# AOZ15953DI

**ECPower™ 2.7V-5.5V 35mΩ Smart Protection Switch With Ideal Diode Reverse Current Blocking**

## General Description

The AOZ15953DI is a protection switch intended for USB Type-C PD EPR applications that require reverse current protection. The input operating voltage range is between 2.7 V and 5.5 V, and the VOUT terminals are rated at 60 V Absolute Maximum. AOZ15953DI provides under-voltage lockout, over-voltage, and over-temperature protection. The FLTB pin flags thermal shutdown and over-voltage faults.

AOZ15953DI supports USB PD Fast Role Swap (FRS). When FON pin is high, the device is in fast-turn-on mode to ensure output voltage rises quickly to meet the USB PD specification.

AOZ15953DI features Ideal Diode True Reverse Current Blocking (IDTRCB) protection to prevent reverse current flow from VOUT to VIN at any load. This feature complies with the USB PD specification. The device also features fast recovery from reverse blocking to prevent excessive VOUT droop in power swap applications

The AOZ15953DI is available in a thermally enhanced 4mm x 4mm DFN-16L package which can operate over -40 °C to +125 °C junction temperature range.

## Features

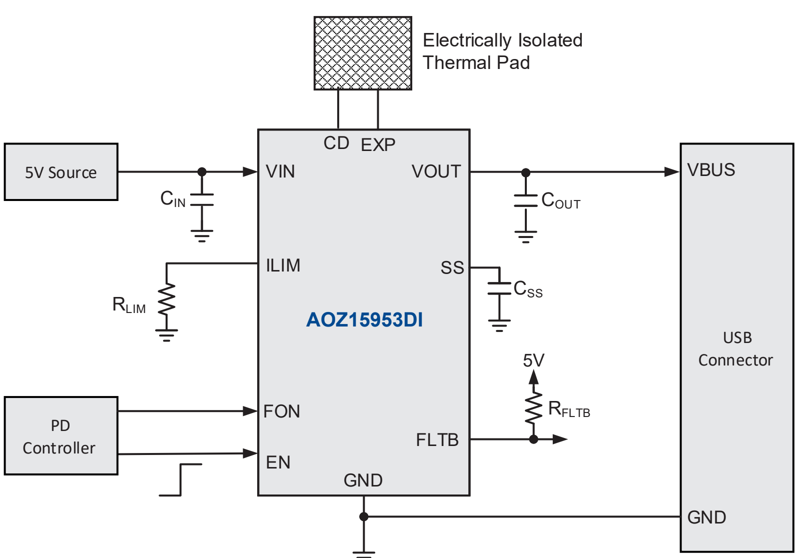
- 60V abs max rating on VOUT pin
- 2.7 V to 5.5 V operating input voltage
- 3.5 A continuous current
- 35 mΩ typical ON resistance
- Supports USB PD Fast Role Swap (FRS)
- Integrated Positive and Negative Transient Voltage Suppression at VOUT
- Ideal Diode True Reverse Current Blocking (IDTRCB)
- Programmable current limit
- Programmable Soft-Start
- VIN Under-Voltage Lockout (UVLO)
- VIN Over-Voltage Lockout (OVLO)
- Thermal Shutdown Protection
- Startup Short Circuit Protection
- IEC61000-4-2:
  - ±8 kV contact on Vin; Vout with 10uF
  - ±15 kV Air Discharge on Vin; Vout with 10uF
- Thermally Enhanced DFN4x4-16L package

## Applications

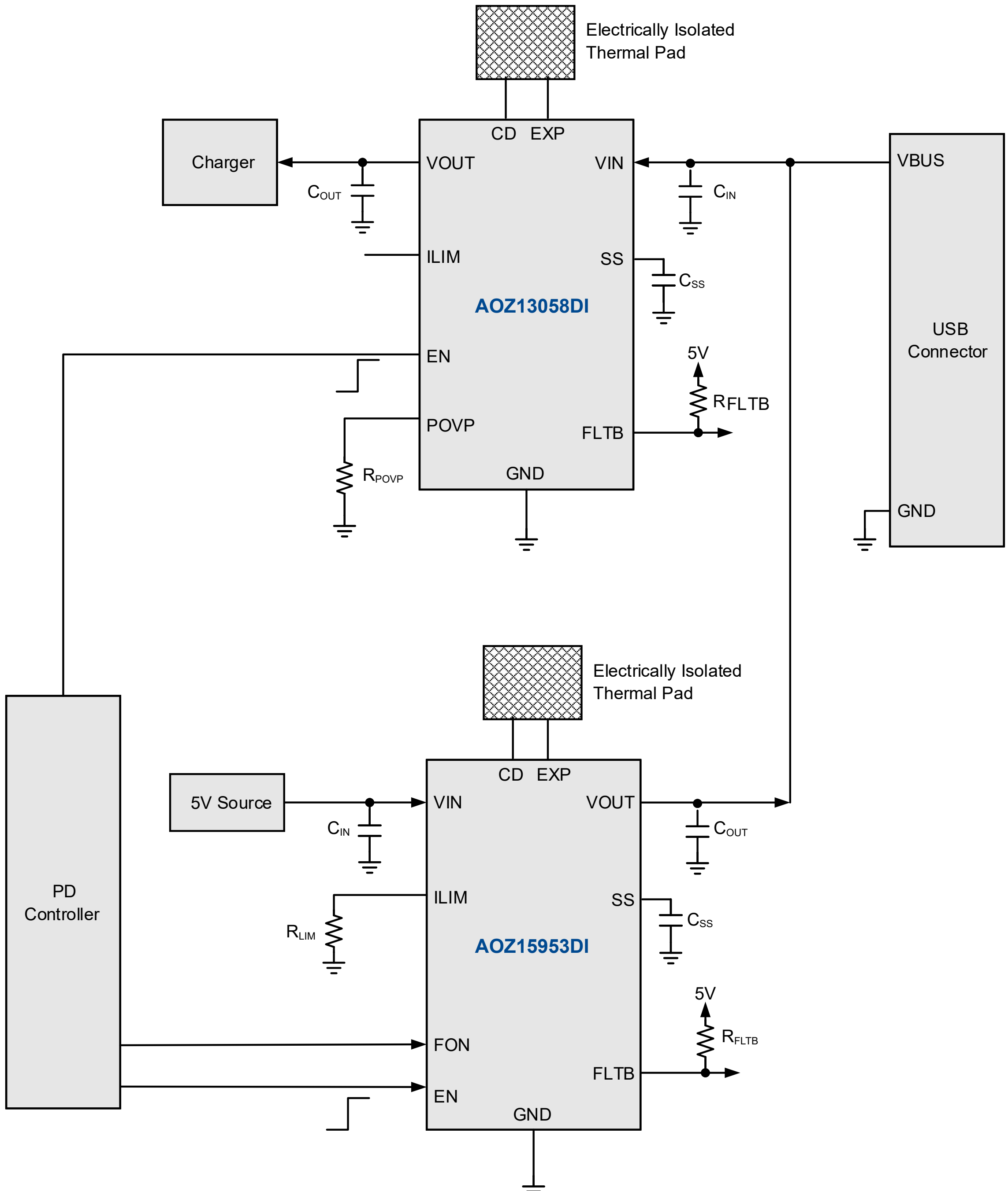
- Thunderbolt/USB Type-C PD EPR power switch
- Notebooks computer barrel jack
- Docking Stations / Dongles

GREEN Product

## Typical Application



## USB PD EPR Application

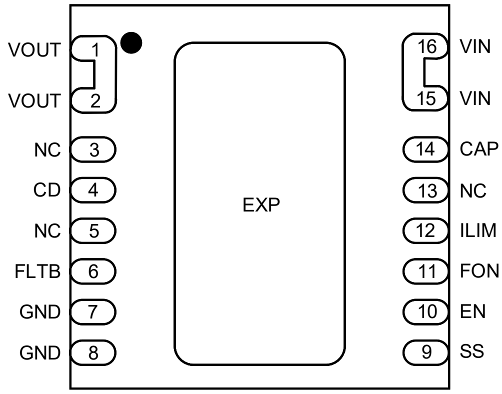


## Ordering Information

| Part Number | Recovery | Junction Temperature Range | Package | Environmental |
|---|---|---|---|---|
| AOZ15953DI-01 | Auto-restart | -40°C to +125°C | DFN4x4-16L | RoHS |
| AOZ15953DI-02 | Latch-off | -40°C to +125°C | DFN4x4-16L | RoHS |

AOS products are offered in packages with Pb-free plating and compliant to RoHS standards.
Please visit https://aosmd.com/sites/default/files/media/AOSGreenPolicy.pdf for additional information.

## Pin Configuration




**DFN4x4-16L**
**(Top Transparent View)**

## Pin Description

| Pin Number | Pin Name | Pin Function |
|---|---|---|
| 1, 2 | VOUT | Output pins. Connect to adapter. |
| 3 | NC | No connect |
| 4 | CD | Common Drain node for the power switches and it must be electrically connected to Exposed Pad (EXP). |
| 5 | NC | No connect |
| 6 | FLTB | Fault Indicator, Open-drain output. Pull low after a fault condition is detected. |
| 7, 8 | GND | Ground. |
| 9 | SS | Soft-start pin. Connect a capacitor CSS from SS to GND to set the soft-start time. |
| 10 | EN | Enable Active High. |
| 11 | FON | Fast turn-on. Active High. Pull high to enable fast turn-on mode. |
| 12 | ILIM | Current limit set pin. Connect a 1% resistor RLIM between ILIM and GND to set the current limit threshold. Floating or short this pin to GND will limit the current to 1.1A. |
| 13 | NC | No connect |
| 14 | CAP | Connect a 10nF Capacitor to GND. |
| 15, 16 | VIN | Supply input. Connect to internal power regulator. Place a 10 µF capacitor from VIN to GND. |
| EXP | EXP | Exposed Thermal Pad. It is the common drain node for the power switches and it must be electrically isolated. Solder to a metal surface directly underneath the EXP and connect to floating copper thermal pads on multiple PCB layers through many VIAs. For best thermal performance, make the floating copper pads as large as possible. |

