is enabled when the EN pin is asserted high and the device is disabled when EN pin is asserted low. The EN input is compatible with both TTL and CMOS logic. This pin cannot be left floating and must be tied either high or low for proper functionality.

### INPUT CAPACITOR

To limit the voltage drop on the input supply when the switch turns on into a discharged load capacitor resulting in a transient inrush current, a capacitor needs to be placed between VIN and GND. Use 1µF capacitor or a larger value for high-current applications. Place the capacitor close to the VIN pins.

### OUTPUT CAPACITOR

The recommended output capacitor value is 0.1µF when switching lighter load. For heavier loads close to 6A, it is recommended that the VIN and VOUT trace lengths need to be a minimum. In addition, a bulk capacitor ( $\geq 10\mu\text{F}$ ) may also be placed close to the VOUT pin. If using a bulk capacitor on VOUT, it is important to control the inrush current by choosing an appropriate soft-start time in order to minimize the droop on the input supply.

### TRI-STATE SOFT-START TIME

Soft-start slew rate can be set by tri-state input with SS pin. The tri-state SS pin status is latched upon initial power up when VBIAS becomes valid state and the first EN pin goes high, so it is recommended to set SS pin state prior to valid VBIAS and EN goes to HIGH. In order to avoid wrong state detection, an external capacitor is not allowed and if using an external pull-up or pull-down resistor, it is recommended to use less than 10kΩ respectively. For floating state resistance between SS and GND, it needs to be higher than 2MΩ. When Float state is desired, it is recommended to use as minimum trace as possible ( $< 0.01\text{in}$ ) to avoid noise coupling by adjacent signal and minimize parasitic capacitance. Please refer to *PCB Layout Example*.

The input inrush current can be controlled by selecting appropriate soft-start time. The table below shows the slew rate on V<sub>OUT</sub> by V<sub>SS</sub> conditions as follows.

| V <sub>ss</sub>                  | Slew Rate | Unit  |
|----------------------------------|-----------|-------|
| HIGH ( $> 1.05\text{V}$ )        | 2         | mV/us |
| LOW ( $< 0.5\text{V}$ )          | 1         |       |
| Floating ( $> 2\text{M}\Omega$ ) | 16.7      |       |

### QUICK OUTPUT DISAHRGE (QOD)

The AP22980 includes a QOD (Quick Output Discharge) feature with typical 50Ω of an internal discharge resistor. When the switch is disabled by EN pin or switch is enabled and during ON delay time ( $t_{\text{DON}}$ ), an internal discharge resistor is connected between VOUT and GND to remove the remaining charge from the output. Even if the switch is in OFF state without valid VBIAS, QOD stays working.

| VBIAS   | EN          | QOD                     | Device                    |
|---------|-------------|-------------------------|---------------------------|
| Invalid | Don't Care  | ON                      | OFF                       |
| Valid   | LOW         | ON                      | Disabled                  |
|         | LOW to HIGH | ON for $t_{\text{DON}}$ | Enabled and in soft-start |
|         | HIGH        | OFF                     | Enabled                   |

### THERMAL CONSIDERATOIN

The maximum junction temperature should be restricted to +150°C under normal operating conditions. The maximum allowable power dissipation  $P_{\text{D(MAX)}}$  can be calculated as:

$$P_{\text{D(MAX)}} = (T_{\text{J(MAX)}} - T_{\text{A}}) / \theta_{\text{JA}}$$

where,

$T_{\text{J(MAX)}}$  is the maximum operating junction temperature. For AP22980,  $T_{\text{J(MAX)}} = +150^{\circ}\text{C}$ .

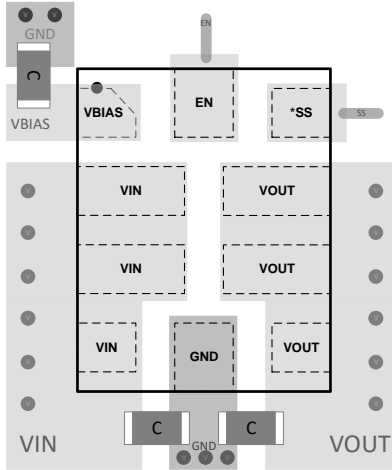
$T_{\text{A}}$  is the ambient temperature of the device.

$\theta_{\text{JA}}$  is the junction-to-air thermal impedance.

### BOARD LAYOUT

Good PCB layout is important for improving the thermal performance of the device. All trace lengths should be kept as short as possible. Place input and output capacitors close to the device to minimize the effects of parasitic inductance. The input and output PCB traces should be as wide as possible. SS pin must have minimum trace length ( $< 0.1\text{in}$ ) for float pin configuration to avoid unexpected coupling from adjacent signal.

