

## General Description

The AOZ1356DI is a current-limiting protection switch targeting applications that require comprehensive protections. For AOZ1356DI-01 and -02 the input operating voltage range is 3.4V to 5.5V, and for AOZ1356DI-05 and -06, the input operating voltage range is between 3.6V and 5.3V. The output terminal is rated 28V absolute maximum. The internal current-limiting circuit protects the supply from large load current. The current limit level is set with an external resistor. The internal soft-start circuit controls inrush current due to highly capacitive loads. The device features very low quiescent current. The supply current reduces to 6 $\mu$ A in shut-down. It also has under-voltage lockout (UVLO), over-voltage protection (OVP) and thermal shutdown protection.

The AOZ1356DI has True Reverse-Current Blocking (TRCB) protection to avoid undesired reverse-current from VOUT to VIN.

The AOZ1356DI supports USB PD Fast Role Swap. When FON pin is high, the device is in fast turn-on mode to ensure output voltage rises quickly to meet USB PD spec. The device also features fast recovery to turn on power switch once reverse current blocking protection is de-activated.

The AOZ1356DI is available in 3mm x 3mm 12-Pin DFN package.

## Features

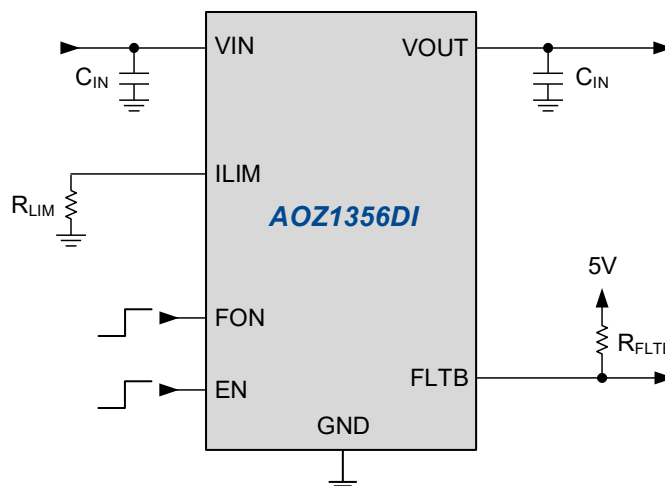
- 28V voltage rating on VOUT pin
- Up to 3.5A current capability
- Typical  $R_{ON}$ : 39m $\Omega$
- Supports USB PD Fast Role Swap (FRS)
- Programmable current limit
- True Reverse-Current Blocking (TRCB)
- Fast recovery from TRCB
- 125 $\mu$ A quiescent current
- Over-voltage protection (OVP)
- Short-circuit protection (SCP)
- Input under-voltage lockout (UVLO)
- Thermal shutdown protection (TSD)
- $\pm 4$ kV HBM rating
- $\pm 1$ kV CDM rating
- IEC61000-4-5: 45V (No Cap)
- IEC61000-4-2 (VOUT Pin):  $\pm 8$ kV
- 3mm x 3mm DFN-12L package
- IEC 62368-1: 2014 Certificate No. US-33248-UL

## Applications

- USB PD power source switch
- Smartphones and tablets
- Notebooks, ultra books and desktops
- Portable devices



## Typical Application



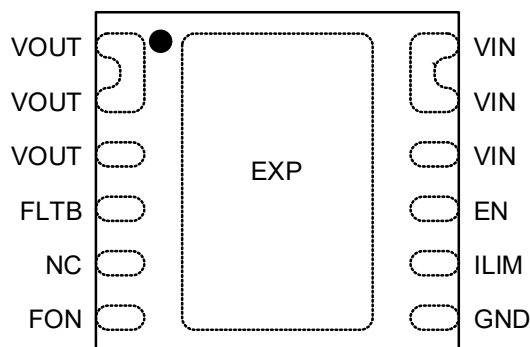
## Ordering Information

| Part Number  | Fault Recovery | Operating Voltage Range | Package    | Environmental |
|--------------|----------------|-------------------------|------------|---------------|
| AOZ1356DI-01 | Auto-Restart   | 3.4V-5.5V               | DFN3x3-12L | RoHS          |
| AOZ1356DI-02 | Latch-Off      | 3.4V-5.5V               | DFN3x3-12L | RoHS          |
| AOZ1356DI-05 | Auto-Restart   | 3.6V-5.3V               | DFN3x3-12L | RoHS          |
| AOZ1356DI-06 | Latch-Off      | 3.6V-5.3V               | DFN3x3-12L | RoHS          |



All 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



**DFN3x3-12L**  
(Top Transparent View)

## Pin Description

| Pin Number | Pin Name | Pin Function                                                                                                                                                                                                                                                               |
|------------|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1, 2, 3    | VOUT     | Power output. Connect to adapter. Pin 3 is internally connected to Pins 1 and 2.                                                                                                                                                                                           |
| 4          | FLTB     | Fault indicator. Open-drain output. Active low.                                                                                                                                                                                                                            |
| 5          | NC       | Not connected internally. Leave it floating or connect it to GND.                                                                                                                                                                                                          |
| 6          | FON      | Fast-On. Active high. This pin signals the device that the fast turn-on mode is desired. Internal pulled down with a resistor.                                                                                                                                             |
| 7          | GND      | Ground.                                                                                                                                                                                                                                                                    |
| 8          | ILIM     | Current limit set pin. Connect a 1% resistor $R_{LIM}$ between $I_{LIM}$ and GND to set the current limit threshold.                                                                                                                                                       |
| 9          | EN       | IC Enable. Active high. Internally pulled down with a resistor.                                                                                                                                                                                                            |
| 10, 11, 12 | VIN      | Supply input. Connected to internal power regulator. Pin 10 is internally connected to Pins 11 and 12.                                                                                                                                                                     |
| EXP        | EXP      | Exposed Thermal Pad. Connect to GND. Solder to a metal surface directly underneath the EXP and connect to PCB ground on multiple layers through VIAs. For best thermal performance make the ground copper pads as large as possible and connect to EXP with multiple VIAs. |

## Absolute Maximum Ratings

Exceeding the Absolute Maximum Ratings may damage the device.

| Parameter                              | Rating          |
|----------------------------------------|-----------------|
| VOUT to GND                            | -0.3V to +28V   |
| VIN, EN, ILIM, FON, FLTB to GND        | -0.3V to +6V    |
| Junction Temperature (T <sub>J</sub> ) | +150°C          |
| Storage Temperature (T <sub>S</sub> )  | -65°C to +150°C |
| ESD Rating HBM/CDM                     | ±4kV / ±1kV     |

## Recommended Operating Ratings

The device is not guaranteed to operate beyond the Maximum Operating Ratings.

| Parameter                                     | Rating         |
|-----------------------------------------------|----------------|
| VIN to GND                                    | 3.4V to 5.5V   |
| FON, EN, FLTB to GND                          | 0V to 5.5V     |
| Switch Current (I <sub>SW</sub> )             | 0A to 3.5A     |
| ILIM                                          | 0V to 2V       |
| Ambient Temperature (T <sub>A</sub> )         | -40°C to +85°C |
| Package Thermal Resistance (θ <sub>JA</sub> ) | 50°C/W         |

## Electrical Characteristics

T<sub>A</sub> = 25°C, V<sub>IN</sub> = 5V, V<sub>EN</sub> = 5V, V<sub>FON</sub> = 0V, unless otherwise specified.

