3A 5V 1MHz Synchronous Buck Converter

## Features

- **High Efficiency up to 95%**
  **- Automatic Skip/PWM Mode Operation**
- **Adjustable Output Voltage from 0.6V to VIN**
- **Integrated 75mΩ High side 65mΩ Low Side MOSFET**
- **Stable with Low ESR Ceramic Capacitors**
- **Power-On-Reset Detection on VIN**
- **Integrate Soft Start and Soft-Stop**
- **Over-Temperature Protection**
- **Over Voltage Protection**
- **Under Voltage Protection**
- **High Side Current Limit**
- **Power Good Indication**
- **Enable/ShutdownFunction**
- **Small TDFN2x2-8, SOT 23-6 packages**
- **Lead Free and Green Devices Available (RoHS compliant)**

## General Description

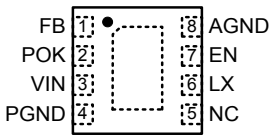
APW8827B is a 3A synchronous buck converter with integrated 75mΩ high side and 65mΩ low side power MOSFETs. The APW8827B design with a current-mode control scheme, can convert wide input voltage of 2.9V to 5.5V to provide excellent output voltage regulation.
The APW8827B is equipped with an automatic Skip/PWM mode operation. At light load, the IC operates in the Skip mode to reduce the switching losses. At heavy load, the IC works in PWM mode.
The APW8827B is also equipped with Power-on-reset, soft start and whole protections (under-voltage, overvoltage, over-temperature and current-limit) into a single package.
This device is available in TDFN2x2-8, SOT 23-6 provide a very compact system solution external components and PCB area.

## Applications

- **Notebook Computer & UMPC**
- **LCDMonitor/TV**
- **Set-Top Box**
- **DSL, Switch HUB**
- **Portable Instrument**

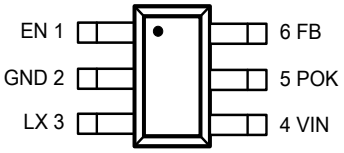
## Pin Configuration

APW8827B



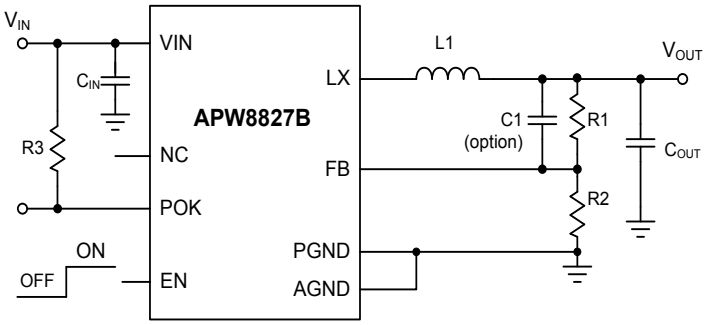

**TDFN2x2-8**
**(Top View)**

APW8827B

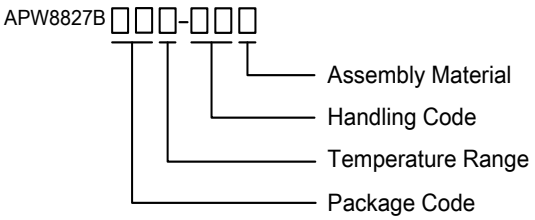



**SOT23-6**
**(Top View)**

## Simplified Application Circuit



## Ordering and Marking Information




Package Code
QB : TDFN-2x2-8 C:SOT 23-6
Operating Ambient Temperature Range
I : -40 to 85°C
Handling Code
TR : Tape & Reel
Assembly Material
G: Halogen and Lead Free Device

APW8827B QB : 

X - Date Code

APW8827B C : 

X - Date Code

Note: ANPEC lead-free products contain molding compounds/die attach materials and 100% matte tin plate termination finish; which are fully compliant with RoHS. ANPEC lead-free products meet or exceed the lead-free requirements of IPC/JEDEC J-STD-020D for MSL classification at lead-free peak reflow temperature. ANPEC defines “Green” to mean lead-free (RoHS compliant)and halogen free (Br or Cl does not exceed 900ppm by weight in homogeneous material and total of Br and Cl does not exceed 1500ppm by weight).

## Absolute Maximum Ratings (Note 1)

| Symbol | Parameter | | Rating | Unit |
|---|---|---|---|---|
| $V_{IN}$ | Input Supply Voltage to PGND | | -0.3 ~ 6.5 | V |
| $V_{LX}$ | LX to GND Voltage | < 30ns pulse width | -3 ~ 8 | V |
| | | > 30ns pulse width | -1 ~$V_{IN}$+0.3 | V |
| $V_{IN}$-$V_{LX}$ | VIN to LX Voltage | < 30ns pulse width | -3 ~ 8 | V |
| | | > 30ns pulse width | -0.3 ~ $V_{IN}$+0.3 | V |
| | POK, FB, EN to PGND Voltage | | -0.3 ~ 6.5 | V |
| | AGND to PGND Voltage | | -0.3 ~ 0.3 | V |
| $T_J$ | Junction Temperature | | 150 | °C |
| $T_{STG}$ | Storage Temperature | | -65 ~ 150 | °C |
| $T_{SDR}$ | Maximum Lead Soldering Temperature(10 Seconds) | | 260 | °C |

Note1: Stresses beyond those listed under "absolute maximum ratings" may 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 rating conditions for extended periods may affect device reliability.

## Thermal Characteristics

| Symbol | Parameter | | Typical Value | Unit |
|---|---|---|---|---|
| $\theta_{JA}$ | Junction-to-Ambient Resistance in free air (Note 2) | TDFN2x2-8 | 75 | °C/W |
| | | SOT-23-6 | 250 | |

Note 2: $\theta_{JA}$ is measured with the component mounted on a high effective thermal conductivity test board in free air.

## Recommended Operating Conditions (Note 3)

| Symbol | Parameter | Range | Unit |
|---|---|---|---|
| $V_{IN}$ | Control and Driver Supply Voltage | 2.9 ~ 5.5 | V |
| $I_{OUT}$ | Converter Output Current | 0 ~ 3 | A |
| $T_A$ | Ambient Temperature | -40 ~ 85 | °C |
| $T_J$ | Junction Temperature | -40 ~ 125 | °C |

Note 3: Refer to the typical application circuit.

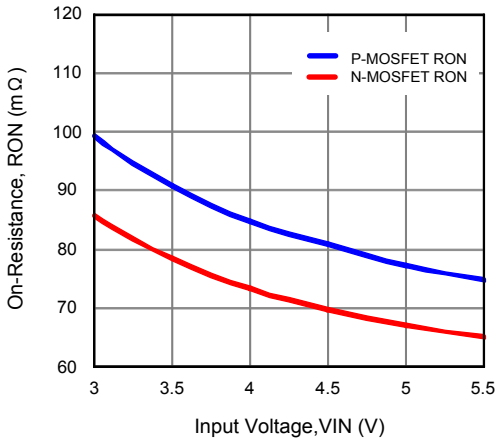
## Electrical Characteristics

Unless otherwise specified, these specifications apply over $V_{IN}$=3.7V and $T_A$= -40 to 85 °C. Typical values are at $T_A$=25°C.