## Absolute Maximum Ratings

*Exceeding the Absolute Maximum ratings may damage the device.*

| Parameter | Rating |
|---|---|
| VOUT to GND | -0.3 V to +60 V |
| VIN, EN, FLTB, FON to GND | -0.3 V to +6 V |
| SS, ILIM to GND | -0.3 to 3.5 V |
| CAP to VIN | -0.3 V to +6 V |
| CD=EXP to the greater of VIN or VOUT | -0.3 V |
| CD=EXP to GND | 66 V |
| Junction Temperature ($T_J$) | +150 °C |
| Storage Temperature ($T_S$) | -65 °C to +150 °C |
| ESD Rating CDM All Pins | ±1 kV |
| IEC 61000-4-2 VIN and VOUT Pins | ±8 kV |

## Recommended Operating Conditions

*The device is not guaranteed to operate beyond the Maximum Recommended Operating Conditions.*

| Parameter | Rating |
|---|---|
| Supply Voltage VIN to GND | 2.7V to 5.5V |
| EN, FLTB, FON to GND | 0 V to 5.5 V |
| SS, ILIM to GND | 0 V to 3 V |
| CD=EXP to the greater of VIN or VOUT | 0 V |
| CD=EXP to GND | 55V |
| DC Fully On Switch Current ($I_{SW}$) | 0 V to 3.5 V |
| Junction Temperature ($T_J$) | -40 °C to +125 °C |

## Electrical Characteristics

$T_A$ = 25 °C, VIN = 5 V, EN = 5 V, $C_{IN}$ = 10 µF, $C_{OUT}$ = 10 µF, $C_{SS}$ = 5.6 nF, $C_{CAP}$ = 10 nF, unless otherwise specified.

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| **General** | | | | | | |
| $V_{VIN}$ | Input Supply Voltage | | 2.7 | | 5.5 | V |
| $V_{UVLO}$ | Under-voltage Lockout Threshold | VIN rising | 2.35 | | 2.65 | V |
| $V_{UVLO\_HYS}$ | Under-voltage Lockout Hysteresis | | | 150 | | mV |
| $I_{VIN\_ON}$ | Input Quiescent Current | $I_{VOUT}$ = 0 A | | 850 | | µA |
| $I_{VIN\_OFF}$ | Input Shutdown Current | $I_{VOUT}$ = 0 A, EN = 0 V | | 100 | | µA |
| $I_{VOUT\_OFF}$ | Output Leakage Current | VOUT = 20 V, VIN = 0 V, EN = 0 V | | | 100 | µA |
| $R_{ON\_5V}$ | Switch ON-Resistance(1) | $I_{VOUT}$ > 1 A | | 35 | | mΩ |
| $V_{EN\_H}$ | EN Input High Threshold | EN rising | | | 1.4 | V |
| $V_{EN\_L}$ | EN Input Low Threshold | EN falling | 0.4 | | | V |
| $I_{EN}$ | EN Bias current | Ven = 1.8 V | | | 1.5 | uA |
| $V_{FLTB\_LO}$ | FLTB Pin Pull-down Voltage | FLTB sinking 3 mA | | | 0.3 | V |
| **Input Over-Voltage Protection** | | | | | | |
| $V_{OVP}$ | Over Voltage Protection Threshold | | 5.6 | 5.8 | 6.0 | V |
| $V_{OVP\_HYS}$ | Over Voltage Protection Hysteresis (-01) | | | 0.2 | | V |
| $t_{OVP\_DEB}$ | OVP Debounce Time | | | 512 | | us |

**Note:**

1. RON is tested at 1A in test mode to bypass ideal diode regulation

## Electrical Characteristics

$T_A$ = 25 °C, VIN = 20 V, EN = 5 V, $C_{IN}$ = 10 µF, $C_{OUT}$ = 10 µF, $C_{SS}$ = 5.6 nF, $C_{CAP}$ = 1 nF, unless otherwise specified.

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| **True Reverse Current Blocking (TRCB)** | | | | | | |
| $V_{IDRCB}$ | Ideal Diode TRCB Regulation Voltage | VIN – VOUT | | 15 | | mV |
| $V_{FRCB}$ | Fast TRCB Threshold | VOUT - VIN | | 60 | | mV |
| $V_{FRCB\_HYS}$ | Fast TRCB Hysteresis | VOUT - VIN | | 50 | | mV |
| $t_{TRCB\_DEL}$ | TRCB Delay Time | | | 0.6 | | µs |
| **Over Current Protection (OCP)** | | | | | | |
| $I_{LIM}$ | Current Limit Threshold for -40°C to 85°C | RLIM = 5.36kΩ | 3.55 | 4.19 | 4.94 | A |
| | | RLIM = 6.2kΩ | 3.07 | 3.62 | 4.27 | A |
| | | RLIM = 20kΩ | 0.84 | 1.20 | 1.56 | A |
| | | RLIM = short/open | | 1.1 | | A |
| $t_{OCP\_HOLD}$ | Over-Current Duration before Switch Off | From IOUT ≥ ILIM to Switch Off | | 1.5 | | ms |
| $t_{OCP\_FLTB}$ | Over-Current Flag Delay | From IOUT ≥ ILIM to FLTB = Low | | 500 | | µs |
| **Fast Turn On (FON)** | | | | | | |
| $I_{IN\_FON}$ | FON Standby Current | EN = 0V, FON=5V, IOUT = 0A | | 200 | | µA |
| $V_{FON\_H}$ | FON Input Logic High Threshold | FON rising | | | 1.4 | V |
| $V_{FON\_L}$ | FON Input Logic Low Threshold | FON falling | 0.4 | | | V |
| $I_{FON}$ | FON Bias current | VFON = 1.8V | | 1 | 1.5 | µA |
| $t_{FON}$ | Fast Turn-On Time (From VEN=VEN_H to VOUT=4.75V) | VIN = 5V, VEN=5V, VFON=5V, RL = 100Ω, COUT = 1µF | | | 100 | µs |
| $t_{S\_FON}$ | FON Setup Time prior to EN | | 100 | | | µs |
| $t_{H\_FON}$ | FON Hold Time after to EN | | 40 | | | µs |
| $t_{A\_FON}$ | VIN UVLO to FON assertion | Min time between UVLO and FON asserted | | 1.7 | 2.5 | ms |
| **Dynamic Timing Characteristics** | | | | | | |
| $t_{D\_ON}$ | Turn-On Delay Time | From EN rising edge to VOUT reaching 10% of VIN | | 8 | | ms |
| $t_{ON}$ | Turn-On Rise Time | VOUT from 10% to 90% of VIN | | 1.5 | | ms |
| $t_{RST}$ | Auto-retry time (-01) | | | 64 | | ms |
| $t_{SCP\_RST}$ | SCP Restart Time (-01) | During soft start | | 64 | | ms |
| $t_{SCP\_RST}$ | SCP Restart Time (-02) | During soft start | | 4 | | ms |
| $T_{retry}$ | SCP Auto-retry time (-02) | During soft start | | 15 | | times |
| $t_{SCP}$ | SCP Response Time | During steady state | | 500 | | ns |
| $t_{SOA\_TIMEOUT}$ | SOA timeout period | During soft start | | 512 | | us |
| **Thermal Shutdown Protection** | | | | | | |
| $T_{SD}$ | Thermal Shutdown Threshold | Temperature rising | | 140 | | °C |
| $T_{SD\_HYS}$ | Thermal Shutdown Hysteresis (-01) | | | 20 | | °C |

## Electrical Characteristics

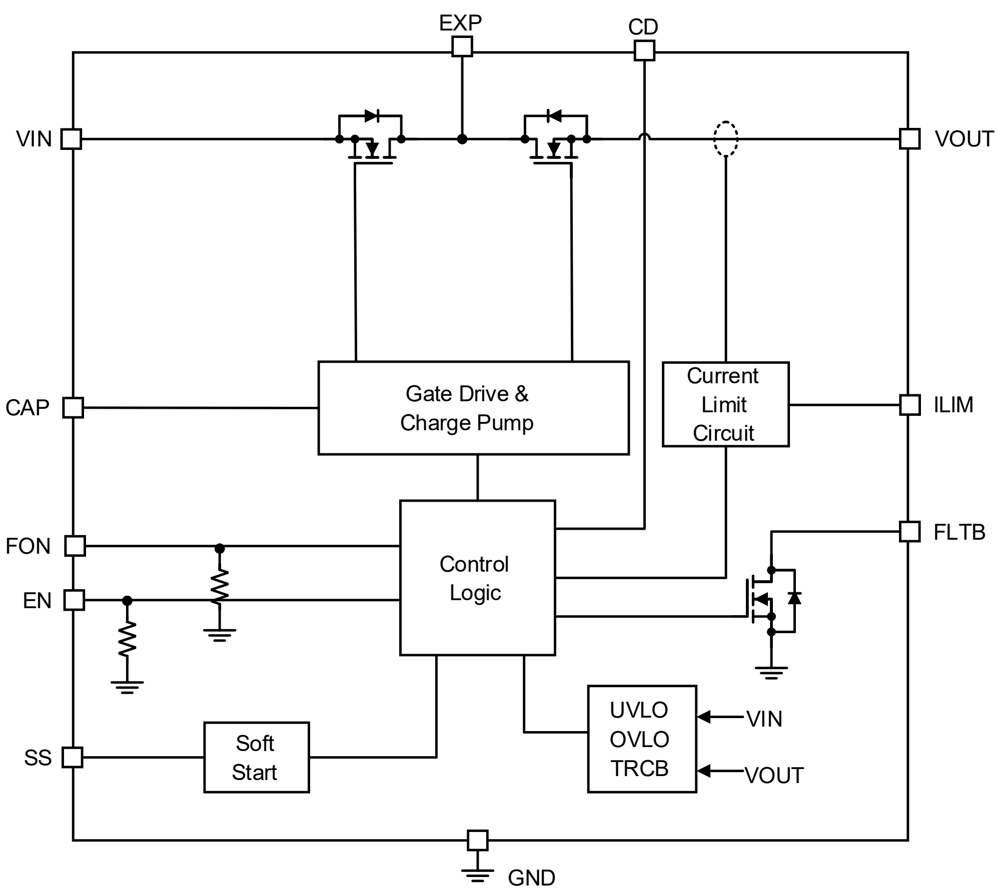
$T_A$ = 25 °C, VIN = 20 V, EN = 5 V, $C_{IN}$ = 10 µF, $C_{OUT}$ = 10 µF, $C_{SS}$ = 5.6 nF, $C_{CAP}$ = 1 nF, unless otherwise specified.