| Symbol                         | Parameter                             | Conditions                       | Min  | Typ  | Max  | Units |
|--------------------------------|---------------------------------------|----------------------------------|------|------|------|-------|
| <b>General</b>                 |                                       |                                  |      |      |      |       |
| V <sub>IN</sub>                | Input Supply Voltage                  | AOZ1356DI-01 and -02             | 3.4  |      | 5.5  | V     |
|                                |                                       | AOZ1356DI-05 and -06             | 3.6  |      | 5.3  | V     |
| V <sub>UVLO_R</sub>            | Under-voltage Lockout Threshold       | VIN rising AOZ1356DI-01 and -02  | 3    | 3.25 | 3.35 | V     |
|                                |                                       | VIN rising AOZ1356DI-05 and -06  | 3.2  | 3.45 | 3.55 | V     |
| V <sub>UVLO_HYS</sub>          | Under-voltage Lockout Hysteresis      | VIN falling                      |      | 150  |      | mV    |
| I <sub>IN_ON</sub>             | Input Quiescent Current               | I <sub>OUT</sub> = 0A, FON = 0V  |      | 125  |      | μA    |
| I <sub>IN_FON</sub>            | FON Standby Current                   | FON = 5V, EN = 0V                |      | 135  |      | μA    |
| I <sub>IN_OFF</sub>            | Input Shutdown Current                | EN = 0V, FON = 0V                |      | 6    | 10   | μA    |
| R <sub>ON</sub>                | Switch On Resistance                  | I <sub>OUT</sub> = 1A            |      | 39   |      | mΩ    |
| V <sub>EN_H</sub>              | Enable Input Logic High Threshold     | EN rising                        | 1.4  |      |      | V     |
| V <sub>EN_L</sub>              | Enable Input Logic Low Threshold      | EN falling                       |      |      | 0.4  | V     |
| I <sub>EN_BIAS</sub>           | Enable Input Bias Current             | EN = 1.8V                        |      | 1    | 1.5  | μA    |
| V <sub>FON_H</sub>             | Fast-On Logic High Threshold          | FON rising                       | 1.4  |      |      | V     |
| V <sub>FON_L</sub>             | Fast-On Logic Low Threshold           | FON falling                      |      |      | 0.4  | V     |
| I <sub>FON_BIAS</sub>          | Fast-On Input Bias Current            | FON = 1.8V                       |      | 1.5  | 4.0  | μA    |
| V <sub>FLTB_LO</sub>           | FLTB Pull-down Voltage                | I <sub>SINK</sub> = 3mA          |      |      | 0.3  | V     |
| <b>Over-Voltage Protection</b> |                                       |                                  |      |      |      |       |
| V <sub>IN_OVLO_R</sub>         | Over-voltage Lockout Threshold        | VIN rising AOZ1356DI-01 and -02  | 5.6  | 5.8  | 6    | V     |
| V <sub>IN_OVLO_R</sub>         |                                       | VIN rising AOZ1356DI-05 and -06  | 5.75 | 5.9  |      |       |
| V <sub>IN_OVLO_HYS</sub>       | Over-voltage Lockout Hysteresis       |                                  |      | 250  |      | mV    |
| V <sub>OUT_OVLO</sub>          | Output Over-Voltage Lockout Threshold | VOUT rising AOZ1356DI-05 and -06 | 5.3  |      | 5.5  | V     |
| t <sub>DELAY_OVP</sub>         | OVP Turn-Off Delay                    |                                  |      | 2    |      | μs    |

## Electrical Characteristics

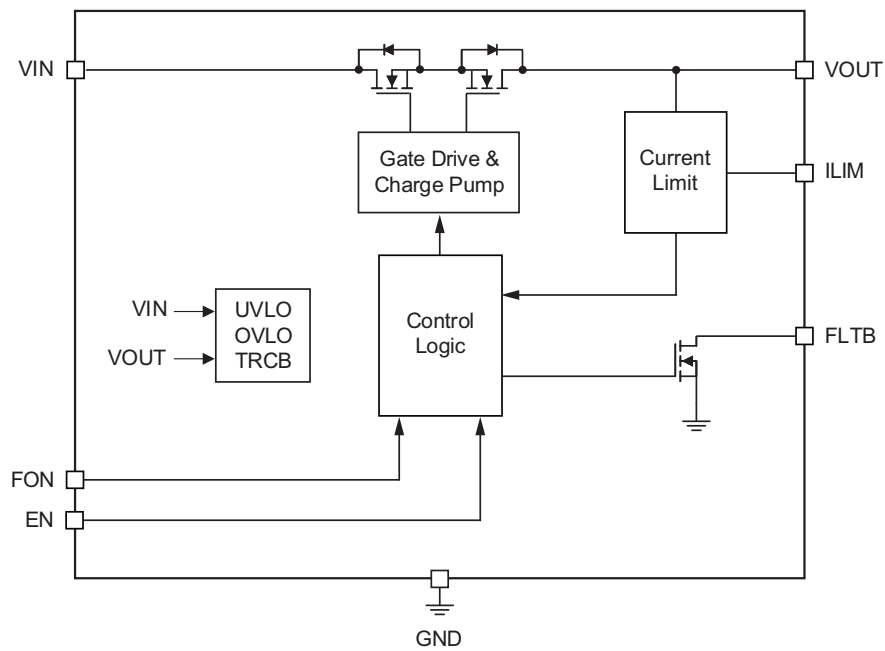
$T_A = 25^\circ\text{C}$ ,  $V_{IN} = 5\text{V}$ ,  $V_{EN} = 5\text{V}$ ,  $V_{FON} = 0\text{V}$ , unless otherwise specified.

| Symbol                         | Parameter                                                                                                    | Conditions                                                                                                                    | Min  | Typ              | Max  | Units                 |
|--------------------------------|--------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|------|------------------|------|-----------------------|
| Over-Current Protection        |                                                                                                              |                                                                                                                               |      |                  |      |                       |
| I <sub>LIM</sub>               | Current Limit Threshold                                                                                      | V <sub>OUT</sub> = 5V, R <sub>LIM</sub> = 4.02kΩ                                                                              | 3.15 | 3.5              | 3.85 | A                     |
|                                |                                                                                                              | V <sub>OUT</sub> = 5V, R <sub>LIM</sub> = 7.15kΩ                                                                              | 1.78 | 2                | 2.22 |                       |
|                                |                                                                                                              | V <sub>OUT</sub> = 5V, R <sub>LIM</sub> = 14.3kΩ                                                                              | 0.9  | 1                | 1.1  |                       |
| I <sub>LIM_FOLDBACK</sub>      | Current Limit Foldback                                                                                       |                                                                                                                               |      | 8 <sup>(1)</sup> |      | % of I <sub>LIM</sub> |
| t <sub>OCP_FLTB</sub>          | Over-Current Flag Delay                                                                                      | From I <sub>OUT</sub> ≥ I <sub>LIM</sub> to FLTB pulled low                                                                   |      | 12               |      | ms                    |
| True Reverse-Current Blocking  |                                                                                                              |                                                                                                                               |      |                  |      |                       |
| V <sub>T_TRCB</sub>            | TRCB Protection Trip Point                                                                                   | V <sub>OUT</sub> -V <sub>IN</sub> , V <sub>OUT</sub> rising                                                                   |      | 25               |      | mV                    |
| V <sub>R_TRCB</sub>            | TRCB Protection Release Trip Point                                                                           | V <sub>IN</sub> -V <sub>OUT</sub> , V <sub>OUT</sub> falling                                                                  |      | 40               |      | mV                    |
| V <sub>TRCB_HYS</sub>          | TRCB Hysteresis                                                                                              | V <sub>T_TRCB</sub> + V <sub>R_TRCB</sub>                                                                                     |      | 65               |      | mV                    |
| t <sub>TRCB</sub>              | TRCB Response Time                                                                                           |                                                                                                                               |      | 600              |      | ns                    |
| t <sub>TRCB_RECOVERY</sub>     | TRCB Fast Recovery                                                                                           | C <sub>OUT</sub> = 1μF, R <sub>L</sub> = 100Ω                                                                                 |      | 80               |      | μs                    |
| Thermal Shutdown               |                                                                                                              |                                                                                                                               |      |                  |      |                       |
| T <sub>SD</sub>                | Thermal Shutdown Threshold                                                                                   | Temperature rising                                                                                                            |      | 140              |      | °C                    |
| T <sub>SD_HYS</sub>            | Thermal Shutdown Hysteresis                                                                                  | Temperature falling                                                                                                           |      | 20               |      |                       |
| Dynamic Characteristics        |                                                                                                              |                                                                                                                               |      |                  |      |                       |
| t <sub>D_ON</sub>              | Turn-On Delay Time (From EN 50% to V <sub>OUT</sub> = 0.5V)                                                  | V <sub>IN</sub> = 5V, R <sub>L</sub> = 100Ω, C <sub>OUT</sub> = 1μF, R <sub>LIM</sub> = 14.3kΩ                                |      | 2.1              |      | ms                    |
| t <sub>ON</sub>                | Turn-ON Time (V <sub>OUT</sub> from 0.5V to 4.5V)                                                            | V <sub>IN</sub> = 5V, R <sub>L</sub> = 100Ω, C <sub>OUT</sub> = 1μF, R <sub>LIM</sub> = 14.3kΩ                                |      | 2.7              |      | ms                    |
| t <sub>FON</sub>               | Fast Turn-On Time (From EN = V <sub>EN_H</sub> to V <sub>OUT</sub> = 4.75V)                                  | V <sub>IN</sub> = 5V, EN = 5V, V <sub>FON</sub> = 5V, R <sub>L</sub> = 100Ω, C <sub>OUT</sub> =1μF, R <sub>LIM</sub> = 14.3kΩ |      | 50               | 100  | μs                    |
| t <sub>S_FON</sub>             | FON Setup Time prior to EN                                                                                   |                                                                                                                               | 100  |                  |      | μs                    |
| t <sub>H_FON</sub>             | FON Hold Time after EN                                                                                       |                                                                                                                               | 40   |                  |      | μs                    |
| Short Circuit Protection (SCP) |                                                                                                              |                                                                                                                               |      |                  |      |                       |
| V <sub>SC_DETECT</sub>         | V <sub>IN</sub> -V <sub>OUT</sub> difference at which a V <sub>OUT</sub> short circuit condition is detected |                                                                                                                               |      | 270              |      | mv                    |
| t <sub>SC_RSPONSE</sub>        | Response time to open the switch after a V <sub>OUT</sub> short circuit condition is detected                | V <sub>IN</sub> - V <sub>OUT</sub> > 270mV                                                                                    |      | 1                |      | μs                    |