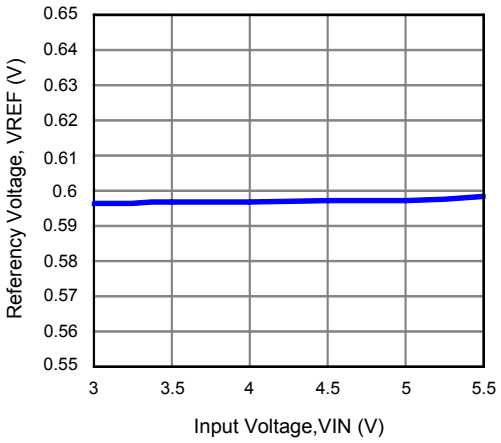
| Symbol | Parameter | Test Conditions | APW8827B | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | |
| **Supply Current** | | | | | | |
| $I_{DD}$ | VIN Supply Current | $V_{FB}$=0.66V | - | 65 | - | μA |
| $I_{SHDN}$ | VIN Shutdown Supply Current | EN=GND | - | - | 1 | μA |
| **Power-On-Reset (POR)** | | | | | | |
| | VIN POR Voltage Threshold | $V_{IN}$ Rising | 2.3 | 2.4 | 2.5 | V |
| | VIN POR Hysteresis | | 0.1 | 0.2 | 0.3 | V |
| **Reference Voltage** | | | | | | |
| $V_{REF}$ | Reference Voltage | | - | 0.6 | - | V |
| | | $T_A$=25°C | -1 | - | +1 | % |
| | Output Accuracy | $I_{OUT}$=10mA~3A, $V_{IN}$=2.9~5.5V | -1.5 | - | +1.5 | % |
| **Oscillator** | | | | | | |
| $F_{OSC}$ | Oscillator Frequency | | 0.85 | 1 | 1.15 | MHz |
| | Minimum on Time | | - | 70 | - | ns |
| **Power MOSFET** | | | | | | |
| | High Side P-MOSFET Resistance | $V_{IN}$=5V, $I_{LX}$=0.5A, $T_A$=25°C | - | 75 | - | mΩ |
| | Low Side N-MOSFET Resistance | $V_{IN}$=5V, $I_{LX}$=0.5A, $T_A$=25°C | - | 65 | - | mΩ |
| | High/Low Side MOSFET Leakage Current | | - | - | 10 | μA |
| | Internal Discharge Resistance | | - | 1.1 | - | kΩ |
| **Protections** | | | | | | |
| $I_{LIM}$ | High Side MOSFET current-limit | Peak Current, $V_{IN}$=2.9~5.5V<br>$T_A$= -40 ~125 °C | 4 | 5 | 6 | A |
| $T_{OTP}$ | Over-temperature Trip Point<br>(Resoft start after OTP) | | - | 160 | - | °C |
| | Over-temperature Hysteresis | | - | 50 | - | °C |
| | Over- Voltage Protection threshold | $V_{OUT}$ Rising | 120 | 125 | 130 | %$V_{REF}$ |
| | Under-Voltage Protection threshold | | - | 50 | - | %$V_{REF}$ |
| | Over-Voltage Protection debounce time | | 20 | 25 | 30 | μs |
| **Soft-Start, Enable and POK** | | | | | | |
| $T_{SS}$ | Soft Start time | | 0.5 | 0.8 | 1.1 | ms |
| | EN Enable threshold | | 1.4 | - | - | V |
| | EN shutdown threshold | | - | - | 0.5 | V |
| | EN Pull Low Current | | - | 0.5 | 1 | μA |
| | POK threshold | POK in from Lower<br>(POK Goes High) | 82.5 | 87.5 | 92.5 | %$V_{OUT}$ |
| | | POK Low Hysteresis<br>(POK Goes Low) | - | 5 | - | %$V_{OUT}$ |
| | | POK in from Higher<br>(POK Goes High) | 120 | 125 | 130 | %$V_{OUT}$ |
| | Power Good pull low resistance | | - | - | 30 | Ω |
| | Power Good Debounce | High to low | - | 20 | - | us |
| $T_{D\_EN}$ | EN Delay Time | | 400 | 600 | 800 | μs |
| $T_{D\_PG}$ | Power Good Debounce | Low to High | 1 | 3 | 5 | μs |