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| **Short Circuit Protection** | | | | | | |
| $I_{SCP}$ | Current Limit Threshold for Short Circuit Protection | During steady state | | 10 | | A |
| $I_{SOA\_LIM}$ | Current Limit Threshold for Short Circuit Protection | During soft start | | 15 | | A |

## Thermal Characteristics

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| **Short Circuit Protection** | | | | | | |
| $R_{th(J-C)}$ | Thermal Resistance from junction to case | | | 4.2 | | °C/W |
| $R_{th(J-A)}$ | Thermal Resistance from junction to ambient | | | 38 | | °C/W |

## Functional Block Diagram



## Timing Diagrams

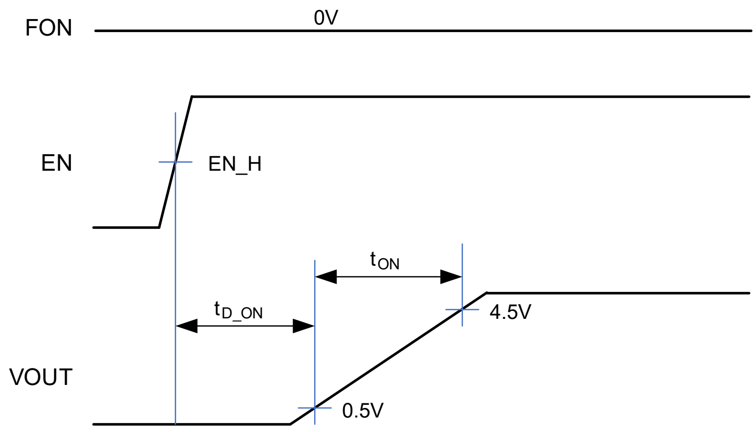



**Figure 1. Standard Turn-on Delay and Turn-on Time (FON = 0V)**

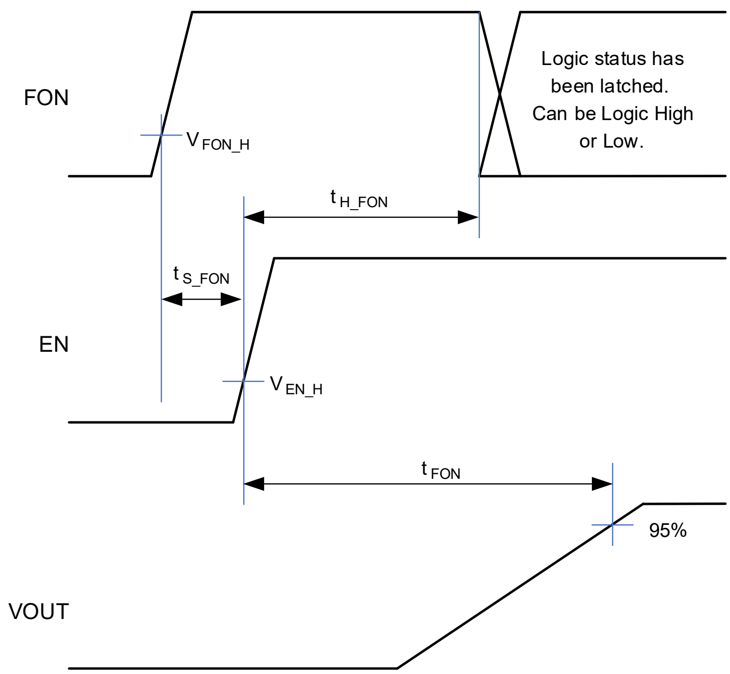



**Figure 2. Fast Turn-on Time (FON = 5V before EN)**

## Timing Diagrams (Continued)

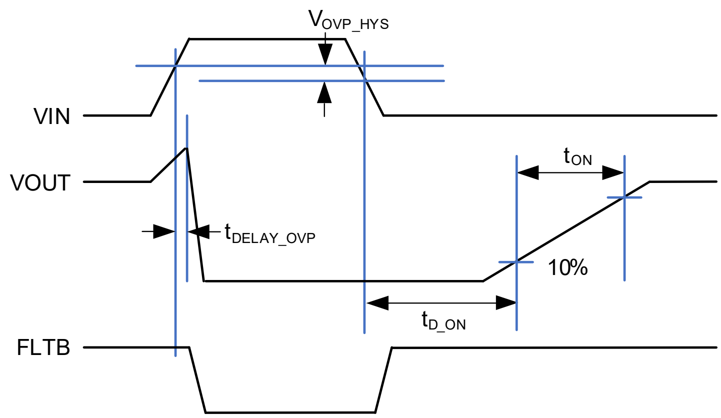



**Figure 3. Over Voltage Protection (-01)**

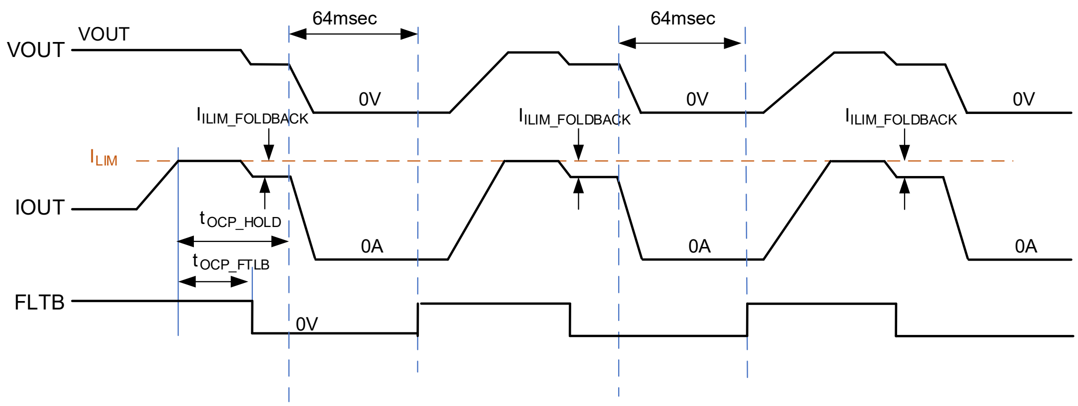