**Note:**

1. Guaranteed by characterization and design.

## Functional Block Diagram



## Timing Diagrams

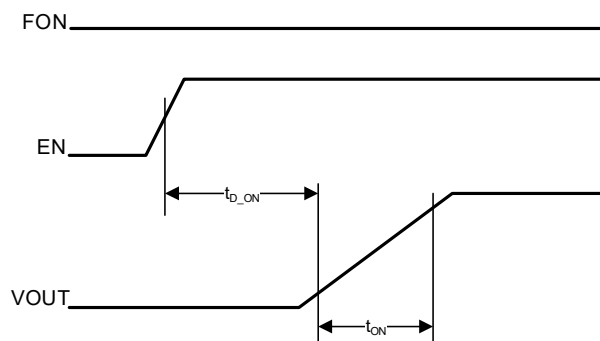


Figure 1. Normal Turn-on Delay and Turn-on Time ( $V_{FON}=0V$ )

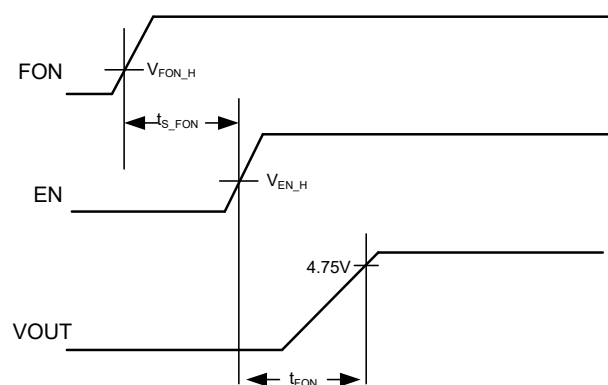


Figure 2. Fast Turn-on Time ( $V_{IN}=5V$ )

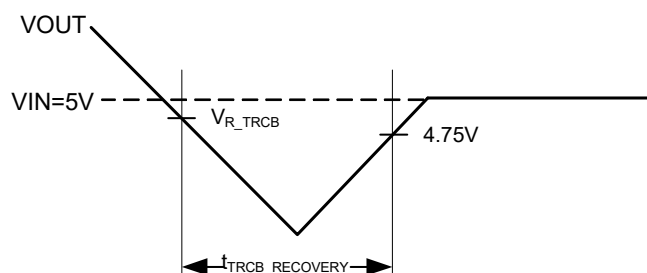


Figure 3. Fast Recovery from  $t_{RCB}$

## Timing Diagrams (Continued)

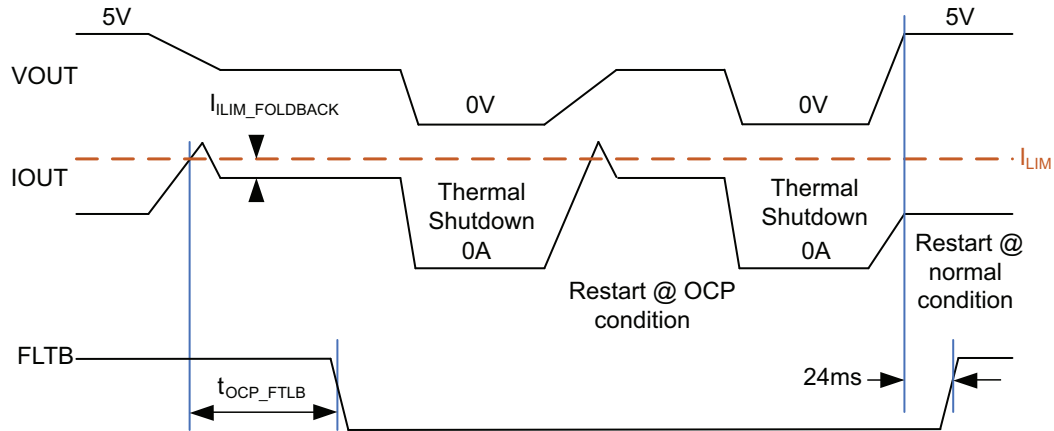


Figure 4. Current Limit (OCP) Operation

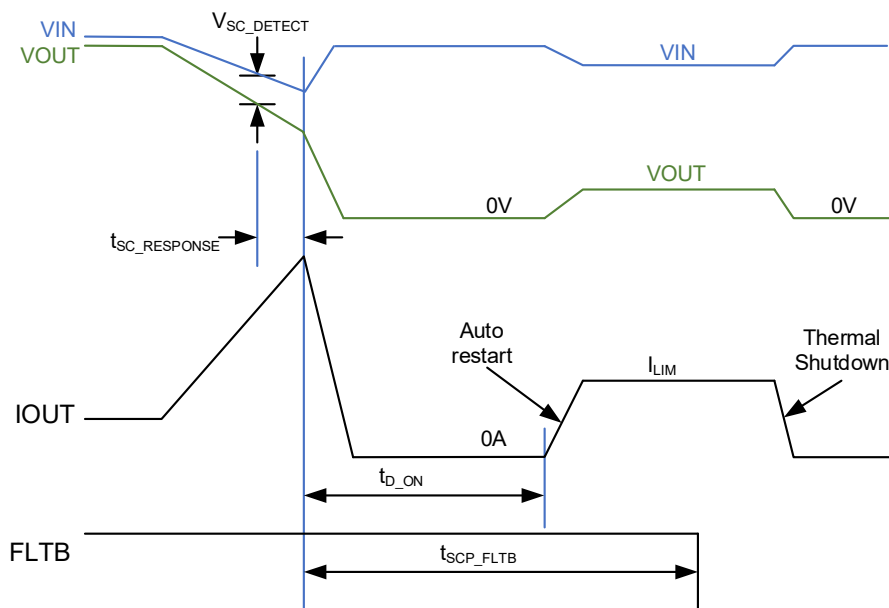


Figure 5. Short Circuit Protection (SCP) Operation

## Typical Characteristics

$T_A = 25^\circ\text{C}$ ,  $V_{IN} = 5\text{V}$ ,  $C_{IN} = 76\mu\text{F}$ ,  $C_{OUT} = 9.4\mu\text{F}$ , FON floating,  $R_{OVP} = 4.75\text{k}\Omega$ , unless otherwise specified.

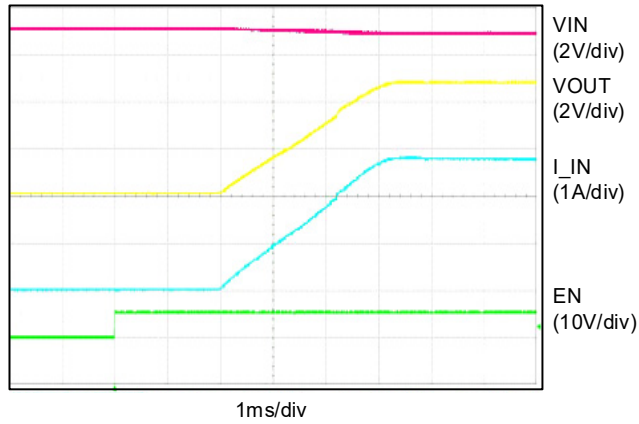


Figure 6. Soft Start by EN (LOAD = 1.8Ω)