## Typical Operating Characteristics

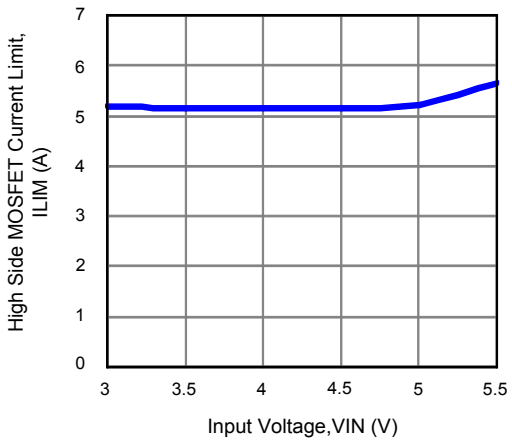
**On-Resistance vs. Input Voltage**



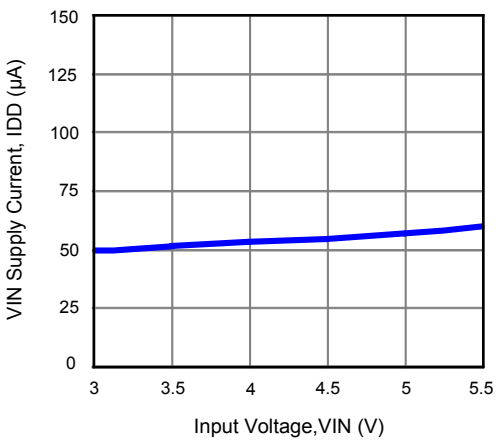

**Referency Voltage vs. Input Voltage**



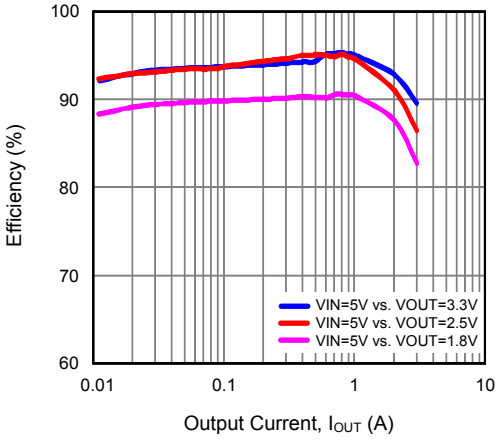

**High Side MOSFET Current Limit vs. Input Voltage**



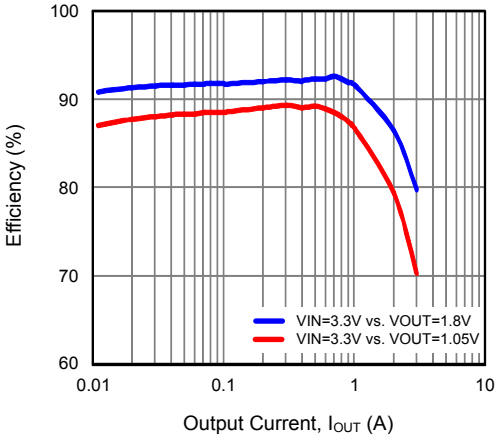

**VIN Supply Current vs. Input Voltage**



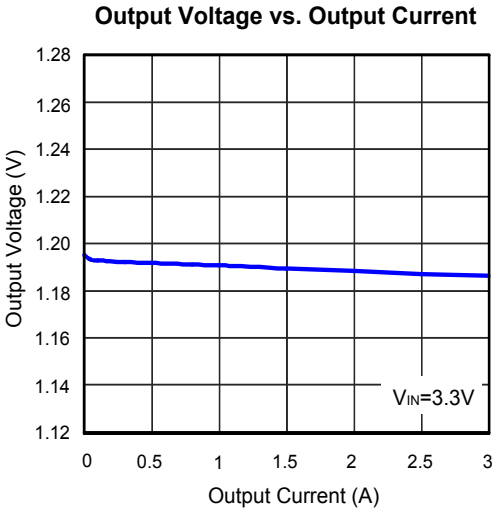

**Efficiency vs. Load Current**

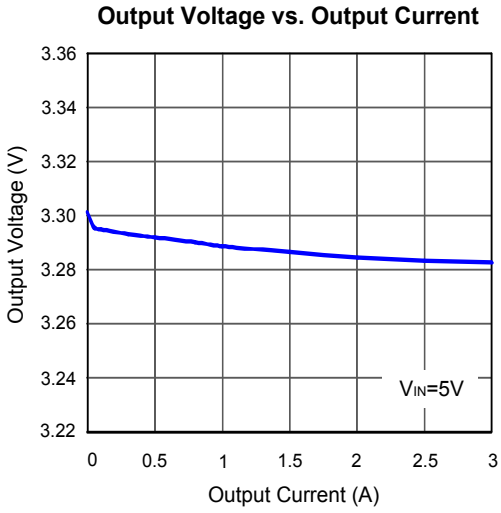



**Efficiency vs. Load Current**



## Typical Operating Characteristics

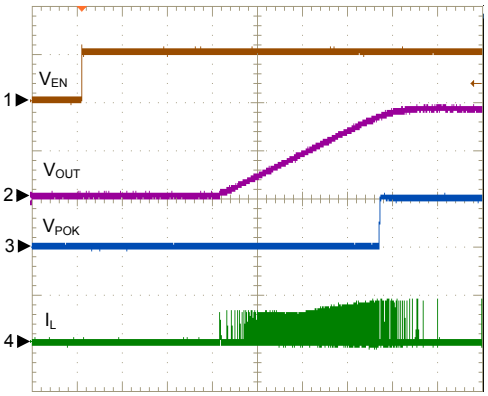


## Operating Waveforms

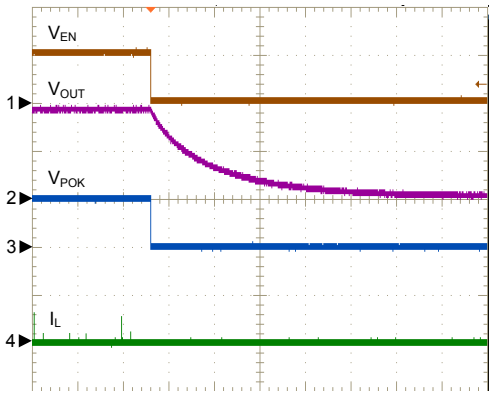
Refer to the typical application circuit. The test condition is $V_{IN}$=5V, $V_{OUT}$=1.8V, $T_A$= 25°C unless otherwise specified.

**Enable without Loading**



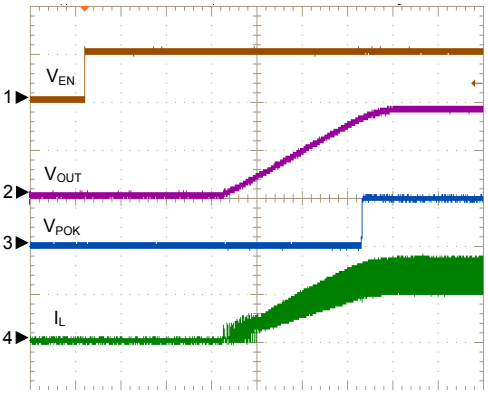

CH1: $V_{EN}$, 5V/Div, DC
CH2: $V_{OUT}$, 1V/Div, DC
CH3: $V_{POK}$, 5V/Div, DC
CH4: $I_L$, 1A/Div, DC
TIME: 200us/Div

**Shutdown without Loading**



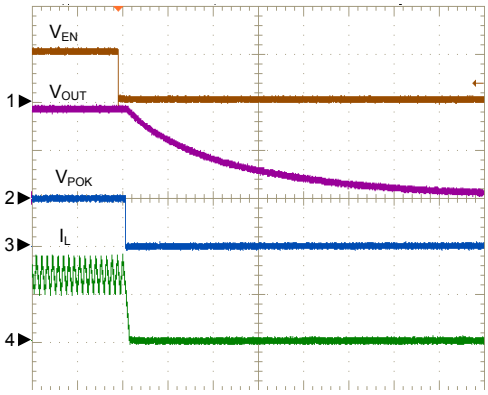

CH1: $V_{EN}$, 5V/Div, DC
CH2: $V_{OUT}$, 1V/Div, DC
CH3: $V_{POK}$, 5V/Div, DC
CH4: $I_L$, 1A/Div, DC
TIME: 40ms/Div

**Enable with 3A Loading**




CH1: $V_{EN}$, 5V/Div, DC
CH2: $V_{OUT}$, 1V/Div, DC
CH3: $V_{POK}$, 5V/Div, DC
CH4: $I_L$, 2A/Div, DC
TIME: 200us/Div

**Shutdown with 3A Loading**

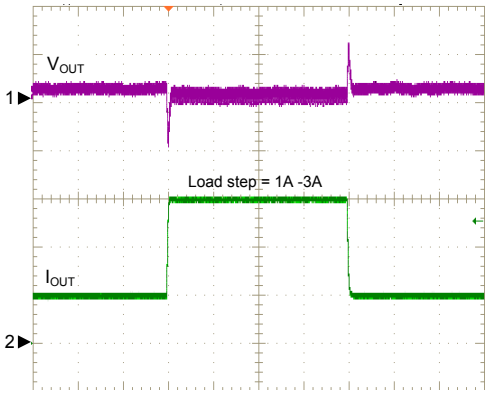



CH1: $V_{EN}$, 5V/Div, DC
CH2: $V_{OUT}$, 1V/Div, DC
CH3: $V_{POK}$, 5V/Div, DC
CH4: $I_L$, 2A/Div, DC
TIME: 10us/Div

## Operating Waveforms (Cont.)

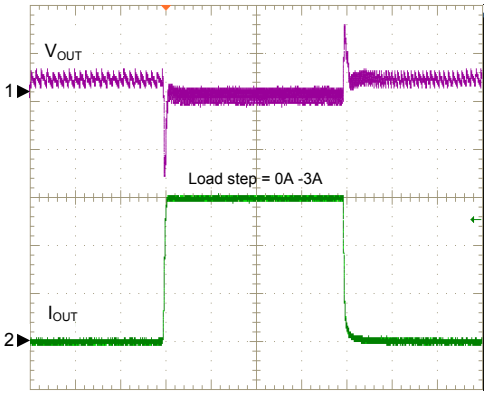
Refer to the typical application circuit. The test condition is $V_{IN}$=5V, $V_{OUT}$=1.8V, $T_A$= 25°C unless otherwise specified.

**Load Transient**



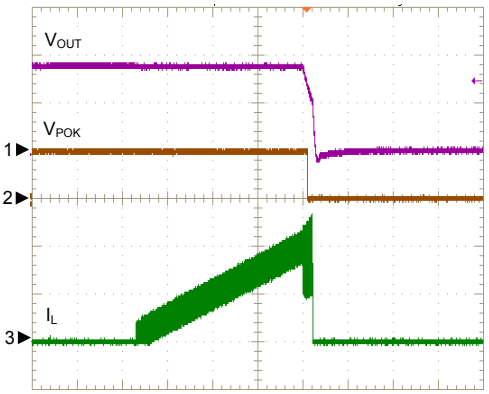

CH1: $V_{OUT}$, 50mV/Div, DC, Offset=1.8V
CH2: $I_{OUT}$, 1A/Div, DC
TIME: 200us/Div

**Load Transient**



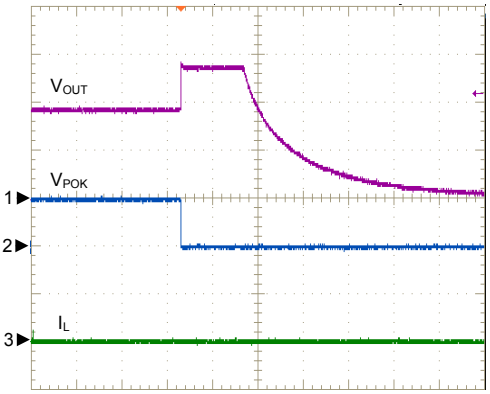

CH1: $V_{OUT}$, 50mV/Div, DC, Offset=1.8V
CH2: $I_{OUT}$, 1A/Div, DC
TIME: 200us/Div

**Current Limit**




CH1: $V_{OUT}$, 1V/Div, DC
CH2: $V_{POK}$, 5V/Div, DC
CH3: $I_L$, 2A/Div, DC
TIME: 200us/Div