**Figure 4a. Over Current Protection (-01)**

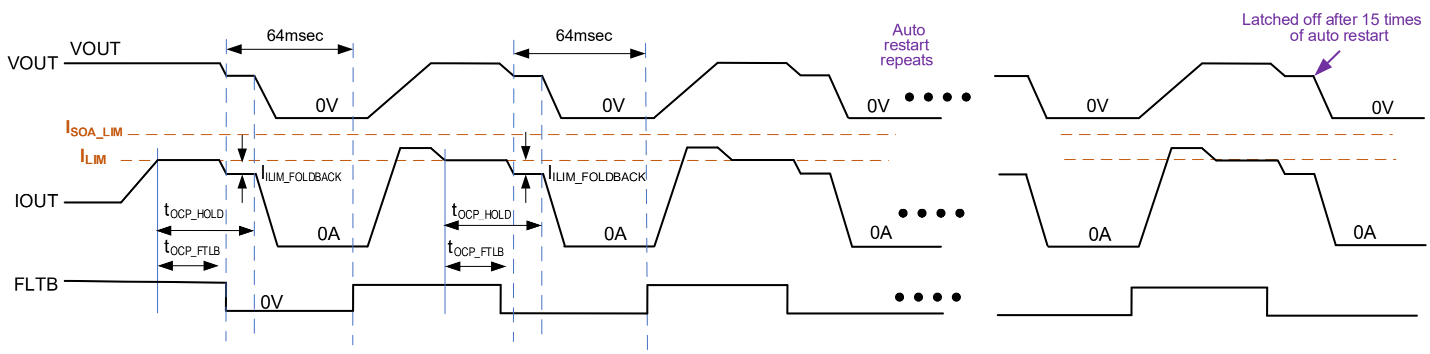



**Figure 4b. Over Current Protection (-02)**

## Timing Diagrams (Continued)

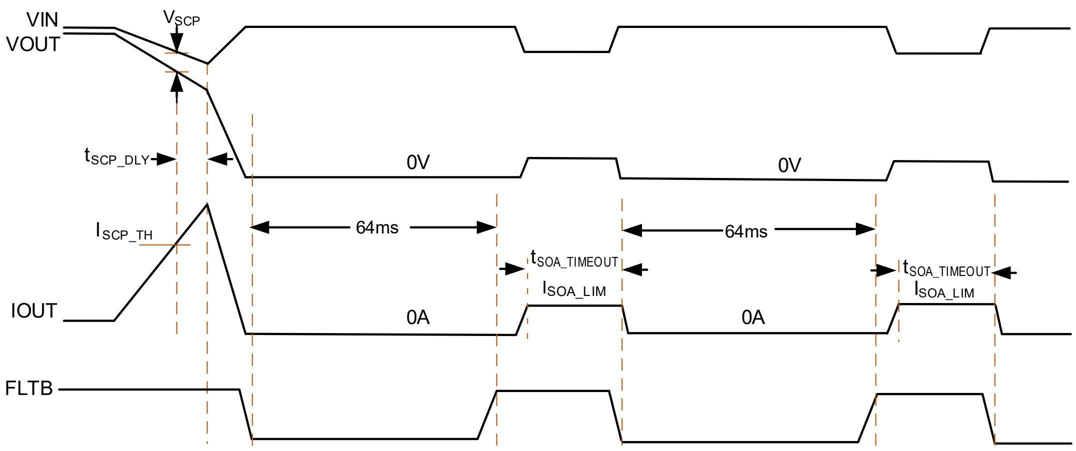



**Figure 5a. Short Current Protection (-01) Short After Start-up**

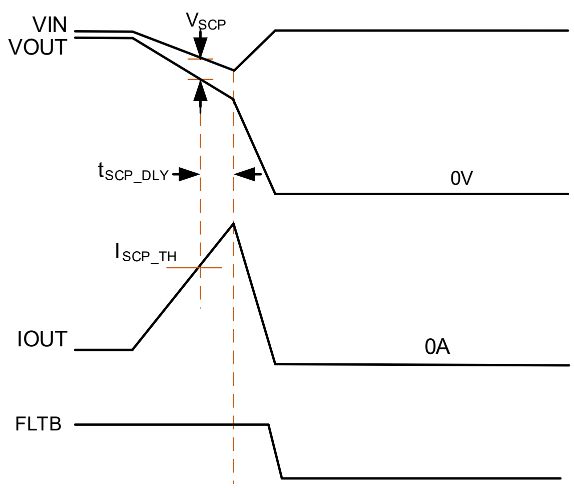



**Figure 5b. Short Current Protection (-02) Short After Start-up**

## Timing Diagrams (Continued)

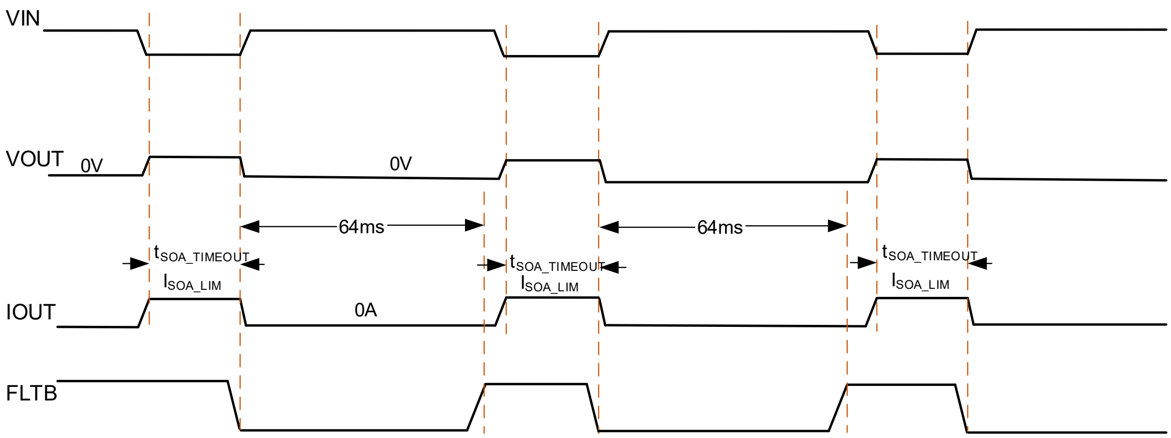



**Figure 6a. Short Current Protection (-01) Short Before Start-up**

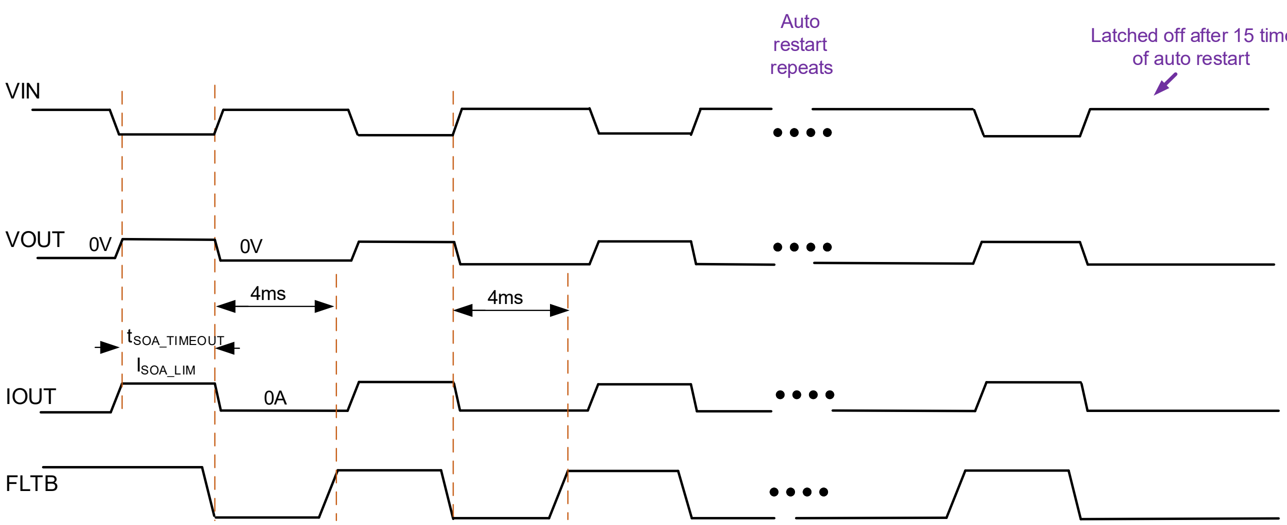
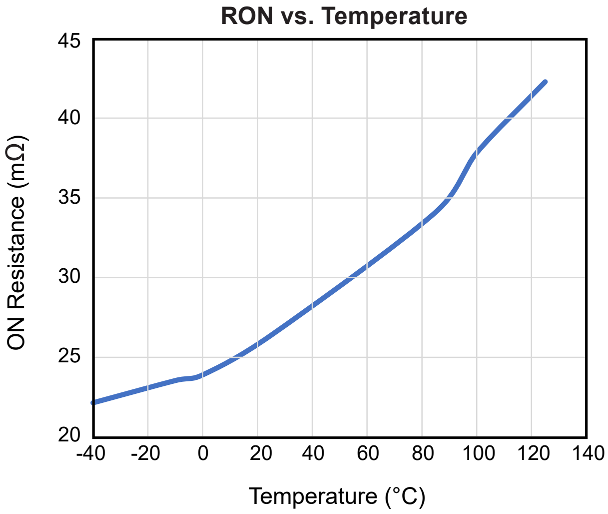
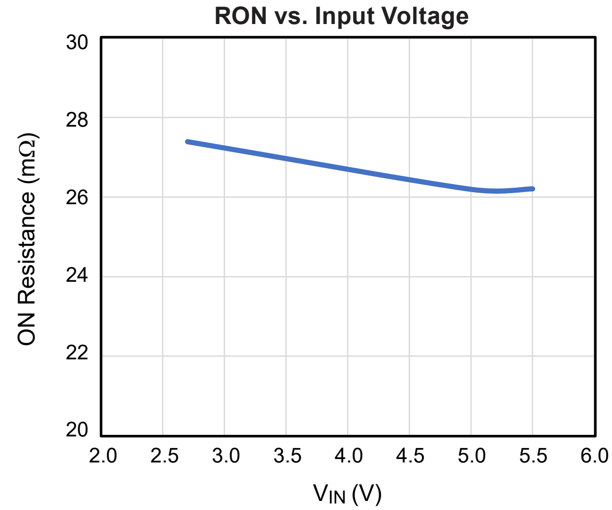


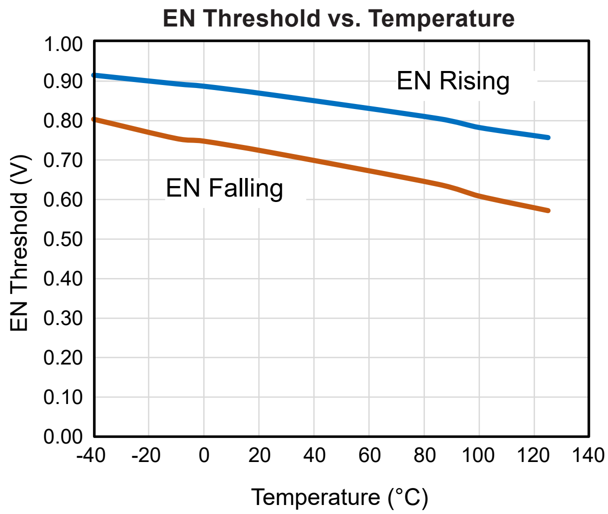

**Figure 6b. Short Current Protection (-02) Short Before Start-up**

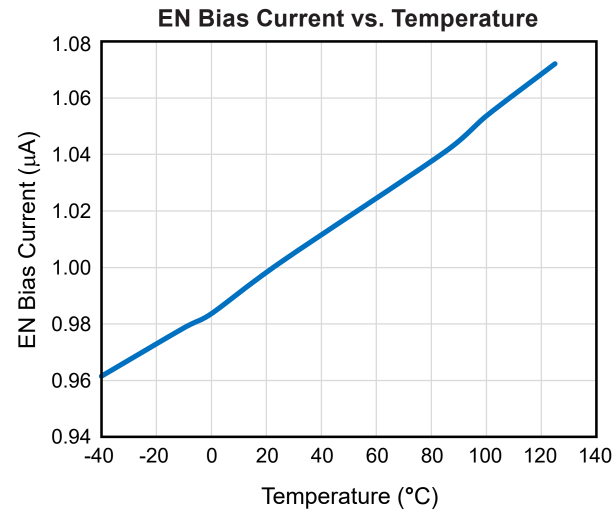
## Typical Characteristics

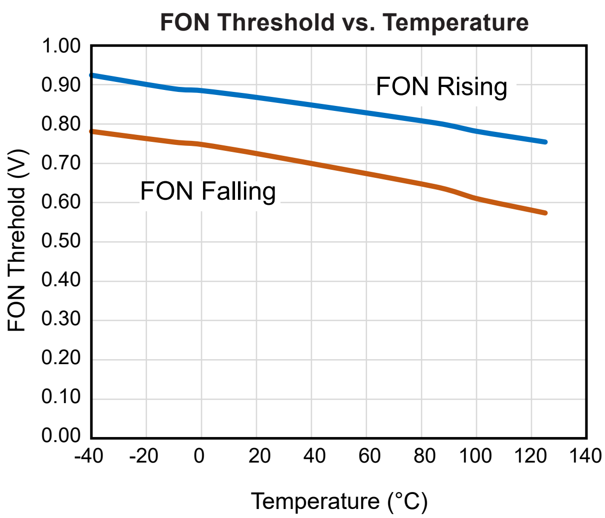
$T_A$ = 25 °C, $V_{IN}$ = 5V, $V_{FON}$ =0V, unless otherwise specified.