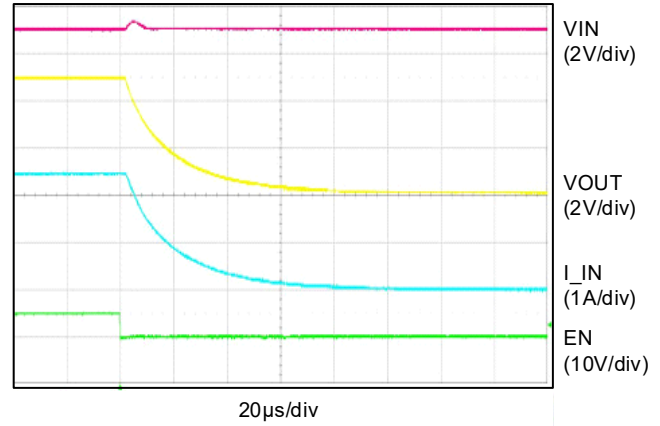


Figure 7. Shutdown by EN (LOAD = 2Ω)

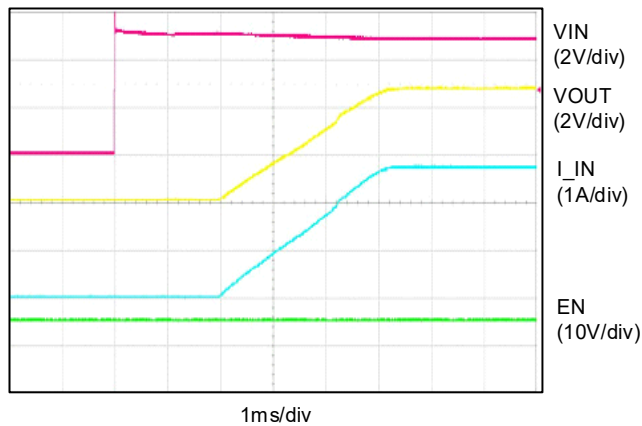


Figure 8. Soft Start by Toggling VIN (LOAD = 1.8Ω)

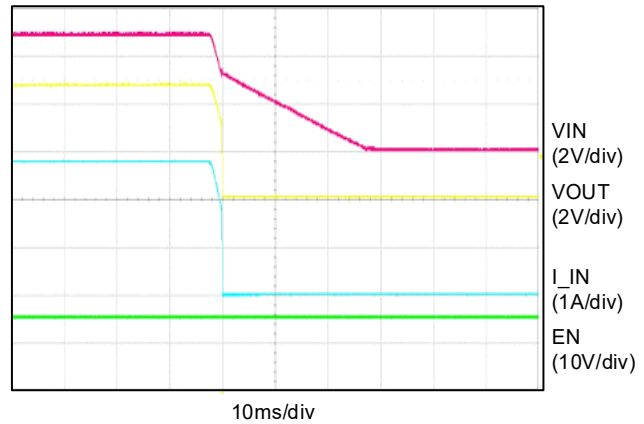


Figure 9. Shutdown by Toggling VIN (LOAD = 1.8Ω)

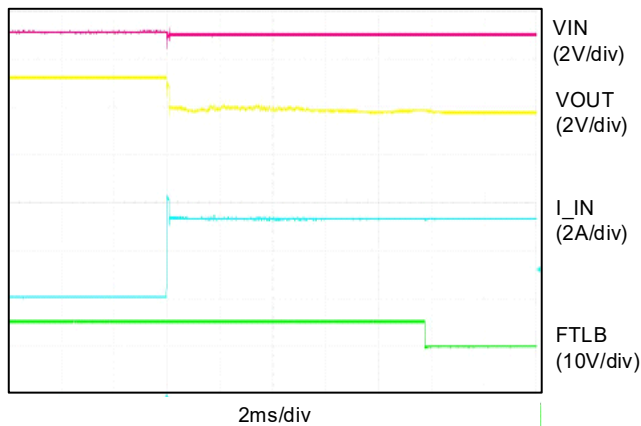


Figure 10. Over Current FLT B Timing (LOAD = 1.2Ω Plugged In)

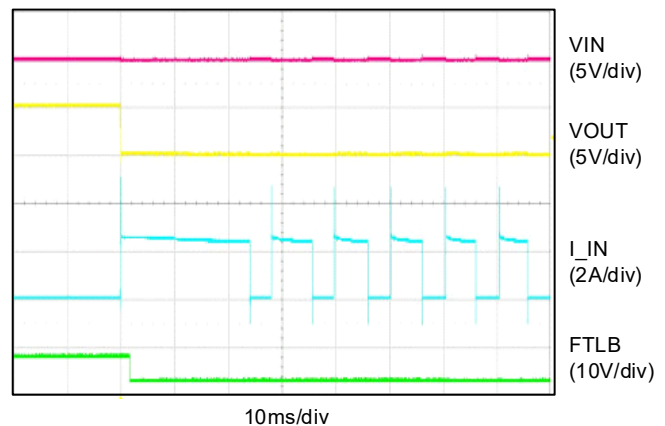
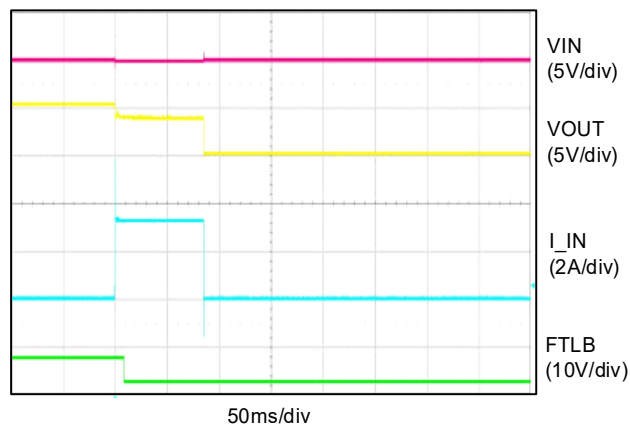


Figure 11. Short Circuit Protection, Thermal Shutdown (Auto Restart)

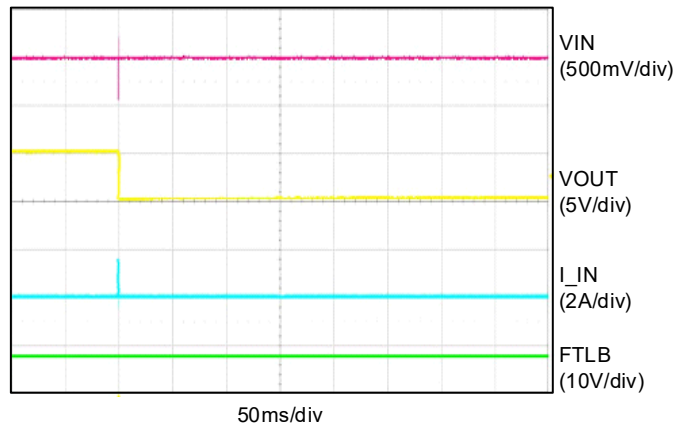


## Typical Characteristics (continued)

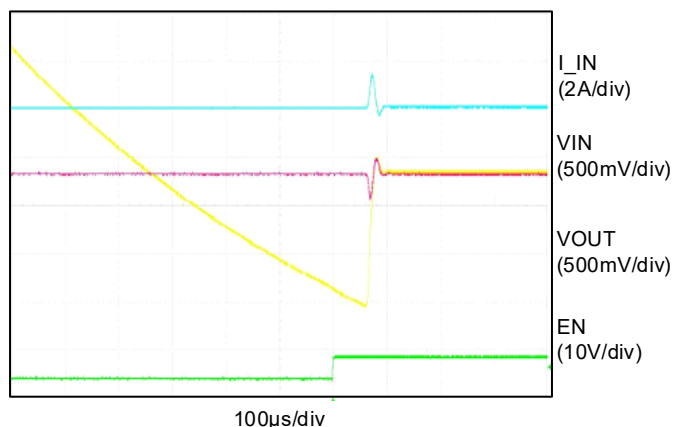
$T_A = 25^\circ\text{C}$ ,  $V_{IN} = 5\text{V}$ ,  $C_{IN} = 76\mu\text{F}$ ,  $C_{OUT} = 9.4\mu\text{F}$ , FON floating,  $R_{OVP} = 4.75\text{k}\Omega$ , unless otherwise specified.