**Over Voltage Protection**

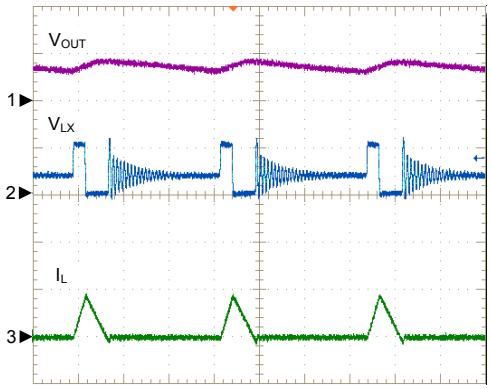



CH1: $V_{OUT}$, 1V/Div, DC
CH2: $V_{POK}$, 5V/Div, DC
CH3: $I_L$, 2A/Div, DC
TIME: 40ms/Div

## Operating Waveforms (Cont.)

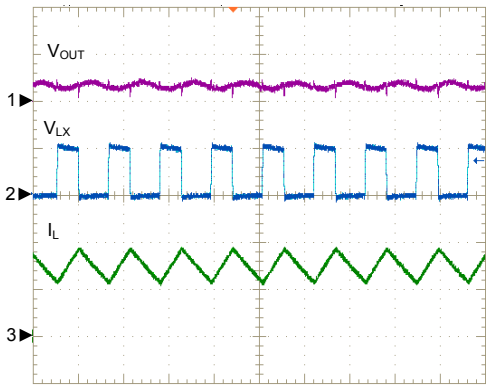
Refer to the typical application circuit. The test condition is $V_{IN}$=5V, $V_{OUT}$=1.8V, $T_A$= 25°C unless otherwise specified.

**Normal Operation in Light Load**




$I_{OUT}$ =100mA
CH1: $V_{OUT}$, 50mV/Div, DC, Offset=1.8V
CH2: $V_{LX}$, 5V/Div, DC
CH3: $I_L$, 1A/Div, DC
TIME: 1us/Div

**Normal Operation in Heavy Load**

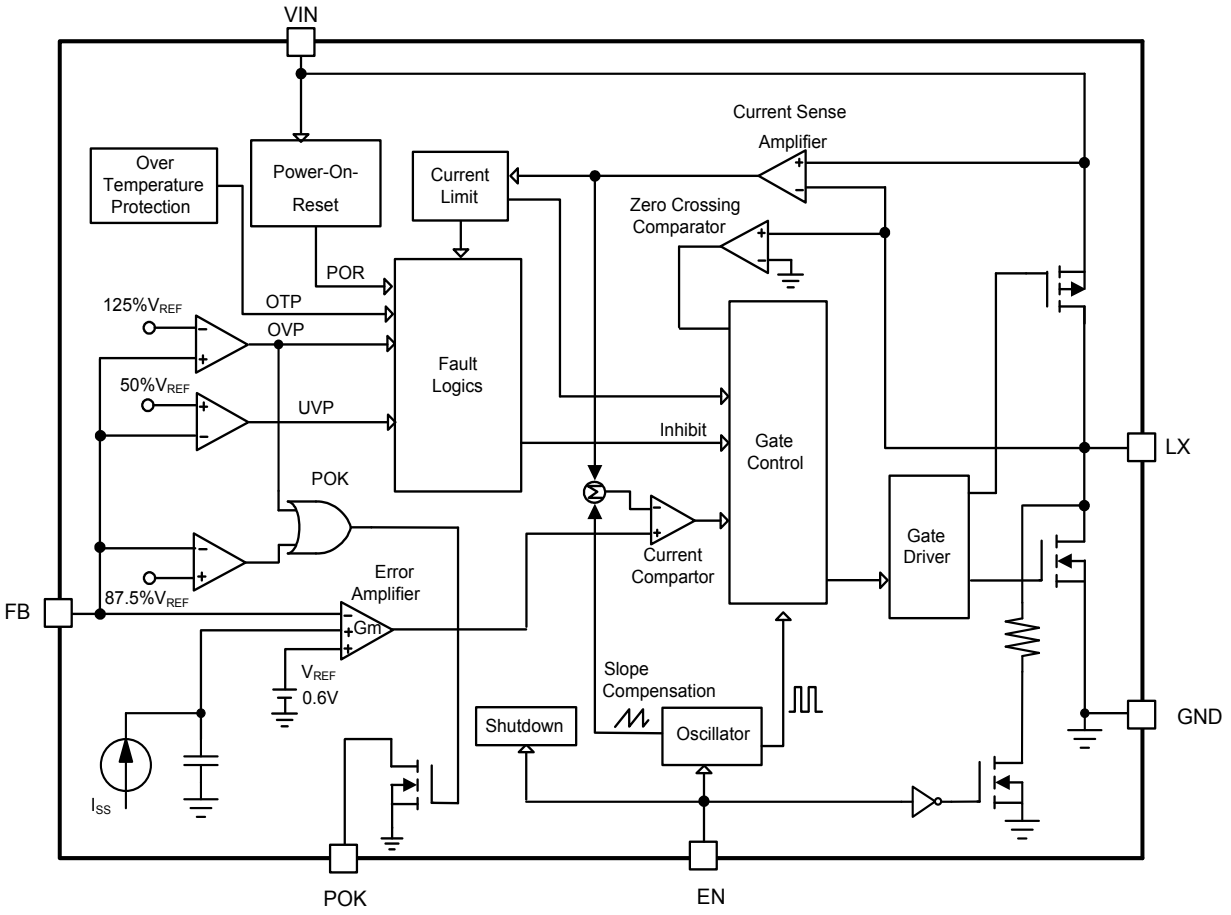



$I_{OUT}$ = 3A
CH1: $V_{OUT}$, 50mV/Div, DC, Offset=1.8V
CH2: $V_{LX}$, 5V/Div, DC
CH3: $I_L$, 2A/Div, DC
TIME: 1us/Div

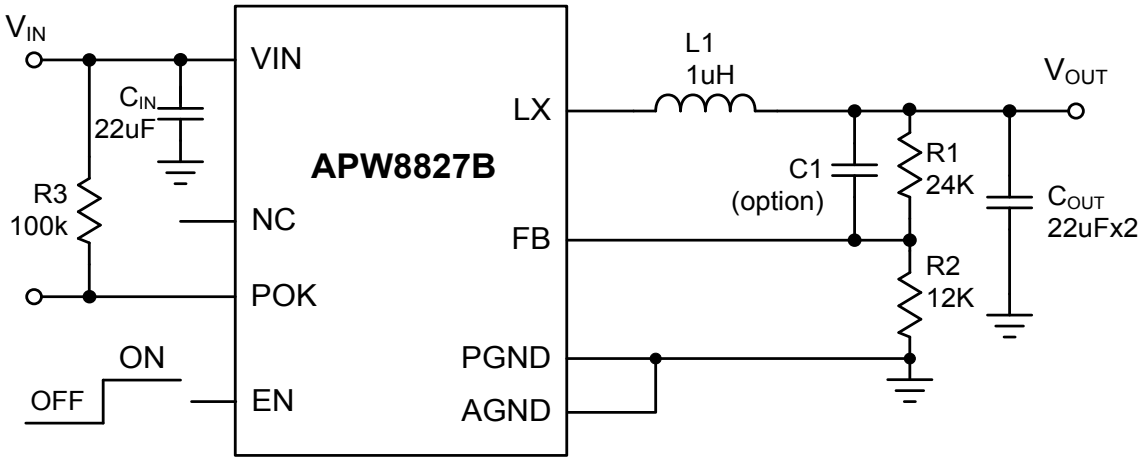
## Pin Descriptions

| PIN | | | Function |
|---|---|---|---|
| TDFN2x2-8 | TSOP23-6 | Name | |
| 1 | 6 | FB | Output Feedback Input. The APW8827B senses the feedback voltage via FB and regulates the voltage at 0.6V. Connecting FB with a resistor-divider from the converter's output sets the output voltage. |
| 2 | 5 | POK | Power Good Output. This pin is open-drain logic output that is pulled to ground when the output voltage is not within 10% of regulation point. |
| 3 | 4 | VIN | The control circuitry and converter supply input. Connecting a ceramic bypass capacitor from VIN to GND to eliminate switching noise and voltage ripple on the input to the IC. |
| 4, Exposed pad | - | PGND | Power ground. Connect this pin to AGND. |
| 5 | - | NC | No internal connection. |
| 6 | 3 | LX | Power Switching Output. LX is the Junction of the high-side and low-side Power MOSFETs to supply power to the output LC filter. |
| 7 | 1 | EN | Enable Input. EN is a digital input that turns the regulator on or off. Drive EN high to turn on the regulator, drive it low to turn it off. |
| 8 | - | AGND | Analog ground. Connect this pin to PGND. |
| - | 2 | GND | Power and signal ground. |