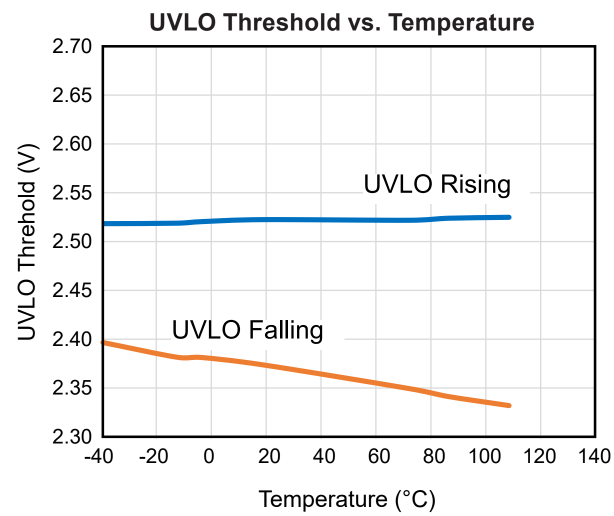


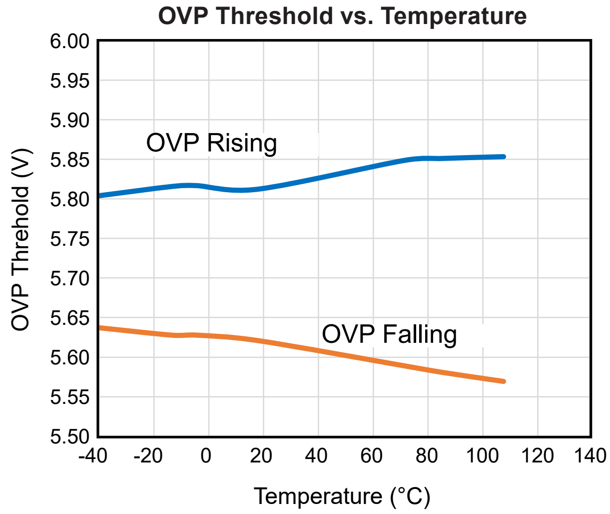



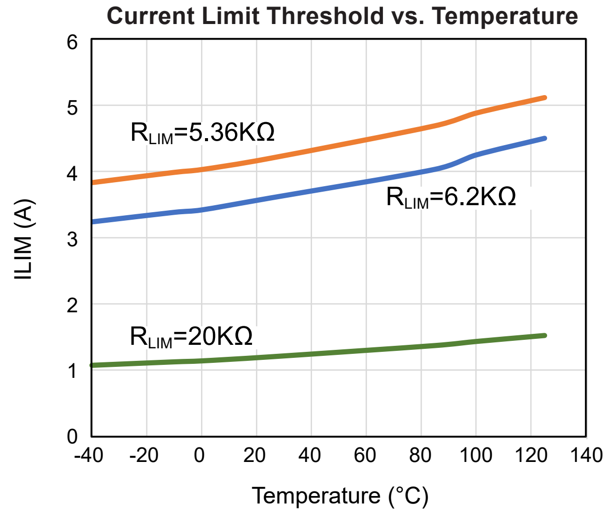



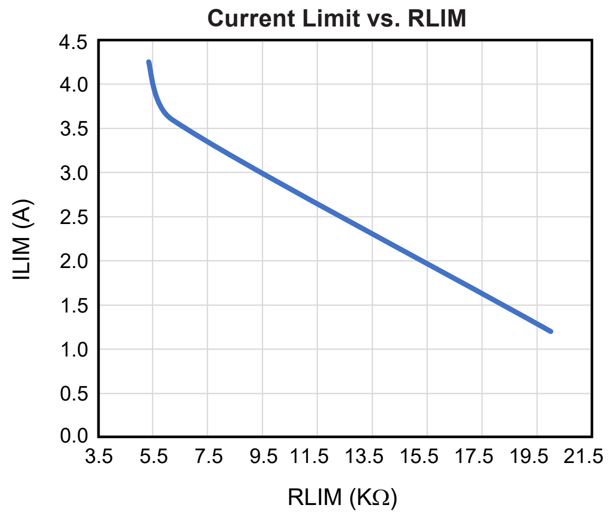



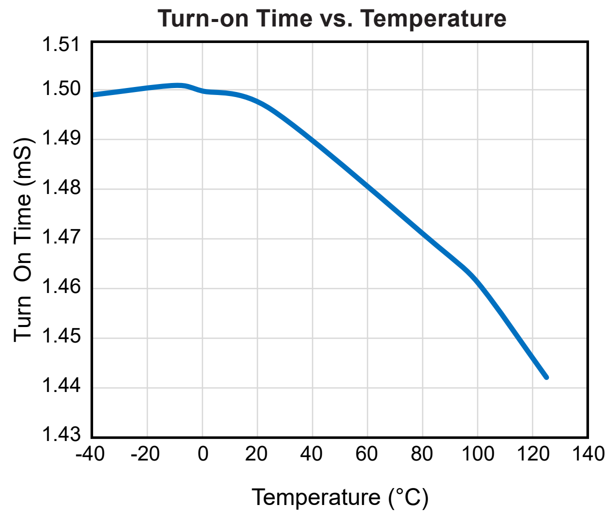
## Typical Characteristics

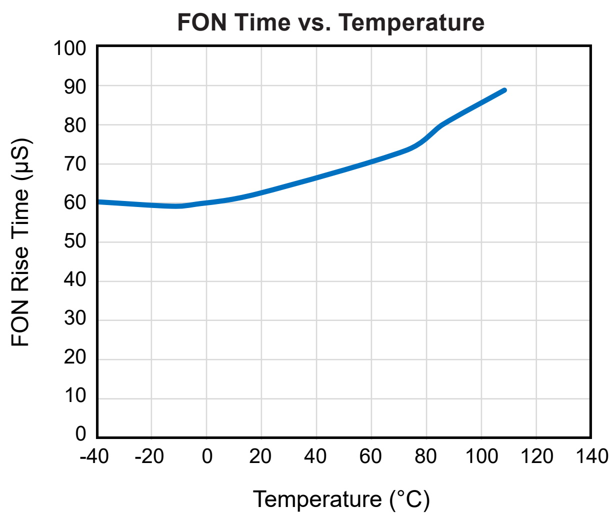
$T_A$ = 25 °C, $V_{IN}$ = 5V, $V_{FON}$ =0V, unless otherwise specified.



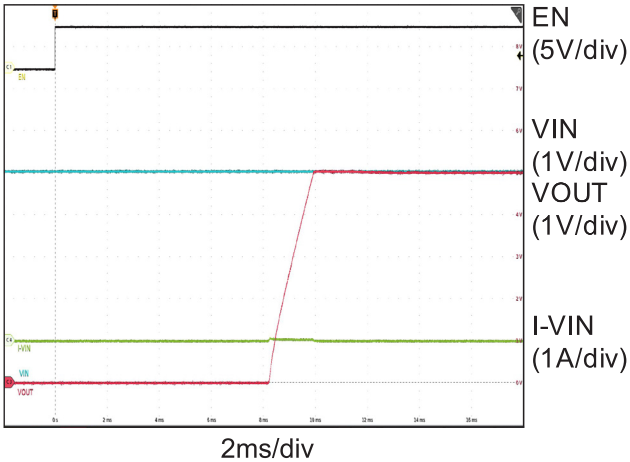



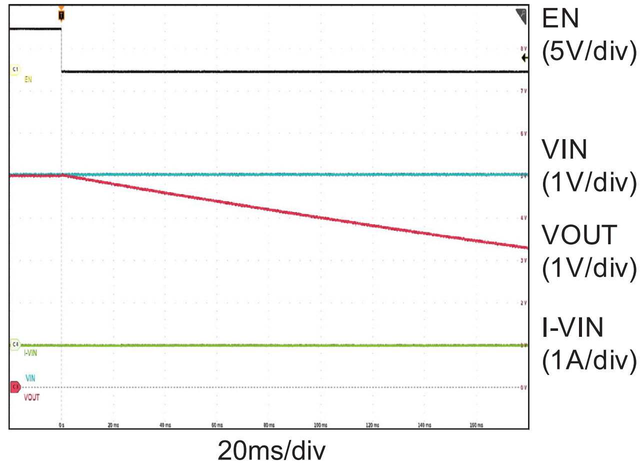
## Typical Characteristics

$T_A$ = 25 °C, VIN = 5 V, $V_{FON}$ = 0 V, $R_{LIM}$ = 5.36kΩ unless otherwise specified.

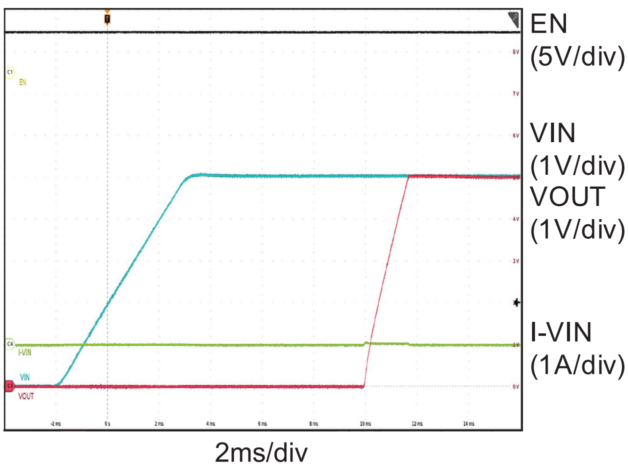
**Soft Start by EN**
**(Css=5.6nF; No load)**