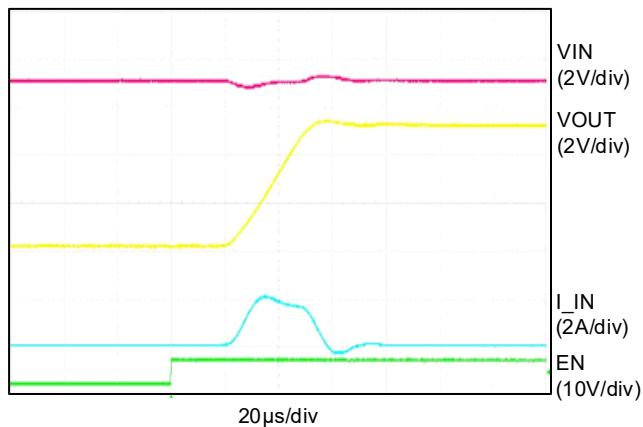
**Figure 12. Over Current Protection (Latch-off)**



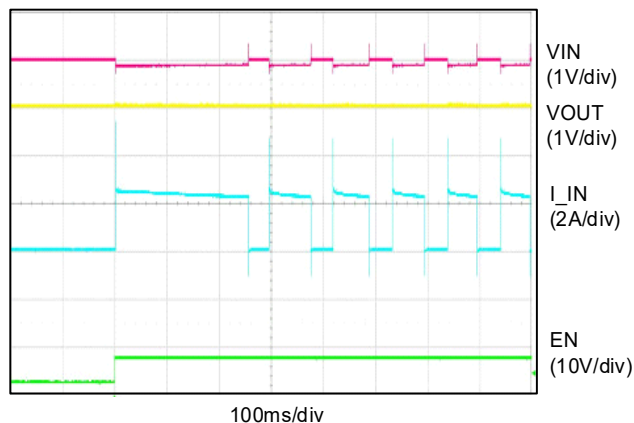
**Figure 13. Short Circuit Protection (Latch-off)**



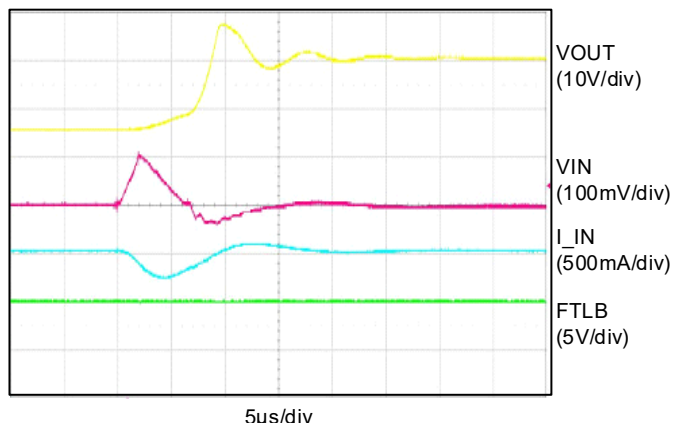
**Figure 14. Fast Role Swap (FON = 0V)**



**Figure 15. Fast Role Swap (FON = 5V, No Load)**



**Figure 16. Starting Up Into Shorted Output (Auto Restart)**



**Figure 17. True Reverse Current Blocking (VOUT Shorted to 20V)**

## Typical Characteristics (continued)

$T_A = 25^\circ\text{C}$ ,  $V_{IN} = 5\text{V}$ ,  $C_{IN} = 76\mu\text{F}$ ,  $C_{OUT} = 9.4\mu\text{F}$ , FON floating,  $R_{OVP} = 4.75\text{k}\Omega$ , unless otherwise specified

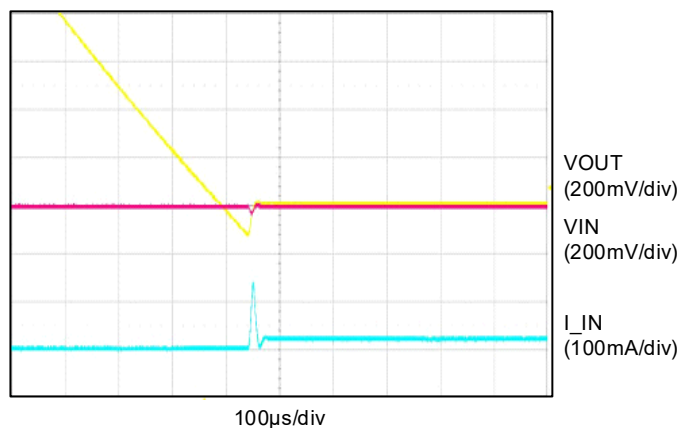


Figure 18. Recovery from True Reverse Current Blocking

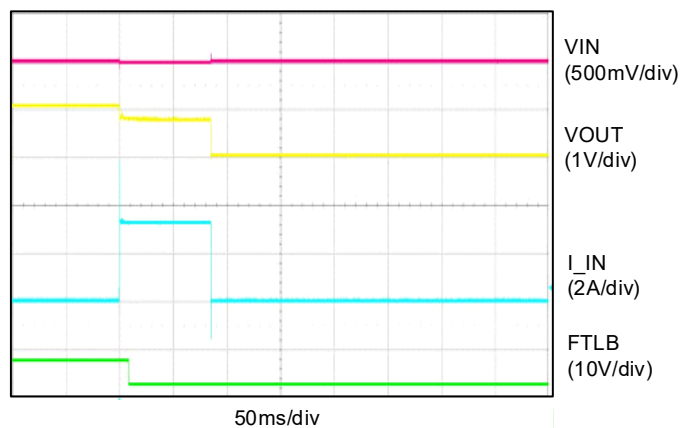


Figure 19. Over Current ( $R_{LIM} = 14.3\text{k}\Omega$ ,  $I_{LIM} = 1.0\text{A}$ ) (Latch-off)

## Typical Characteristics (continued)

$T_A = 25^\circ\text{C}$ ,  $V_{IN} = 5\text{V}$  unless otherwise specified.