## Block Diagram



## Typical Application Circuit



## Function Descriptions

### VIN Power-On-Reset (POR)

The APW8827B keeps monitoring the voltage on VIN pin to prevent wrong logic operations which may occur when VIN voltage is not high enough for internal control circuitry to operate. The VIN POR rising threshold is 2.4V with 0.2V hysteresis.
During startup, the VIN voltage must exceed the POR threshold. Then the IC starts a starts-up process and ramps up the output voltage to the voltage target.

### Output Under-Voltage Protection (UVP)

In the operational process, if a short-circuit occurs, the output voltage will drop quickly. Before the current-limit circuit responds, the output voltage will fall out of the required regulation range. The under-voltage continually monitors the FB voltage after soft-start is completed. If a load step is strong enough to pull the output voltage lower than the under-voltage threshold, the IC shuts down converter's output.
The under-voltage threshold is 50% of the nominal output voltage. The APW8827B will be latched after undervoltage protection.

### Over-Voltage Protection (OVP)

The over-voltage function monitors the output voltage by FB pin. When the FB voltage increases over 125% of the reference voltage due to the high-side MOSFET failure or for other reasons, the over-voltage protection comparator will trigger the voltage of Discharge Resistance and shutdown the converter output.

### Over-Temperature Protection (OTP)

The over-temperature circuit limits the junction temperature of the APW8827B. When the junction temperature exceeds $T_J$ =160°C, a thermal sensor turns off the both power MOSFETs, allowing the devices to cool. The thermal sensor allows the converters to start a start-up process and to regulate the output voltage again after the junction temperature cools by 50°C. The OTP is designed with a 50°C hysteresis to lower the average $T_J$ during continuous thermal overload conditions, increasing lifetime of the APW8827B.

### Current-Limit Protection

The APW8827B monitors the output current, flows through the high-side and low-side power MOSFETs, and limits the current peak at current-limit level to prevent the IC from damaging during overload, short-circuit and overvoltage conditions. Typical high side power MOSFET current limit is 5A.

### Soft-Start

The APW8827B has a built-in soft-start to control the rise rate of the output voltage and limit the input current surge during start-up. During soft-start, an internal voltage ramp connected to one of the positive inputs of the error amplifier, rises up to replace the reference voltage until the voltage ramp reaches the reference voltage. During soft-start without output over-voltage, the APW8827B converter's sinking capability is disabled until the output voltage reaches the voltage target.

### Discharge Resistance

At the moment of shutdown controlled by EN signal, under-voltage event or over-voltage event, the APW8827B use the resistance to discharge the output voltage in the output capacitors. Certainly, the load current also discharges the output voltage.

### Enable and Shutdown

Driving EN to ground places the APW8827B in shutdown. In shutdown mode, the internal power MOSFETs turns off, all internal circuitry shuts down and the quiescent supply current reduces to less than 1μA.

### Power Good Indicator

The IC has an open-drain POK pin that indicates the output regulation state.
During soft start, POK goes high when the output reach 87.5% of their target value. During normal operation, when the output is not within the range of 87.5% to 125% of the target voltage, the POK signal will be pulled low immediately.
When the output returns between 82.5% and 120% of the target value, the POK will remain high again.
Since POK is an open-drain pull-down device, it usually requires an external pull-up resistor; however, if the pin is not used, no resistor is necessary.

## Application Information

### Input Capacitor Selection

Because buck converters have a pulsating input current, a low ESR input capacitor is required. This results in the best input voltage filtering, minimizing the interference with other circuits caused by high input voltage spikes.
Also, the input capacitor must be sufficiently large to stabilize the input voltage during heavy load transients. For good input voltage filtering, usually a 22µF input capacitor is sufficient. It can be increased without any limit for better input-voltage filtering. Ceramic capacitors show better performance because of the low ESR value, and they are less sensitive against voltage transients and spikes compared to tantalum capacitors. Place the input capacitor as close as possible to the input and GND pin of the device for better performance.

### Inductor Selection

For high efficiencies, the inductor should have a low DC resistance to minimize conduction losses. Especially at high-switching frequencies, the core material has a higher impact on efficiency. When using small chip inductors, the efficiency is reduced mainly due to higher inductor core losses. This needs to be considered when selecting the appropriate inductor. The inductor value determines the inductor ripple current. The larger the inductor value, the smaller the inductor ripple current and the lower the conduction losses of the converter. Conversely, larger inductor values cause a slower load transient response. A reasonable starting point for setting ripple current, $\Delta I_L$, is 40% of maximum output current. The recommended inductor value can be calculated as below:

$$L \geq \frac{V_{OUT}\left(1-\frac{V_{OUT}}{V_{IN}}\right)}{F_{SW}\cdot \Delta I_L}$$

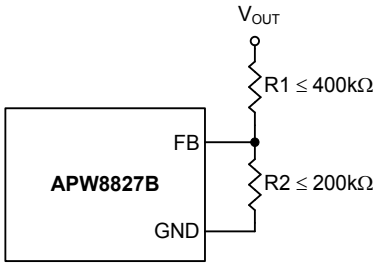
$$I_{L(MAX)} = I_{OUT(MAX)} + 1/2 \times \Delta I_L$$

To avoid the saturation of the inductor, the inductor should be rated at least for the maximum output current of the converter plus the inductor ripple current.

### Output Voltage Setting

In the adjustable version, the output voltage is set by a resistive divider. The external resistive divider is connected to the output, allowing remote voltage sensing as shown in “Typical Application Circuits”. A suggestion of maximum value of R2 is 200kΩ to keep the minimum current that provides enough noise rejection ability through the resistor divider. The output voltage can be calculated as below:

$$V_{OUT} = V_{REF}\cdot\left(1+\frac{R1}{R2}\right) = 0.6\cdot\left(1+\frac{R1}{R2}\right)$$

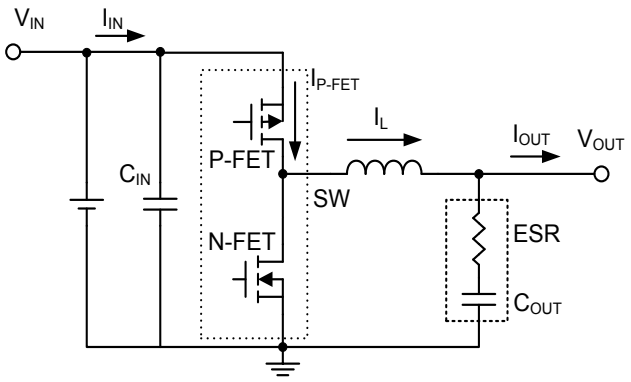


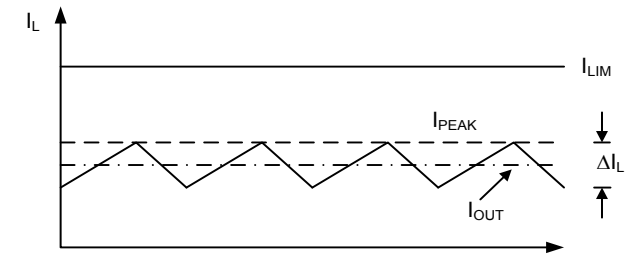

### Output Capacitor Selection

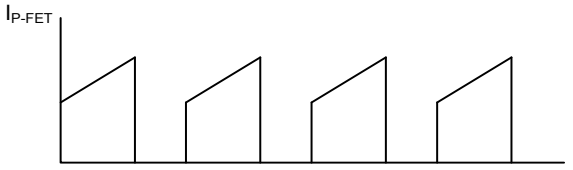
The current-mode control scheme of the APW8827B allows the use of tiny ceramic capacitors. The higher capacitor value provides the good load transients response.
Ceramic capacitors with low ESR values have the lowest output voltage ripple and are recommended. If required, tantalum capacitors may be used as well. The output ripple is the sum of the voltages across the ESR and the ideal output capacitor.