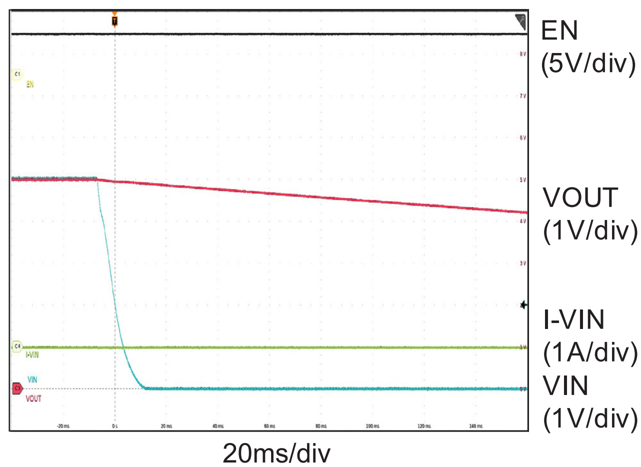

**Shut down by EN**
**(Css=5.6nF; No load)**



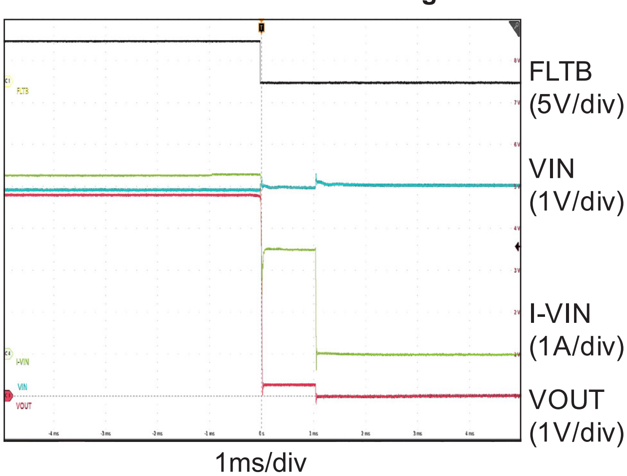

**Soft Start by VIN**
**(Css=5.6nF; No load)**



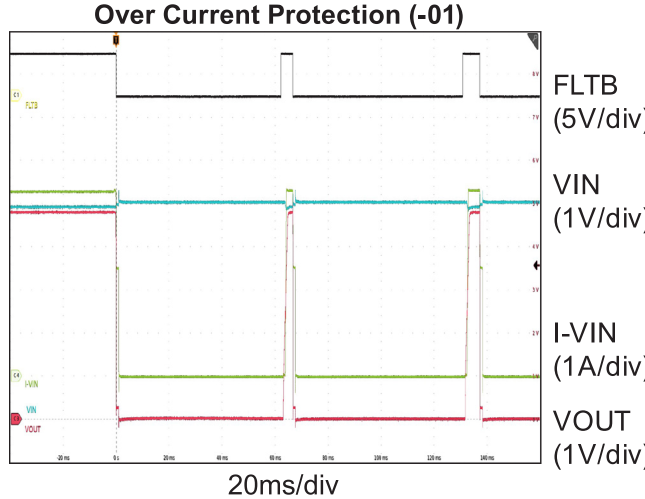

**Shut down by VIN**
**(Css=5.6nF; No load)**




**Over Current FLTB Timing**



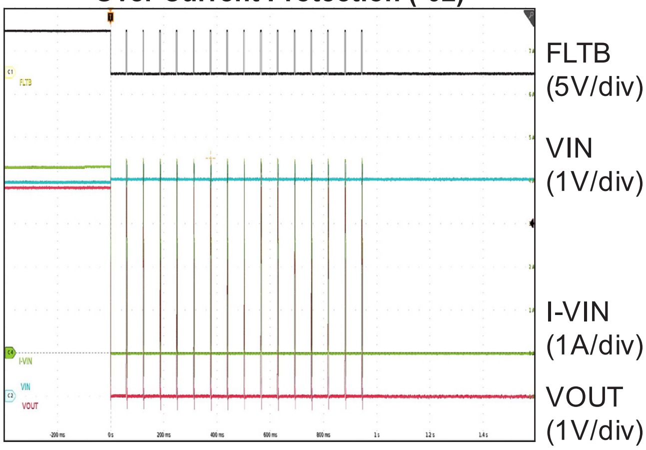

**Over Current Protection (-01)**



## Typical Characteristics

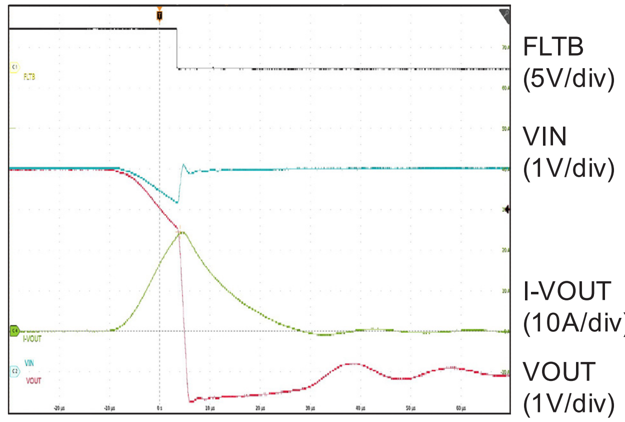
$T_A$ = 25 °C, VIN = 5 V, $V_{FON}$ = 0 V, $R_{LIM}$ = 5.36kΩ unless otherwise specified.

**Over Current Protection (-02)**



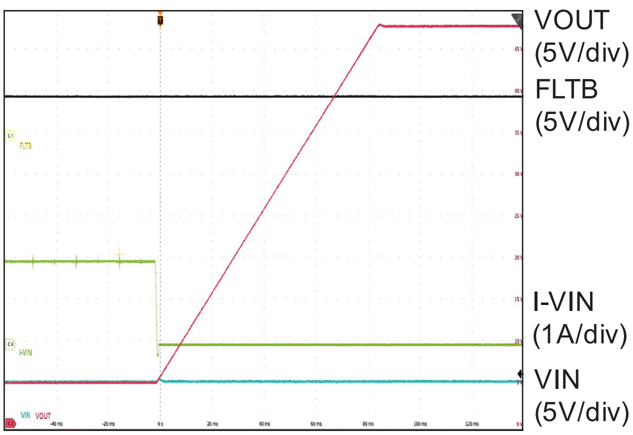

200ms/div

**Short Circuit Protection**



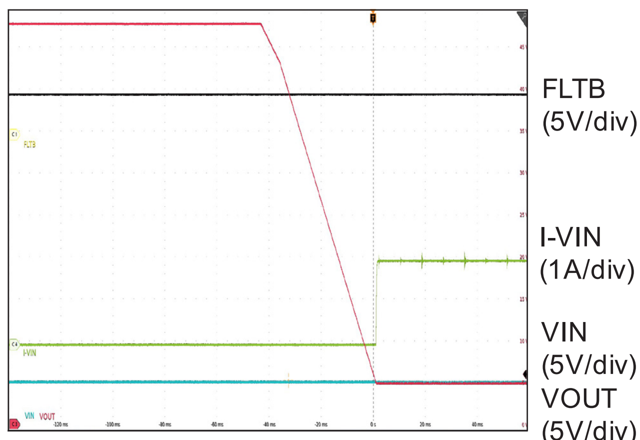

10µs/div

**True Reverse Current Blocking (Vout=48V, 2A load)**



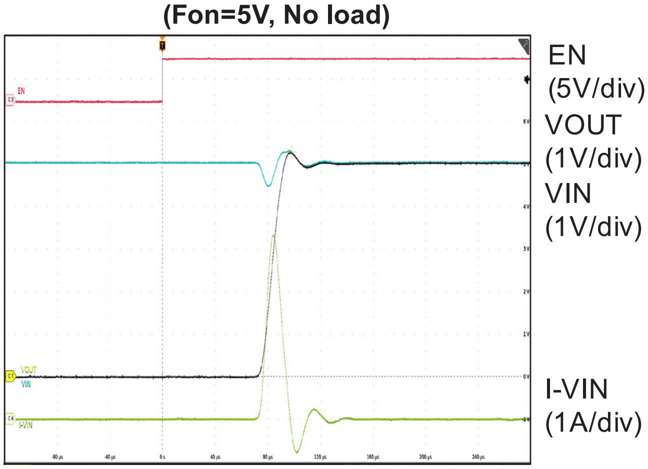

20ms/div

**Recovery from True Reverse Current Blocking**



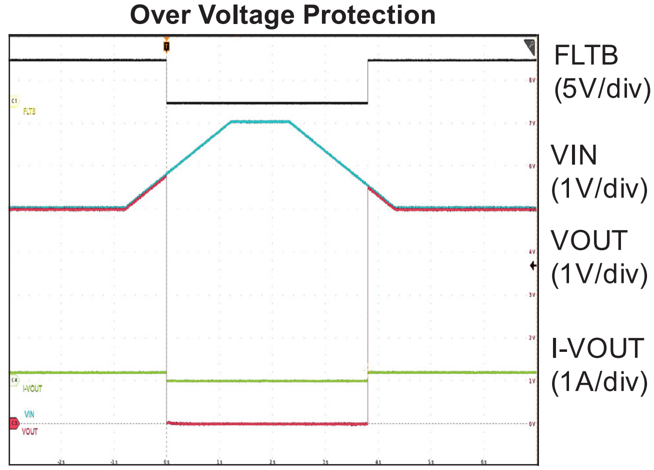

20ms/div

**Fast Role Swap (Fon=5V, No load)**




40µs/div

**Over Voltage Protection**




1s/div

## Detailed Description

The AOZ15953DI is a current limited power switch with over-voltage, over-current, and thermal shutdown protections. The VOUT pin is rated at 60V absolute maximum. The operating input voltage ranges from 2.7V to 5.5V. The switch current is rated up to 3.5A.

The device has ideal diode true reverse-current blocking features that will prevent undesired current flow from output to its input in either enabled or disabled state.

### Enable

The EN pin is the ON/OFF control for the power switch. The device is enabled when EN pin is high and not in under-voltage lockout state. The EN pin must be driven to a logic high or logic low state to guarantee operation. While disabled, the AOZ15953DI only draws typical 100μA from supply.

For AOZ15953DI-02, toggle EN pin to restart the device and clear fault flag after device latches off due to fault.

### Startup

The device is enabled when EN≥$V_{EN\_H}$ and input voltage is higher than UVLO threshold. The device first checks if any fault condition exists. When no fault exists, the power switch is turned on and the output is then ramped up. Power switch is kept off if fault condition was detected.