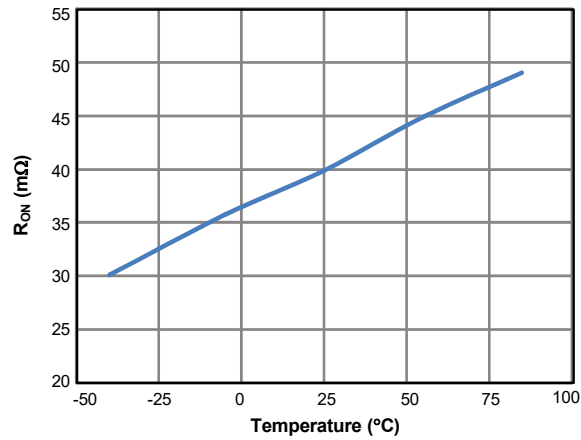


Figure 20.  $R_{ON}$  vs. Temperature

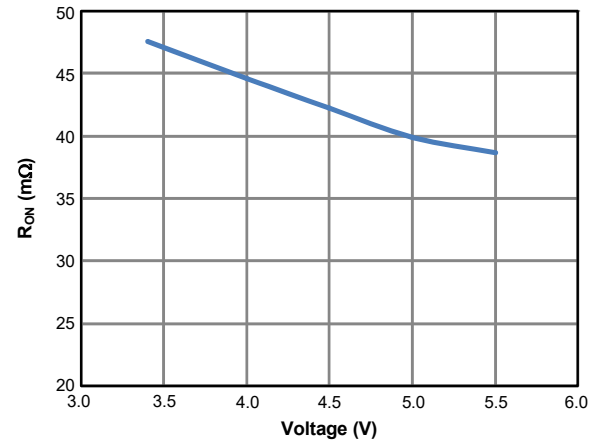


Figure 21.  $R_{ON}$  vs. Input Voltage

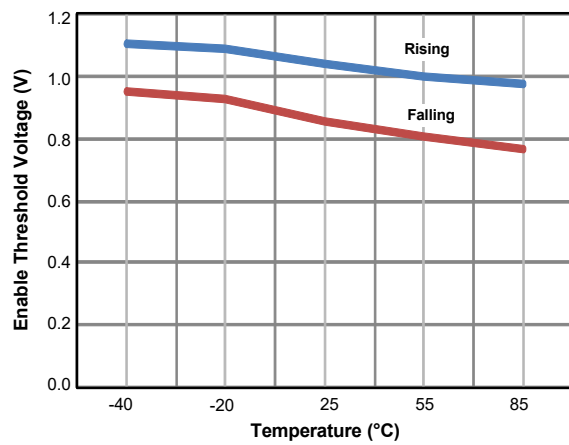


Figure 22. EN Threshold vs. Temperature

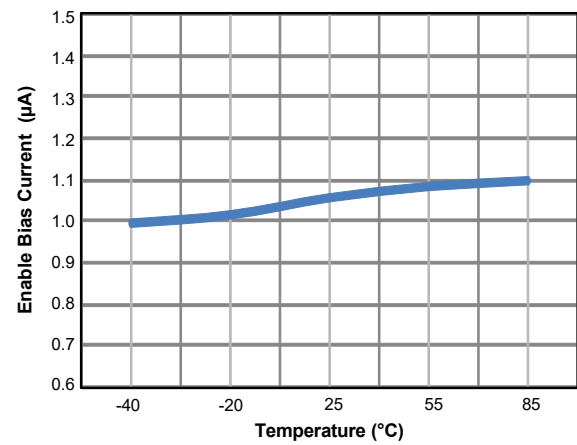


Figure 23. EN Bias Current vs. Temperature

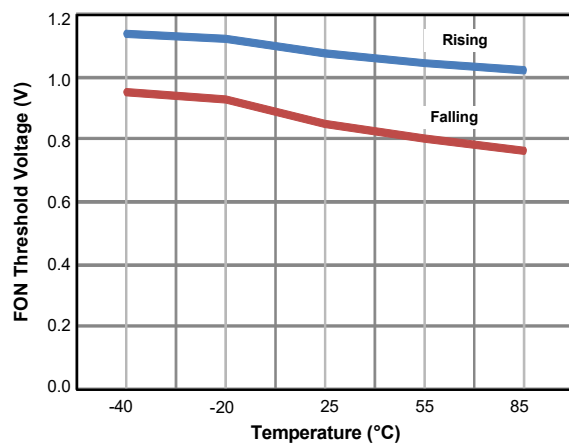


Figure 24. FON Threshold vs. Temperature

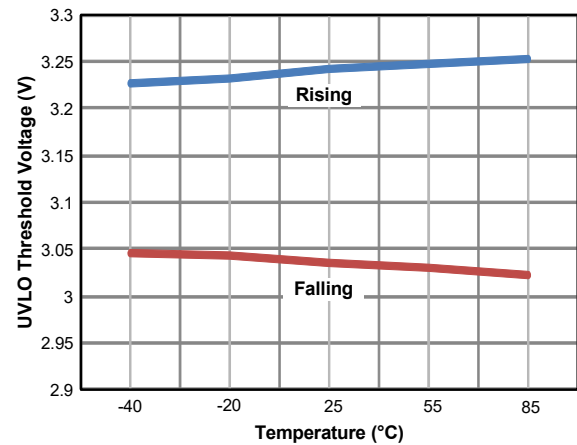


Figure 25. UVLO Threshold vs. Temperature  
(AOZ1356DI-01, -02)

## Typical Characteristics (continued)

$T_A = 25^\circ\text{C}$ ,  $V_{IN} = 5\text{V}$  unless otherwise specified.

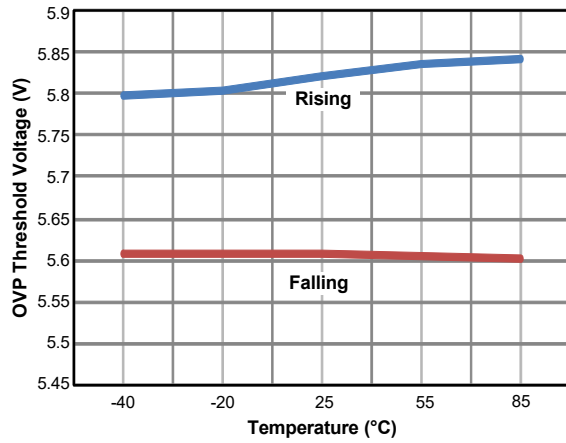


Figure 26. OVP Threshold vs. Temperature (AOZ1356DI-01, -02)

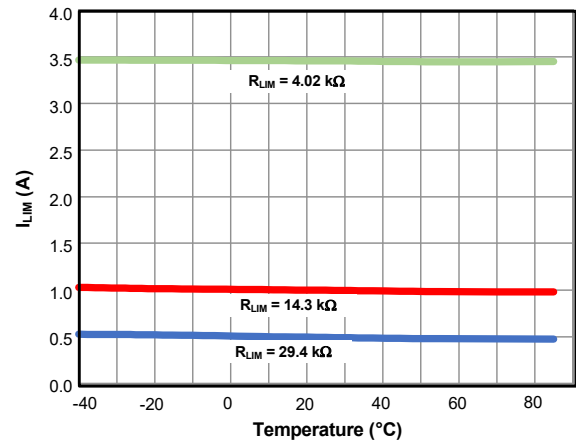


Figure 27. Current Limit Threshold vs. Temperature

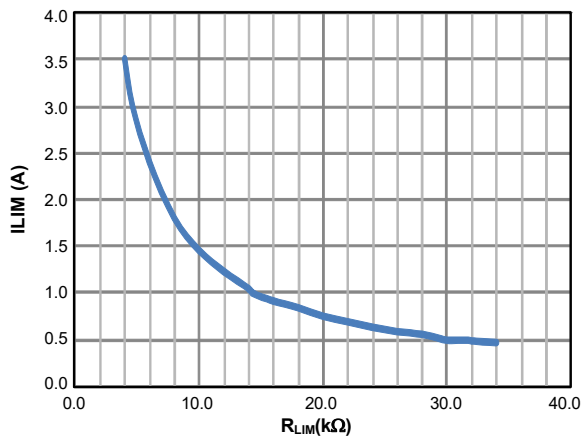


Figure 28. Current Limit vs.  $R_{LIM}$

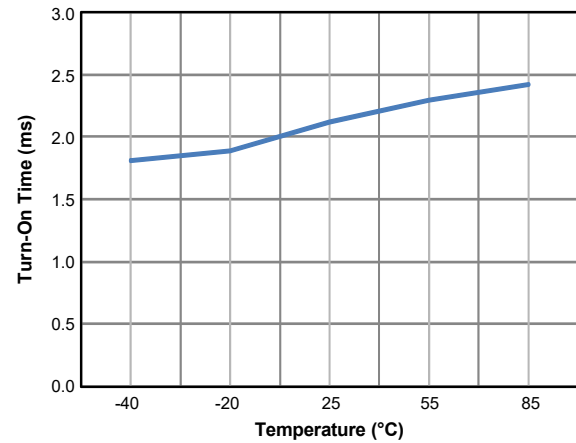


Figure 29. Turn-On Time ( $t_{ON}$ ) vs. Temperature

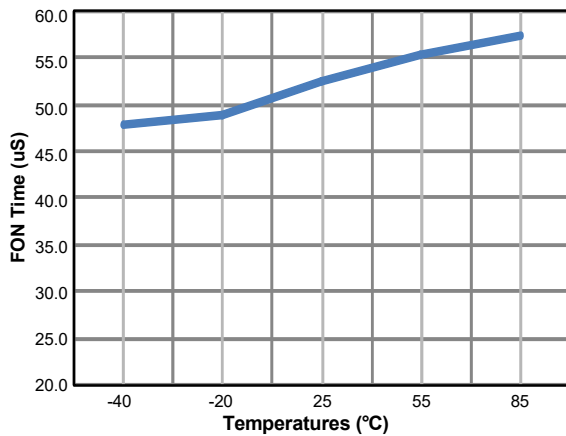


Figure 30. FON Time ( $t_{FON}$ ) vs. Temperature

## Functional Description

The AOZ1356DI is a current limited power switch with over-voltage, over-current, reverse-current and thermal shutdown protections. The VOUT pin is rated 28V. The switch current is rated up to 3.5A.

The device has 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 AOZ1356DI draws 6µA from supply.

For AOZ1356DI-02, -06 toggle EN pin to restart the device and clear fault flag after device latches off due to fault.

### 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 voltages at VIN terminal is constantly monitored once the device is enabled. In case input voltage exceeds the over-voltage lockout threshold ( $V_{IN\_OVLO\_R}$ ), the power switch is either turned off immediately or kept off, depending on its initial state. AOZ1356DI-01, -05 can restart when VIN drops below  $V_{IN\_OVLO\_HYS}$ .

### Programmable Current Limit and Over-Current Protection (OCP)

The AOZ1356DI-01 has current limit feature 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 equations below for the range from 2.5A to 4A:

$$I_{LIM} = 14300/R_{LIM}$$

For example, for 1A current limit threshold, a 14.3kΩ  $R_{LIM}$  resistor should be selected. 1% resistor is recommended for  $R_{LIM}$ .