$$\Delta V_{OUT} \cong \frac{V_{OUT}\cdot\left(1-\frac{V_{OUT}}{V_{IN}}\right)}{F_{SW}\cdot L}\cdot\left(ESR+\frac{1}{8\cdot F_{SW}\cdot C_{OUT}}\right)$$

When choosing the input and output ceramic capacitors, choose the X5R or X7R dielectric formulations. These dielectrics have the best temperature and voltage characteristics of all the ceramics for a given value and size.



## Application Information (Cont.)

### Power Sequencing

At start-up, it is necessary to ensure that the VIN (the voltage supplied to MOSFET drain) and VEN are sequenced correctly to avoid erroneous latch-off. To avoid UVP latch-off happened at start-up due to sequencing issues, the key method is the VIN should be larger than the output under-voltage threshold plus the drop through the pass MOSFET when that output is enabled.
Figure 1 shows the VIN comes up before the VEN. Recommended power on sequence is shown in Figure1.

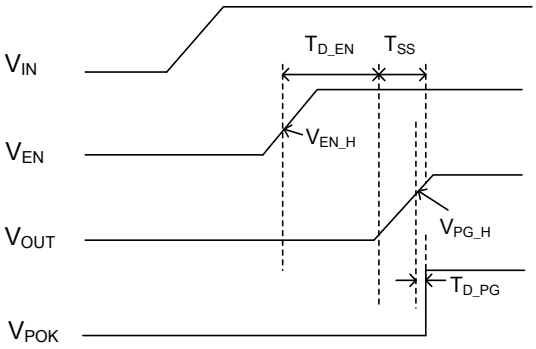
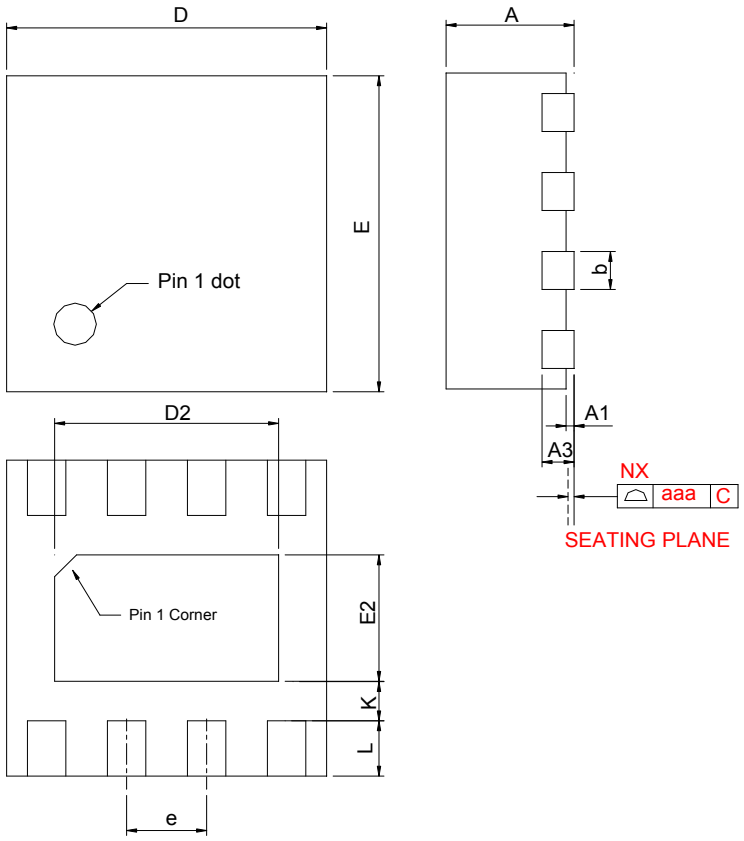



Figure 1. APW8827B power on sequence.

## Package Information

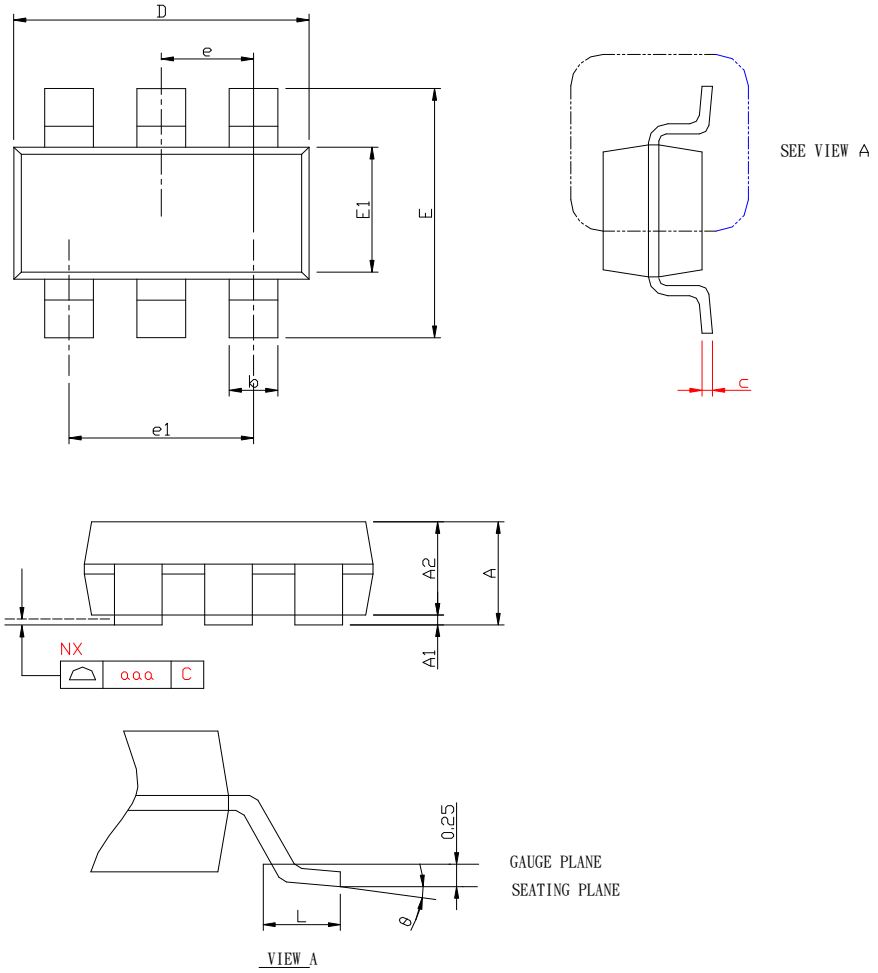
**TDFN2x2-8**




| SYMBOL | TDFN2*2-8 | | | |
|---|---|---|---|---|
| | MILLIMETERS | | INCHES | |
| | MIN. | MAX. | MIN. | MAX. |
| A | 0.70 | 0.80 | 0.028 | 0.031 |
| A1 | 0.00 | 0.05 | 0.000 | 0.002 |
| A3 | 0.20 REF | | 0.008 REF | |
| b | 0.18 | 0.30 | 0.007 | 0.012 |
| D | 1.90 | 2.10 | 0.075 | 0.083 |
| D2 | 1.00 | 1.60 | 0.039 | 0.063 |
| E | 1.90 | 2.10 | 0.075 | 0.083 |
| E2 | 0.60 | 1.00 | 0.024 | 0.039 |
| e | 0.50 BSC | | 0.020 BSC | |
| L | 0.30 | 0.45 | 0.012 | 0.018 |
| K | 0.20 | 0.30 | 0.008 | 0.012 |
| aaa | 0.08 | | 0.003 | |