### Soft-Start

When EN pin is asserted high, the slew rate control applies voltage on the gate of the power switch in a manner such that the output voltage is ramped up linearly until VOUT reaches VIN voltage level. The output ramps up time ($t_{ON}$) is programmable by an external soft-start capacitor ($C_{SS}$). The following formula provides the estimated 10% to 90% ramp up time.

$$t_{ON} = \frac{C_{SS}}{3.73}$$

where $C_{SS}$ is in nF and $t_{ON}$ is in ms.

### Input Under-Voltage Lockout (UVLO)

The under-voltage lockout (UVLO) circuit monitors the input voltage. The power switch is only allowed to turn on when input voltage is higher than UVLO threshold. Otherwise the switch is off.

### Over-Voltage Protection (OVP)

The voltage at VIN terminal is constantly monitored once the device is enabled. In case input voltage exceeds the over-voltage lockout threshold ($V_{OVP}$), the power switch is either turned off immediately or kept off, depending on its initial state.

AOZ15953DI-01 restarts when VIN drops below over-voltage lockout hysteresis ($V_{OVP\_HYS}$).

### Programmable current limit and Over-Current Protection (OCP)

The AOZ15953DI has current limit that ensures the current passing through the switch does not exceed the current limit threshold set by the external resistor $R_{LIM}$.

The current limit threshold can be estimated using the equation below for the range from 1A to 3.5A:

Current Limit = 22.5/$R_{LIM}$

For example, for 3.6A current limit, a 6.2kΩ $R_{LIM}$ should be selected. 1% resistor is recommended for $R_{LIM}$.

For current limit less than 2A, Table 1 values are recommended due to second order non-linearity effects.

**Table 1. RLIM Resistor Value vs Current Limit Threshold**

| Typical Current Limit (A) | Resistor Value ±1% (kΩ) |
|---|---|
| 4.2 | 5.36 |
| 3.6 | 6.2 |
| 3.0 | 7.5 |
| 2.0 | 11 |
| 1.0 | 20 |

AOZ15953DI continuously limits the output current when output is overloaded. Under current-limiting condition, FLTB is pulled low after delay ($t_{OCP\_FLTB}$). Severe overload causes power dissipation and die temperature to increase and may trigger thermal shutdown.

In AOZ15953DI-02 version, the TSD due to OCP event will latch off the power switch after failing to retry 15 times. Power switch can only be turned on again by either toggle EN pin or cycle the input supply.

### Short Circuit Protection (SCP)

When IOUT increases and greater than $I_{SCP}$, the system interprets that as a VOUT shorted to GND condition. From that point it takes $t_{SCP}$ to respond and open the switch which will isolate VIN from VOUT.

### Ideal Diode True Reverse Current Blocking (IDTRCB)

When the device is ON with no load or under light load conditions, it regulates VOUT to be 15 mV below VIN. As the load current is increasing or decreasing, the device adjusts the gate drive to maintain the 15 mV drop from VIN to VOUT. As the load current continues to increase the device increases the gate drive until the gate is fully turned on and VIN to VOUT drop is determined by IR drop through the MOSFET. If for any reason VOUT increases such that VIN to VOUT drop to less than 15 mV, the gate driver forces the switch to turn off.

### Fast Role Swap (FRS) Support

The FON pin allows the power switch to turn-on quickly. FON should be asserted before device is enabled. If VIN>VOUT, the power switch turns on quickly by minimizing turn on delay and disables over-current protection

The Fast Turn-On and Fast Recovery from TRCB allows AOZ15953DI to support Fast Role Swap operation defined in USB Power Delivery Specification Rev 3.0. It allows system to change its role from power consumer to power provider and recover VOUT voltage to > 4.75V in less than 100µs. FRS support would be active if FON = 5V.

### Thermal Shutdown Protection

Thermal shutdown protects device from excessive temperature. The power switch is turned off when the die temperature reaches thermal shutdown threshold of 140°C. There is a 20°C hysteresis. Power switch is allowed to turn on again if die temperature drops below approximately 120°C.

In AOZ15953DI-02 version, the TSD will latch off the power switch after failing to retry 15 times. Power switch can only be turned on again by either toggle EN pin or cycle the input supply.

### Fault Reporting

AOZ15953DI protects itself and load from the following fault condition: over-voltage, over-current, short circuit, reverse-current, and over-temperature.

The FLTB pin is an open drain output that is asserted low when either an over-voltage, over-current, SCP or over-temperature condition occurs. The FLTB pin becomes high impedance when the fault conditions are removed. A pull-up resistor ($R_{FLTB}$) must be connected between FLTB to 5V to provide a logic signal.

When thermal shutdown is activated, FLTB is pulled low immediately to report fault condition to host. FLTB is pull-high once fault is removed (AOZ15953DI-01).

In case of output overload, FLTB pin is pulled low about 1ms ($t_{OCP\_FLTB}$) after device is in current limiting. Power switch is then turned off after thermal shut down or an additional 1ms in current limit.

There is no fault reporting for UVLO and TRCB event.

**Table2. Fault Response**

| Protection | Fault Response (-01) | Fault Response (-02) | FLTB Status |
|---|---|---|---|
| OVP | Auto restart | Latch off | Low |
| OCP | Auto restart | Latch off by thermal shutdown Latch off after 15 times auto restart if no thermal shutdown. | Low |
| SCP | Auto restart | Latch off | Low |
| TSD | Auto restart | Latch off after 16 times auto restart | Low |
| IDTRCB | Auto recovery | Auto recovery | High Impedance |

### Auto-restart or latch-off

**AOZ15953DI-01 (Auto-restart version)**

The device will try to restart 64msec after junction temperature is lower by $T_{SD\_HYS}$ in a TSD event. Likewise, for an OVP event, 64msec restarts after VIN is lowered by $V_{OVP\_HYS}$. For OCP or SCP device will retry 64ms after the FETs turns off from the initial fault.

Power switch is turned on immediately after TRCB event is removed, this is not considered a fault.

**AOZ15953DI-02 (Latch-Off version)**

The device keeps off even after fault event is removed. Power switch can only be turned on again by either toggling EN pin or cycling the input supply.

Power switch is turned on immediately after TRCB event is removed, this is not considered a fault.

### Input Capacitor Selection

The input capacitor prevents large voltage transients from appearing at the input, and provides the instantaneous current needed each time the switch turns on to charge output capacitors and to limit input voltage drop. It also prevents high-frequency noise on the power line from passing through to the output. The input capacitor should be located as close to the pin as possible. A minimum of

10µF ceramic capacitor should be used. However, higher capacitor value is strongly recommended to further reduce the transient voltage drop at the input.

### Output Capacitor Selection

The output capacitor acts in a similar way. Also, the output capacitor has to supply enough current for a large load that it may encounter during system transient. This bulk capacitor must be large enough to supply fast transient load in order to prevent the output from dropping.

The USB specification limits the capacitance on VBUS (VOUT) to a maximum of 10µF. Use this maximum value for noise immunity due to the system and cable plug/unplug transients.

### Power Dissipation Calculation

Calculate the power dissipation for normal load condition using the following equation:

$$\textit{Power Dissipated} = RON \times (IOUT)^2$$

The worst case power dissipation occurs when the load current hits the current limit due to over-current.

The power dissipation can be calculated using the following equation:

$$\textit{Power Dissipated} = |VIN - VOUT| \times \textit{Current Limit}$$

## Layout Guidelines

Good PCB layout is important for improving the thermal and overall performance. To optimize the switch response time to output short-circuit conditions, keep all traces as short as possible to reduce the effect of unwanted parasitic inductance. Place the input and output bypass capacitors as close as possible to the VIN and VOUT pins. The input and output PCB traces should be as wide as possible for the given PCB space.

Use a ground plane to enhance the power dissipation capability of the device.

On the top layer expand the exposed pad island as much as possible for optimal thermal performance. The exposed pad copper plane must be connected to ground.

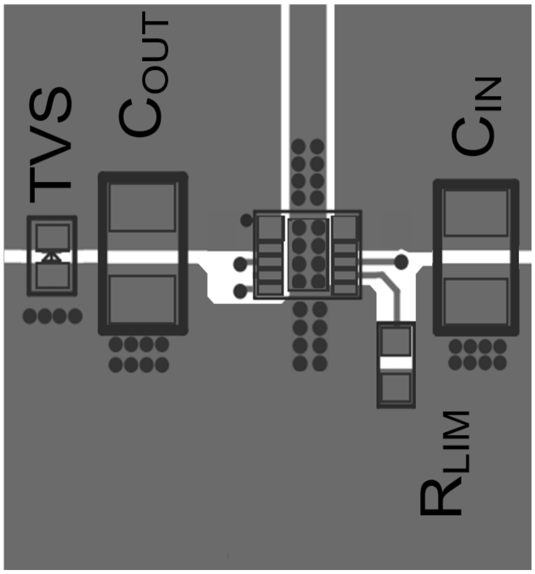



**Figure 4. Top Layer Layout**

In addition to the top plane, if available, connect to the bottom layer ground plane for best thermal performance.