For current less than 2.5A, we recommend to use Table 1 value due to second order non-linearity effects:

**Table 1.  $R_{LIM}$  Resistor Value vs Current Limit Threshold**

| Typical Current Limit (A) | Resistor Value $\pm 1\%$ (kΩ) |
|---------------------------|-------------------------------|
| 4.0                       | 3.52                          |
| 3.5                       | 4.02                          |
| 3.0                       | 4.65                          |
| 2.5                       | 5.62                          |
| 2.0                       | 7.15                          |
| 1.0                       | 14.3                          |
| 0.5                       | 40.2                          |

AOZ1356DI-01 continuously limits the output current when output is overloaded. Under current-limiting condition, FLTB is pulled low after a 10ms delay ( $t_{OCP\_FLTB}$ ). Severe overload causes power dissipation and die temperature to increase and may trigger thermal shutdown.

Under short circuit condition, FLTB is pulled low after a delay  $t_{SCP\_FLTB}$ .

$$t_{SCP\_FLTB} = t_{OCP\_FLTB} + t_{D\_ON}$$

### Current Limit Foldback

Once the system detects an over current condition, the controlled current is reduced (folded back) by 8% from the  $R_{LIM}$  set point. For example, if the  $I_{LIM} = 3A$ , then after detecting current limit the current is regulated to 8% lower or 2.76A.

The AOZ1356DI-01 has a blank out time for over-current pulses to avoid reporting false fault conditions. During plug in or when the output capacitor has been discharged, the system may experience momentary large currents greater than the programmed current limit. The device will ignore these events if they are less than 12ms ( $t_{OCP\_FLTB}$ ).

### Short-Circuit Protection (SCP)

When VOUT drops 270mV ( $V_{SC\_DETECT}$ ) below VIN the system interprets that as a  $V_{OUT}$  shorted to GND condition. From that point it takes 1µs ( $t_{SC\_RESPONSE}$ ) to respond and open the switch which will isolate VIN from VOUT.

### True Reverse-Current Blocking Protection (TRCB)

True reverse-current blocking prevents undesired current flow from output to input when power switch is in either on or off state. When device is enabled, power switch is quickly turned off whenever output voltage is higher than input voltage by 25mV (typical). The power switch is turned on again when output voltage falls below input by 40mV.

## Soft Start

The AOZ1356DI has internal soft-start circuitry to limit in-rush current due to large capacitive load. The turn-on ( $t_{ON}$ ) time is 2.7ms.

## Fast Turn-On

The FON pin allows the power switch to turn-on quickly. FON should be asserted before device is enabled.

If  $V_{IN} > V_{OUT}$ , the power switch turns on quickly by minimizing turn on delay and disables over-current protection.

## Fast Recovery from TRCB

Once TRCB event is removed, power switch turns on again quickly. The recovery time is 80 $\mu$ s typ.

## Fast Role Swap (FRS) Support

The Fast Turn-On and Fast Recovery from TRCB allows AOZ1356DI 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 80 $\mu$ s typ. 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. For AOZ1356DI-01, -05 power switch is allowed to turn on again if die temperature drops below approximately 120°C.

## Startup

The device is enabled when  $EN \geq V_{EN\_H}$  and input voltage is above 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.

## Fault Reporting

AOZ1356DI protects itself and load from the following fault condition: over-voltage, over-current, reverse-current, and over-temperature.

The FLTB pin is an open drain output. It is asserted low when either an over-current, 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 (RFLTB) 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 become impedance again once fault is removed.

In case of output overload, FLTB pin is pulled low about 12ms ( $t_{OCP\_FLTB}$ ) after device is in current-limiting. There is no fault reporting for UVLO, OVP and TRCB event.

## Auto-restart or Latch-off

**AOZ1356DI-01, -05 (auto-restart version):** The device will try to restart 24ms after the power switch is turned off and when OVP or thermal shutdown fault is removed.

Power switch is turned on immediately after a TRCB event is removed.

**AOZ1356DI-02, -06 (latch-off version):** The device keeps off even after the fault condition is removed. Power switch can only be turned on again by either toggle EN pin or recycle the input supply.

## 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 10 $\mu$ F 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

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 10 $\mu$ F. In addition, there is an upper limit for output capacitor for AOZ1356DI-01 to ensure the output capacitor can be charged fully during start-up. This upper limit is set by the current limit level and soft-start time.

$$C_{out} = I_{LIM} \times (t_{ON} / V_{IN})$$

## Power Dissipation Calculation

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

$$Power\ Dissipated = R_{ON} \times (I_{OUT})^2$$

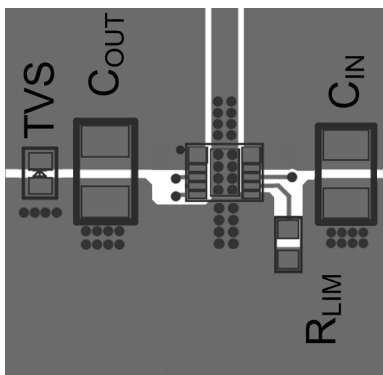
The worst case power dissipation occurs when the load current hits the current limit due to over-current. The power dissipation can be calculated using the following equation:

$$\text{Power Dissipated} = (V_{IN} - V_{OUT}) \times I_{LIM}$$

## Layout Guidelines

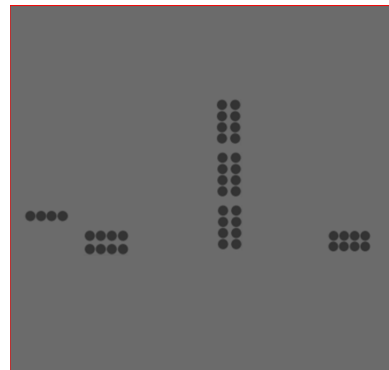
AOZ1356DI-01 is a protection switch designed to deliver high current. Layout is critical to remove the heat generated by this current. For the most efficient heat sinking, connect as much copper as possible to the exposed pad and then connect the exposed pad to ground potential.

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. See example in Figure 31.



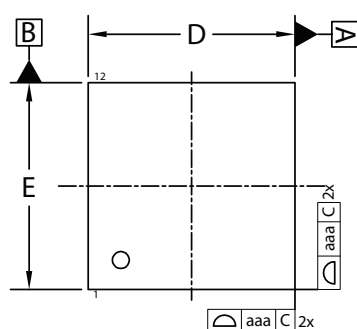
**Figure 31. Top Layer**

In addition to the top plane, if available, connect to the bottom layer ground plane for best thermal performance. See example in Figure 32.

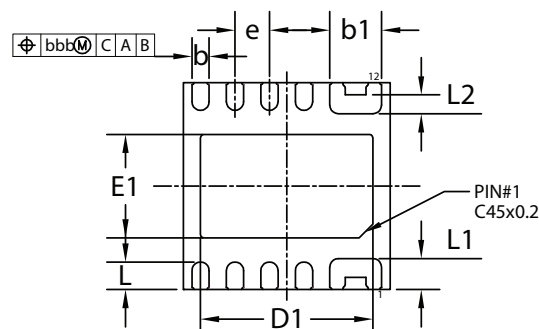


**Figure 32. Bottom Layer**

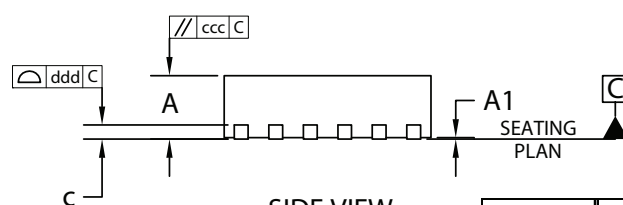
# Package Dimensions, DFN3x3-12L



TOP VIEW

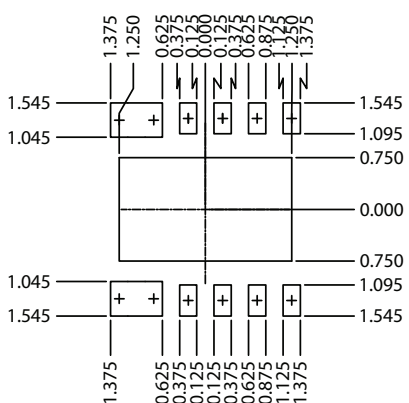


BOTTOM VIEW



SIDE VIEW

## RECOMMENDED LAND PATTERN



UNIT: mm

| SYMBOLS | DIMENSION IN MM |       |       | DIMENSION IN INCHES |       |       |
|---------|-----------------|-------|-------|---------------------|-------|-------|
|         | 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      | 0.700           | 0.750 | 0.800 | 0.028               | 0.030 | 0.031 |
| c       | 0.195           | 0.203 | 0.211 | 0.008               | 0.008 | 0.008 |
| D       | 2.900           | 3.000 | 3.100 | 0.114               | 0.118 | 0.122 |
| D1      | 2.400           | 2.500 | 2.600 | 0.094               | 0.098 | 0.102 |
| E       | 2.900           | 3.000 | 3.100 | 0.114               | 0.118 | 0.122 |
| E1      | 1.400           | 1.500 | 1.600 | 0.055               | 0.059 | 0.063 |
| e       | 0.500 BSC       |       |       | 0.020 BSC           |       |       |
| L       | 0.300           | 0.400 | 0.500 | 0.012               | 0.016 | 0.020 |
| L1      | 0.350           | 0.450 | 0.550 | 0.014               | 0.018 | 0.022 |
| L2      | 0.220           | 0.270 | 0.320 | 0.009               | 0.011 | 0.013 |
| aaa     | 0.150           |       |       | 0.006               |       |       |
| bbb     | 0.100           |       |       | 0.004               |       |       |
| ccc     | 0.100           |       |       | 0.004               |       |       |
| ddd     | 0.080           |       |       | 0.003               |       |       |