## Package Information

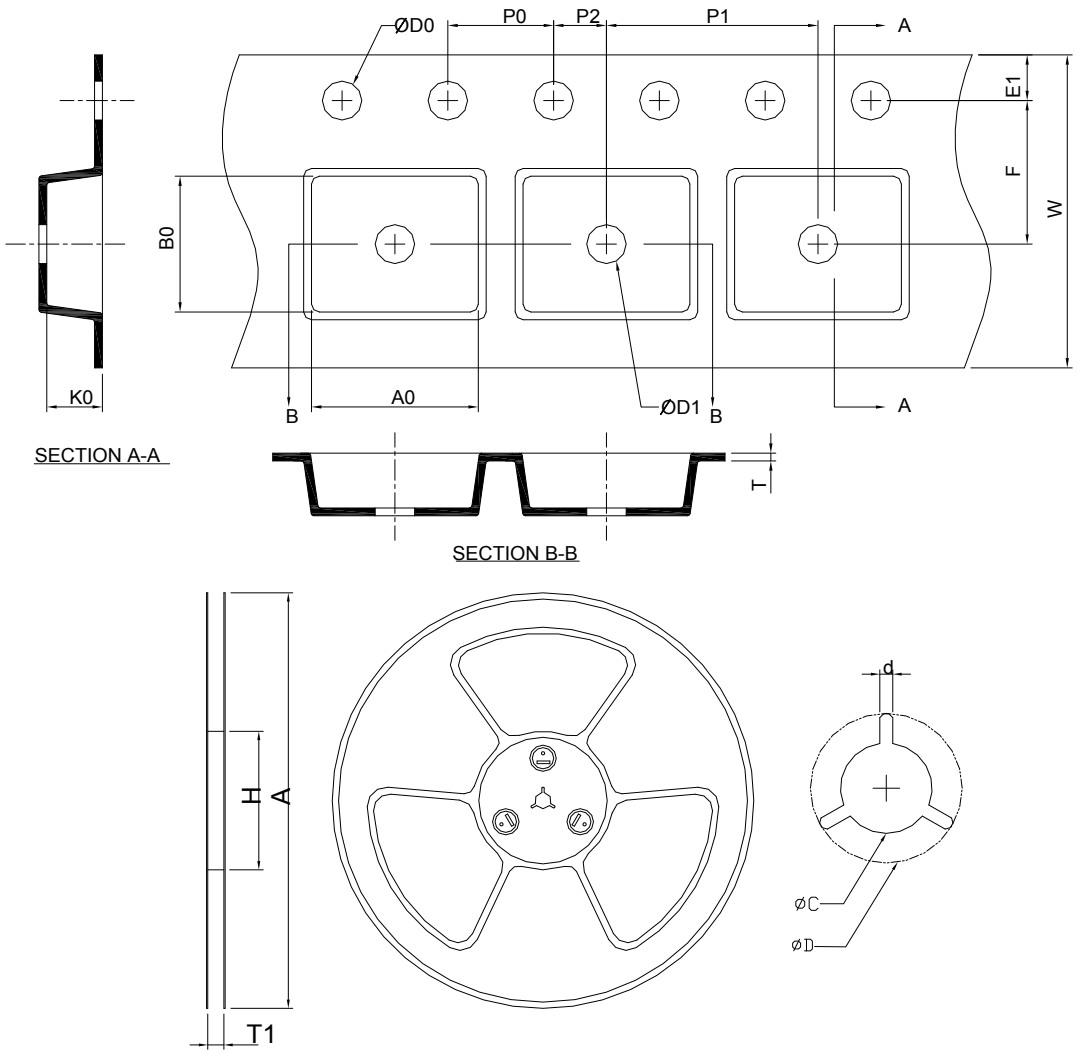
**SOT-23-6**




| SYMBOL | SOT-23-6 | | | |
|---|---|---|---|---|
| | MILLIMETERS | | INCHES | |
| | MIN. | MAX. | MIN. | MAX. |
| A | 0.90 | 1.30 | 0.035 | 0.051 |
| A1 | 0.00 | 0.15 | 0.000 | 0.006 |
| A2 | 0.90 | 1.30 | 0.035 | 0.051 |
| b | 0.30 | 0.50 | 0.012 | 0.020 |
| c | 0.08 | 0.22 | 0.003 | 0.009 |
| D | 2.70 | 3.10 | 0.106 | 0.122 |
| E | 2.60 | 3.00 | 0.102 | 0.118 |
| E1 | 1.40 | 1.80 | 0.055 | 0.071 |
| e | 0.95 BSC | | 0.037 BSC | |
| e1 | 1.90 BSC | | 0.075 BSC | |
| L | 0.30 | 0.60 | 0.012 | 0.024 |
| θ | 0° | 8° | 0° | 8° |
| aaa | 0.10 | | 0.004 | |

Note : 1. Follow from JEDEC TO-178 AB.
2 Dimension D and E1 do not include mold flash, protrusions or gate burrs. Mold flash, protrusion or gate burrs shall not exceed 10 mil per side.

## Carrier Tape & Reel Dimensions




| Application | A | H | T1 | C | d | D | W | E1 | F |
|---|---|---|---|---|---|---|---|---|---|
| TDFN2x2-8 | 178.0±2.00 | 50 MIN. | 8.4+2.00 -0.00 | 13.0+0.50 -0.20 | 1.5 MIN. | 20.2 MIN. | 8.0±0.20 | 1.75±0.10 | 3.5±0.05 |
| | **P0** | **P1** | **P2** | **D0** | **D1** | **T** | **A0** | **B0** | **K0** |
| | 4.0±0.10 | 4.0±0.10 | 2.0±0.05 | 1.5+0.10 -0.00 | 1.5 MIN. | 0.6+0.00 -0.40 | 2.35±0.20 | 2.35±0.20 | 1.00±0.20 |
| **Application** | **A** | **H** | **T1** | **C** | **d** | **D** | **W** | **E1** | **F** |
| SOT-23-6 | 178.0±2.00 | 50 MIN. | 8.4+2.00 -0.00 | 13.0+0.50 -0.20 | 1.5 MIN. | 20.2 MIN. | 8.0±0.30 | 1.75±0.10 | 3.5±0.05 |
| | **P0** | **P1** | **P2** | **D0** | **D1** | **T** | **A0** | **B0** | **K0** |
| | 4.0±0.10 | 4.0±0.10 | 2.0±0.05 | 1.5+0.10 -0.00 | 1.0 MIN. | 0.6+0.00 -0.40 | 3.20±0.20 | 3.10±0.20 | 1.50±0.20 |

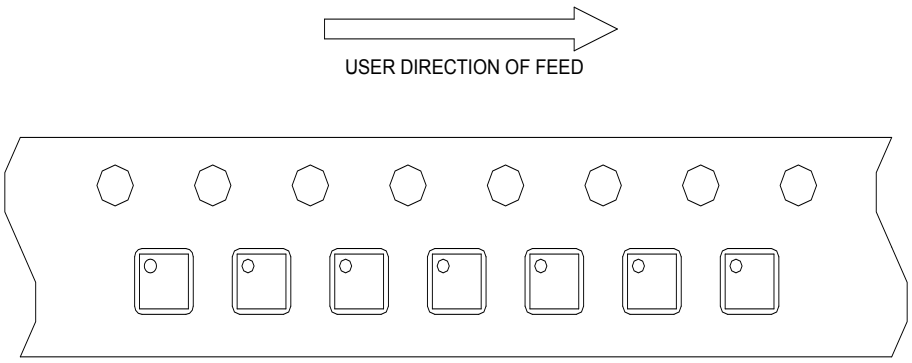
(mm)