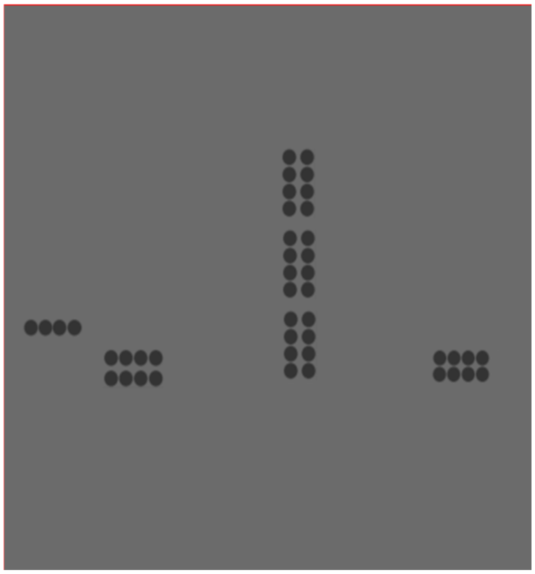
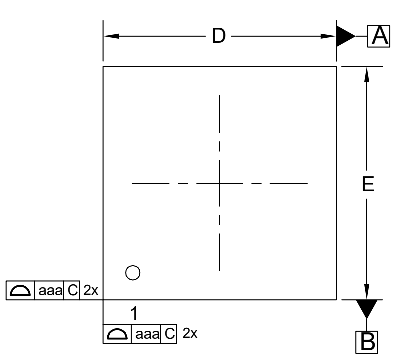
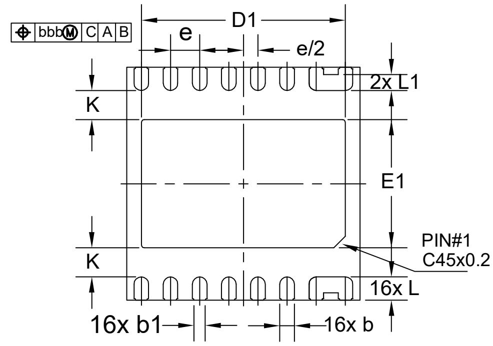


**Figure 5. Bottom Layer Layout**

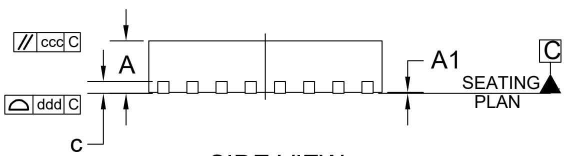
## Package Dimensions, DFN4x4-16L




TOP VIEW

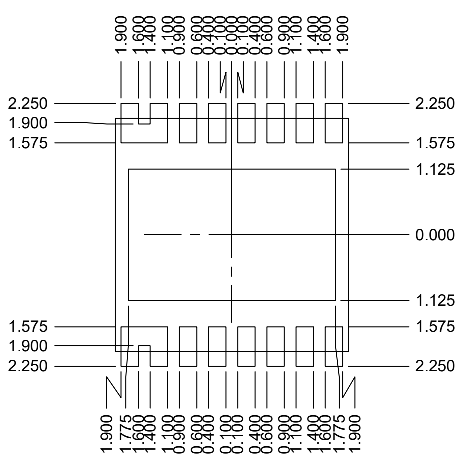



BOTTOM VIEW




SIDE VIEW

RECOMMENDED LAND PATTERN




UNIT: mm

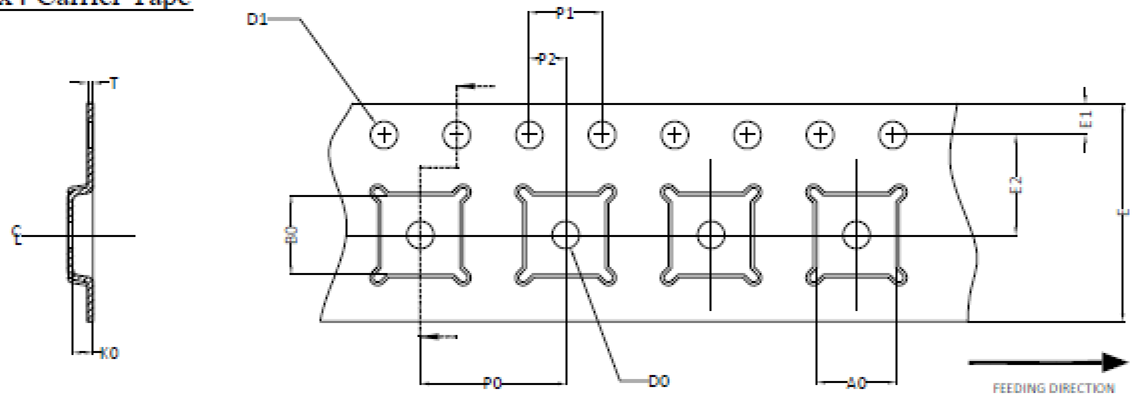
| SYMBOL | DIMENSIONS IN MILLIMETERS | | | DIMENSIONS IN INCHS | | |
|---|---|---|---|---|---|---|
| | MIN. | NOM. | MAX. | MIN. | NOM. | MAX. |
| A | 0.800 | 0.900 | 1.000 | 0.031 | 0.035 | 0.039 |
| A1 | 0.000 | 0.020 | 0.050 | 0.000 | 0.001 | 0.002 |
| b | 0.200 | 0.250 | 0.300 | 0.008 | 0.010 | 0.012 |
| b1 | | 0.190 REF. | | | 0.007 REF. | |
| c | | 0.203 REF. | | | 0.008 REF. | |
| D | 3.900 | 4.000 | 4.100 | 0.154 | 0.157 | 0.161 |
| D1 | 3.400 | 3.500 | 3.600 | 0.134 | 0.138 | 0.142 |
| E | 3.900 | 4.000 | 4.100 | 0.154 | 0.157 | 0.161 |
| E1 | 2.100 | 2.200 | 2.300 | 0.083 | 0.087 | 0.091 |
| e | | 0.500 BSC | | | 0.002 BSC | |
| L | 0.300 | 0.400 | 0.500 | 0.012 | 0.016 | 0.020 |
| L1 | 0.225 | 0.275 | 0.325 | 0.009 | 0.011 | 0.013 |
| K | | 0.500 REF. | | | 0.020 REF. | |
| K1 | | 0.150 | | | 0.006 | |
| K2 | | 0.100 | | | 0.004 | |
| K2 | | 0.100 | | | 0.004 | |
| K3 | | 0.080 | | | 0.003 | |

NOTE:

1. CONTROLLING DIMENSION IS MILLIMETER. CONVERTED INCH DIMENSIONS ARE NOT NECESSARILY EXACT.

## Tape and Reel Dimensions, DFN4x4-16L

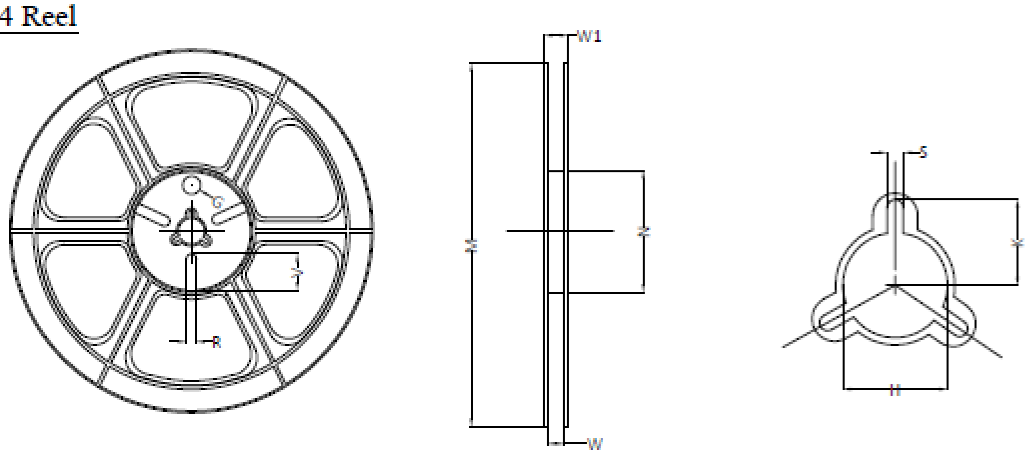
### DFN4x4 Carrier Tape




UNIT: MM

| PACKAGE | A0 | B0 | K0 | D0 | D1 | E | E1 | E2 | P0 | P1 | P2 | T |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DFN4x4 (12 mm) | 4.35 ±0.10 | 4.35 ±0.10 | 1.10 ±0.10 | 1.50 MIN. | 1.50 +0.1 -0.0 | 12.0 ±0.3 | 1.75 ±0.10 | 5.50 ±0.05 | 8.00 ±0.10 | 4.00 ±0.10 | 2.00 ±0.05 | 0.30 ±0.05 |

### DFN4x4 Reel



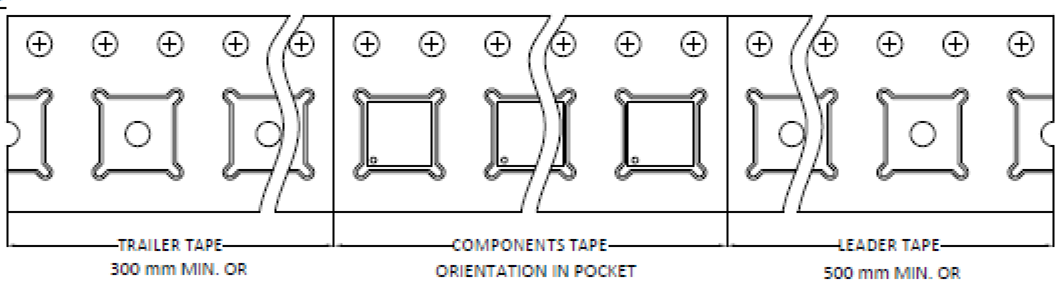

UNIT: MM

| TAPE SIZE | REEL SIZE | M | N | W | W1 | H | K | S | G | R | V |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 12 mm | Ø330 | Ø330.0 ±2.0 | Ø79.0 ±1.0 | 12.4 +2.0 -0.0 | 17.0 +2.6 -1.2 | Ø13.0 ±0.5 | 10.5 ±0.2 | 2.0 ±0.5 | --- | --- | --- |

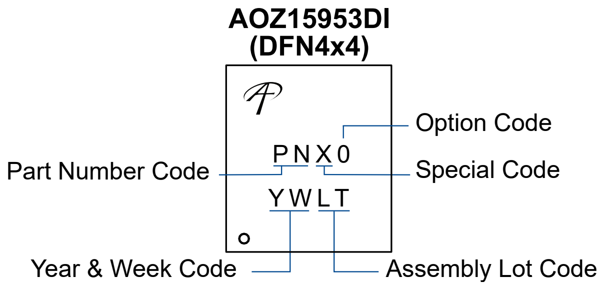
### DFN4x4 Tape

Leader / Trailer
& Orientation

Unit Per Reel:
3000pcs



## Part Marking




| Part Number | Description | Code |
|---|---|---|
| AOZ15953DI-01 | Green Product | AA01 |
| AOZ15953DI-02 | Green Product | AA02 |

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