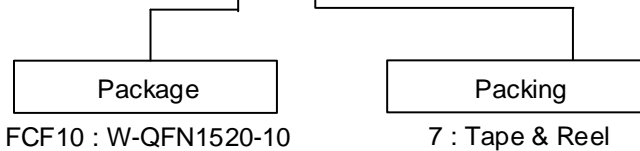
**PCB Layout Example**



\* SS pin trace must be less than 0.01inch for SS = Float configuration.

**Ordering Information**

AP22980 XXXXX - X

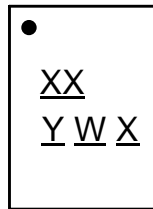


| Part Number    | Part Number Suffix | Package Code | Package      | Packing |                  |
|----------------|--------------------|--------------|--------------|---------|------------------|
|                |                    |              |              | Qty.    | Carrier          |
| AP22980FCF10-7 | -7                 | FCF10        | W-QFN1520-10 | 3000    | 7" Tape and Reel |

**Marking Information**

W-QFN1520-10

(Top View)



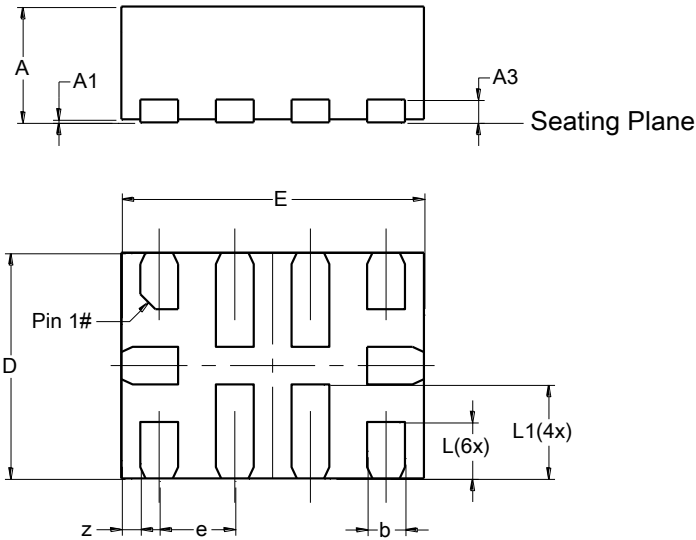
XX : Identification Code  
Y : Year 0 to 9 (ex: 2 = 2022)  
W : Week : A to Z : week 1 to 26;  
 a to z : week 27 to 52; z represents week 52 and 53  
X : Internal Code

| Part Number    | Package      | Identification Code |
|----------------|--------------|---------------------|
| AP22980FCF10-7 | W-QFN1520-10 | A3                  |

## Package Outline Dimensions

Please see <http://www.diodes.com/package-outlines.html> for the latest version.

### W-QFN1520-10

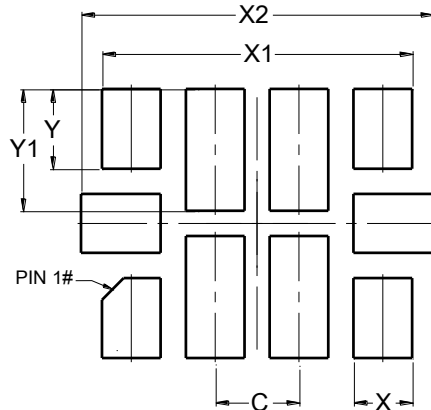


| W-QFN1520-10         |       |       |       |
|----------------------|-------|-------|-------|
| Dim                  | Min   | Max   | Typ   |
| A                    | 0.70  | 0.80  | 0.75  |
| A1                   | 0.00  | 0.05  | 0.03  |
| A3                   | —     | —     | 0.152 |
| b                    | 0.220 | 0.280 | 0.250 |
| D                    | 1.45  | 1.55  | 1.50  |
| E                    | 1.95  | 2.05  | 2.00  |
| e                    | —     | —     | 0.500 |
| L                    | 0.325 | 0.425 | 0.375 |
| L1                   | 0.575 | 0.675 | 0.625 |
| z                    | 0.100 | 0.150 | 0.125 |
| All Dimensions in mm |       |       |       |

## Suggested Pad Layout

Please see <http://www.diodes.com/package-outlines.html> for the latest version.

### W-QFN1520-10



| Dimensions | Value (in mm) |
|------------|---------------|
| C          | 0.500         |
| X          | 0.350         |
| X1         | 1.850         |
| X2         | 2.100         |
| Y          | 0.475         |
| Y1         | 0.725         |
| Y2         | 1.600         |

## Mechanical Data

- Moisture Sensitivity: Level 1 per J-STD-020
- Terminals: Finish – Matte Tin Plated Leads, Solderable per MIL-STD-202, Method 208 (E3)
- Weight: 0.0035 grams (Approximate)

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