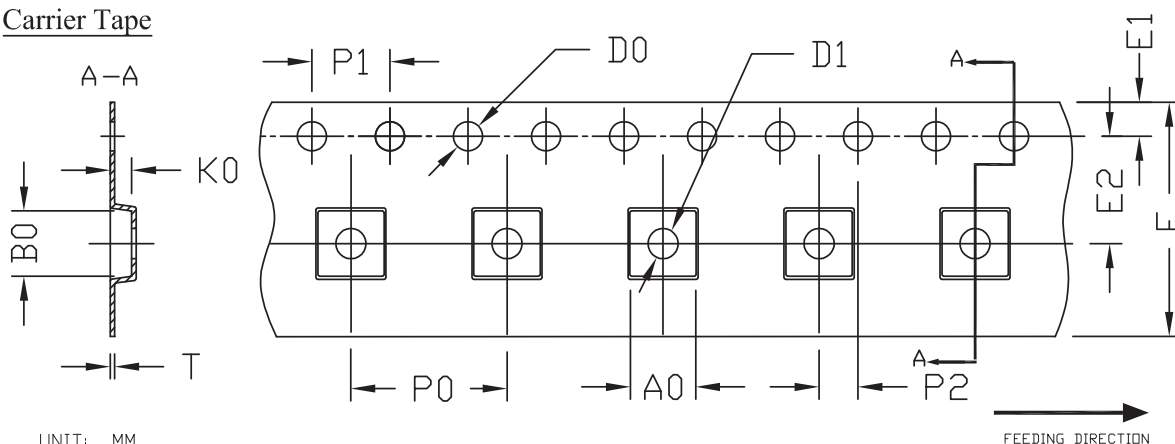
## NOTE:

1. DIMENSIONING AND TOLERANCING CONFORM TO ASME Y14.5M-1994.
2. CONTROLLING DIMENSION IS MILLIMETER.  
CONVERTED INCH DIMENSIONS ARE NOT NECESSARILY EXACT.
3. DIMENSION b APPLIES TO METALLIZED TERMINAL AND IS MEASURED BETWEEN 0.15mm. AND 0.30mm FROM THE TERMINAL TIP. IF THE TERMINAL HAS THE OPTIONAL RADIUS ON THE OTHER END OF THE TERMINAL, THE DIMENSION b SHOULD NOT BE MEASURED IN THAT RADIUS AREA.
4. COPLANARITY ddd APPLIES TO THE TERMINALS AND ALL OTHER BOTTOM SURFACE METALLIZATION.



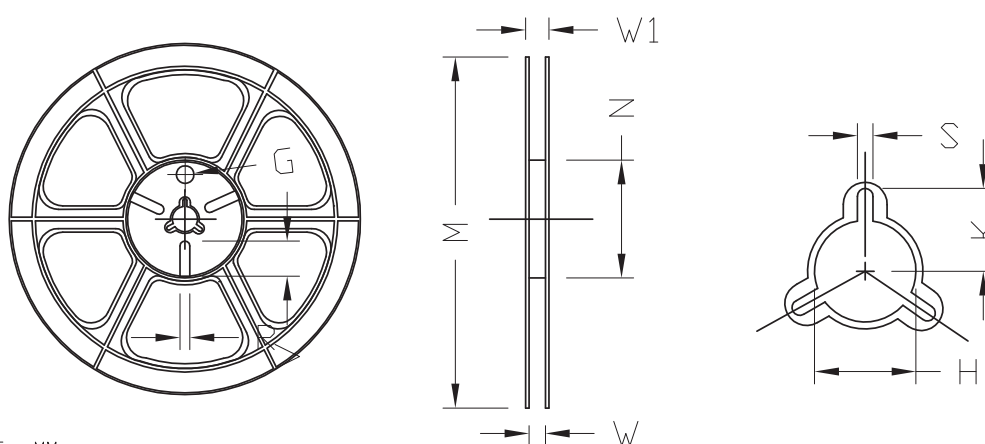
## Tape and Reel Drawing DFN3x3\_EP

### Carrier Tape



| PACKAGE   | A0            | B0            | K0            | D0                  | D1                  | E              | E1            | E2            | P0            | P1            | P2            | T             |
|-----------|---------------|---------------|---------------|---------------------|---------------------|----------------|---------------|---------------|---------------|---------------|---------------|---------------|
| DFN3x3_EP | 3.40<br>±0.10 | 3.35<br>±0.10 | 1.10<br>±0.10 | 1.50<br>+0.10<br>-0 | 1.50<br>+0.10<br>-0 | 12.00<br>±0.30 | 1.75<br>±0.10 | 5.50<br>±0.05 | 8.00<br>±0.10 | 4.00<br>±0.10 | 2.00<br>±0.05 | 0.30<br>±0.05 |

### REEL



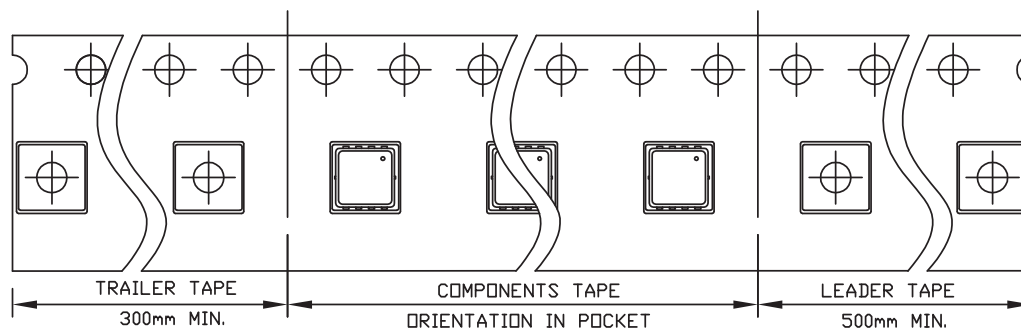
| TAPE SIZE | REEL SIZE | M                | N               | W              | W1             | H                        | K     | S             | G   | R   | V   |
|-----------|-----------|------------------|-----------------|----------------|----------------|--------------------------|-------|---------------|-----|-----|-----|
| 12 mm     | φ330      | φ330.00<br>±0.50 | φ97.00<br>±0.10 | 13.00<br>±0.30 | 17.40<br>±1.00 | φ13.00<br>+0.50<br>-0.20 | 10.60 | 2.00<br>±0.50 | --- | --- | --- |

### TAPE

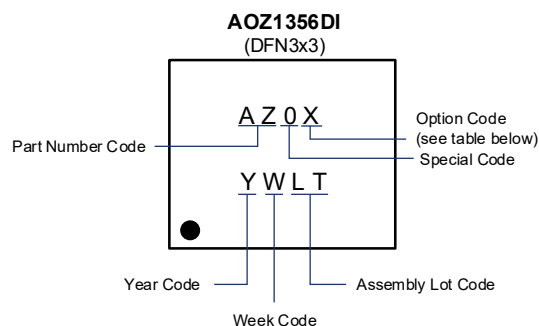
Leader / Trailer  
& Orientation

#### PIC

Unit Per Reel:  
5000pcs



## Part Marking



| Part Number  | Description   | Code |
|--------------|---------------|------|
| AOZ1356DI-01 | Green Product | AZ01 |
| AOZ1356DI-02 | Green Product | AZ02 |
| AOZ1356DI-05 | Green Product | AZ05 |
| AOZ1356DI-06 | Green Product | AZ06 |

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2. A critical component in any component of a life support, device, or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.