## Devices Per Unit

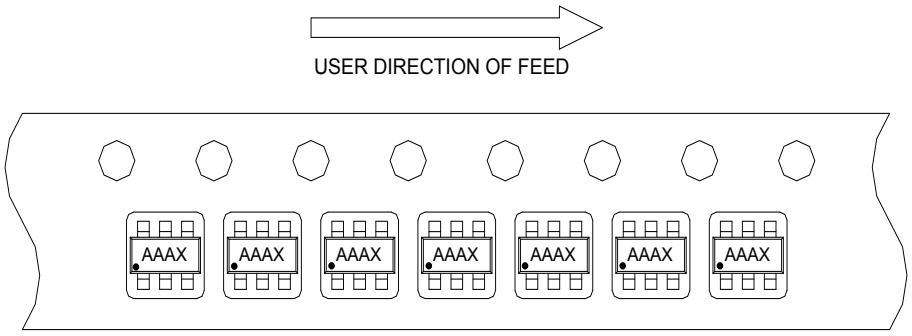
| Package Type | Unit | Quantity |
|---|---|---|
| **TDFN2x2-8** | Tape & Reel | 3000 |
| **SOT-23-6** | Tape & Reel | 3000 |

## Taping Direction Information

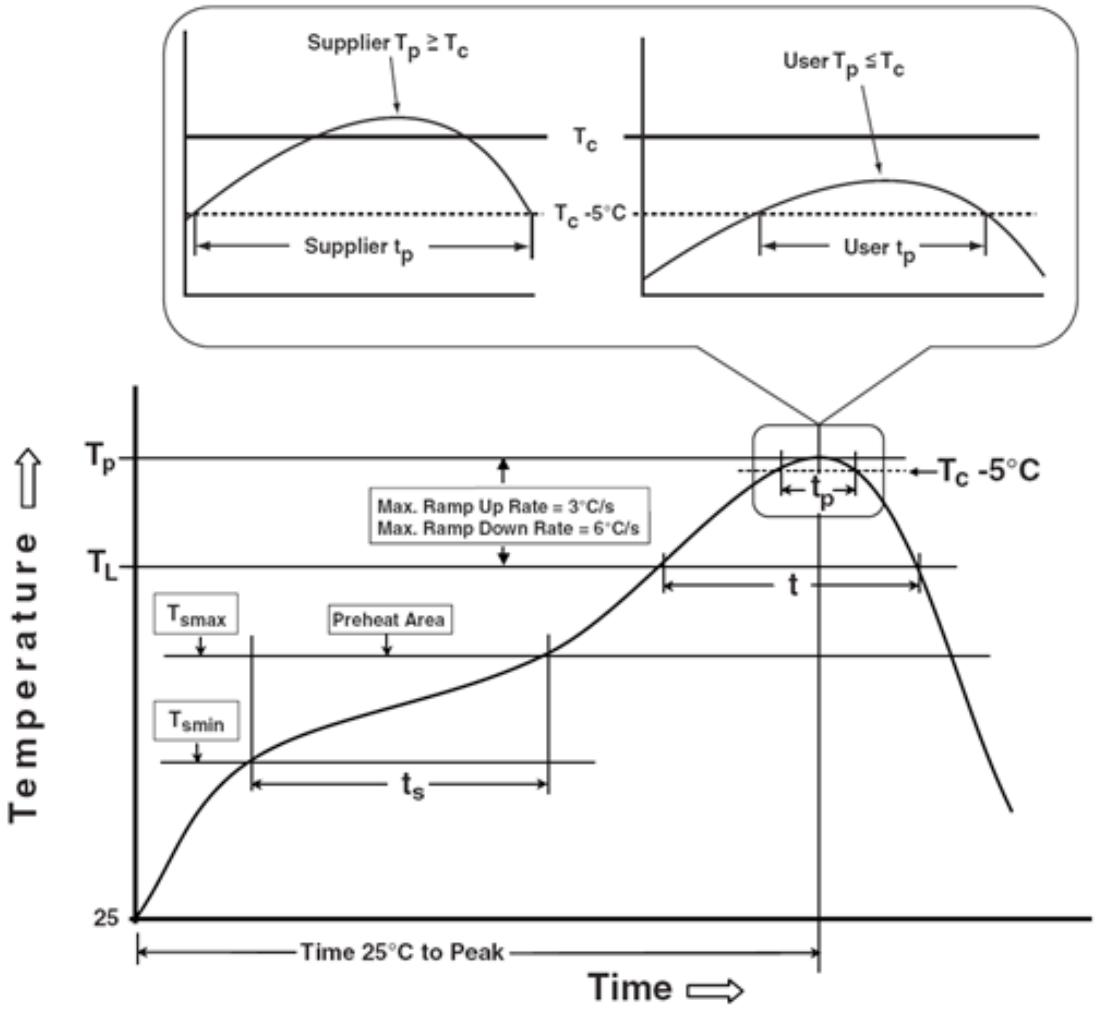
**TDFN2x2-8**




**SOT-23-6**



## Classification Profile



## Classification Reflow Profiles

| Profile Feature | Sn-Pb Eutectic Assembly | Pb-Free Assembly |
|---|---|---|
| **Preheat & Soak**<br>Temperature min ($T_{smin}$)<br>Temperature max ($T_{smax}$)<br>Time ($T_{smin}$ to $T_{smax}$) ($t_s$) | 100 °C<br>150 °C<br>60-120 seconds | 150 °C<br>200 °C<br>60-120 seconds |
| Average ramp-up rate ($T_{smax}$ to $T_P$) | 3 °C/second max. | 3°C/second max. |
| Liquidous temperature ($T_L$)<br>Time at liquidous ($t_L$) | 183 °C<br>60-150 seconds | 217 °C<br>60-150 seconds |
| Peak package body Temperature ($T_p$)* | See Classification Temp in table 1 | See Classification Temp in table 2 |
| Time ($t_P$)** within 5°C of the specified classification temperature ($T_c$) | 20** seconds | 30** seconds |
| Average ramp-down rate ($T_p$ to $T_{smax}$) | 6 °C/second max. | 6 °C/second max. |
| Time 25°C to peak temperature | 6 minutes max. | 8 minutes max. |
| * Tolerance for peak profile Temperature ($T_p$) is defined as a supplier minimum and a user maximum.<br>** Tolerance for time at peak profile temperature ($t_p$) is defined as a supplier minimum and a user maximum. | | |

Table 1. SnPb Eutectic Process – Classification Temperatures (Tc)

| Package Thickness | Volume $mm^3$ <350 | Volume $mm^3$ ≥350 |
|---|---|---|
| <2.5 mm | 235 °C | 220 °C |
| ≥2.5 mm | 220 °C | 220 °C |

Table 2. Pb-free Process – Classification Temperatures (Tc)

| Package Thickness | Volume $mm^3$ <350 | Volume $mm^3$ 350-2000 | Volume $mm^3$ >2000 |
|---|---|---|---|
| <1.6 mm | 260 °C | 260 °C | 260 °C |
| 1.6 mm – 2.5 mm | 260 °C | 250 °C | 245 °C |
| ≥2.5 mm | 250 °C | 245 °C | 245 °C |

## Reliability Test Program

| Test item | Method | Description |
|---|---|---|
| SOLDERABILITY | JESD-22, B102 | 5 Sec, 245°C |
| HOLT | JESD-22, A108 | 1000 Hrs, Bias @ $T_j$=125°C |
| PCT | JESD-22, A102 | 168 Hrs, 100%RH, 2atm, 121°C |
| TCT | JESD-22, A104 | 500 Cycles, -65°C~150°C |
| HBM | MIL-STD-883-3015.7 | VHBM ≧ 2KV |
| MM | JESD-22, A115 | VMM ≧ 200V |
| Latch-Up | JESD 78 | 10ms, $1_{tr}$ ≧ 100mA |

## Customer Service

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