## DESCRIPTION

AP8263 is a highly integrated current mode PWM control IC optimized for high performance, low standby power and cost effective offline flyback converter applications in sub 30W range.

PWM switching frequency at normal operation is externally programmable and trimmed to tight range. At no load or light load condition, the IC operates in extended 'burst mode' to minimize switching loss. Lower standby power and higher conversion efficiency is thus achieved.

The internal slope compensation improves system large signal stability and reduces the possible subharmonic oscillation at high PWM duty cycle output. Leading-edge blanking on current sense(CS) input removes the signal glitch due to snubber circuit diode reverse recovery and thus greatly reduces the external component count and system cost in the design.

Excellent EMI performance is achieved with proprietary frequency shuffling technique together with soft switching control at the totem pole gate drive output.

The AP8263 is available in SOT26、SOP8 and DIP8 Package

## ORDERING INFORMATION

| Package Type | Part Number | |
|---|---|---|
| SOT-26 | E6 | AP8263E6R |
| | | A8263E6VR |
| DIP8 | P8 | AP8263P8U |
| | | AP8263P8VU |
| SOP-8 | M8 | AP8263M8R |
| | | AP8263M8VR |
| Note | R: Tape & Reel<br>V: Green Package | |
| AiT provides all Pb free products<br>Suffix " V " means Green Package | | |

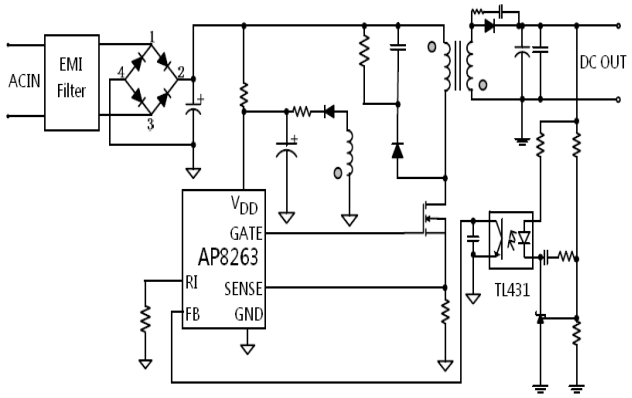
## FEATURES

- Proprietary Frequency Shuffling Technology for Improved EMI Performance.
- Extended Burst Mode Control For Improved Efficiency and Minimum Standby Power Design
- Audio Noise Free Operation
- External Programmable PWM Switching Frequency
- Internal Synchronized Slope Compensation
- Low $V_{DD}$ Startup Current and Low Operating Current (1.4mA)
- Leading Edge Blanking on Current Sense Input
- Owning soft start-up function
- Good Protection Coverage With Auto Self-Recovery
- $V_{DD}$ Over Voltage Clamp and Under Voltage Lockout with Hysteresis (UVLO)
- Gate Output Maximum Voltage Clamp (18V)
- Proprietary Line Input Compensated Cycle-by-Cycle Over-current Threshold Setting For Constant Output Power Limiting Over Universal Input Voltage Range.
- Overload Protection (OLP)
- Available in SOT26、SOP8 and DIP8 Package

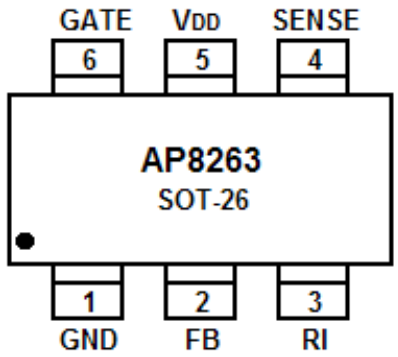
## APPLICATION

- Offline AC/DC flyback converter for
- Battery Charger
- Power Adaptor
- Set-Top Box Power Supplies
- Open-frame SMPS

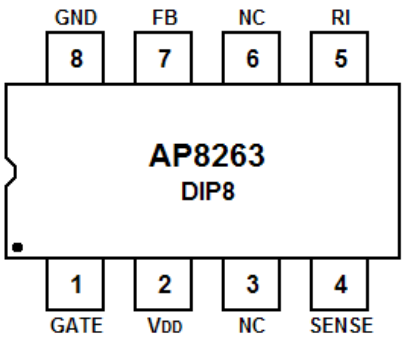
## TYPICAL APPLICATION



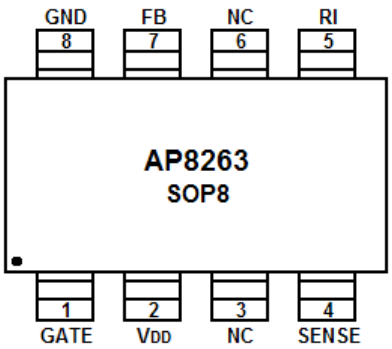
## PIN DESCRIPTION




Top View




Top View




Top View

| Pin # | | | Symbol | Function |
|---|---|---|---|---|
| SOT-26 | DIP8 | SOP-8 | | |
| 1 | 8 | 8 | GND | Ground |
| 2 | 7 | 7 | FB | Feedback input pin. The PWM duty cycle is determined by voltage level into this pin and SENSE pin input. |
| 3 | 5 | 5 | RI | Internal Oscillator frequency setting pin. A resistor connected between RI and GND sets the PWM frequency. |
| 4 | 4 | 4 | SENSE | Current sense input pin. Connected to MOSFET current sensing resistor node. |
| 5 | 2 | 2 | $V_{DD}$ | Chip DC power supply pin. |
| 6 | 1 | 1 | GATE | Totem-pole gate drive output for the power MOSFET. |
| | 3,6 | 3,6 | NC | |

## ABSOLUTE MAXIMUM RATINGS

| | |
|---|---|
| $V_{DD}$ to GND Voltage | 28V |
| $V_{DD}$ Clamp Current | 10mA |
| $V_{DD}$ Clamp Voltage | 28V |
| $V_{FB}$, $V_{SENSE}$ and $V_{RI}$ to GND Voltage | -0.3V to + 7V |
| Junction temperature | -20°C to + 150° |
| Storage Temperature | -55°C to + 160°C |
| $V_{DD}$ Voltage | 10V to + 27V |
| RI Resistor Value | 100kOhm |
| Operating Ambient Temperature | -20°C to + 85°C |
| Human body mode | 2000V |
| Machine mode | 200V |

Stresses above 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 in the Electrical Characteristics are not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

NOTE: Do not exceed these limits to prevent damage to the device. Exposure to absolute maximum rating conditions for long periods may affect device reliability.

## ELECTRICAL CHARACTERISTICS

$T_A$ = 25°C if not otherwise specified

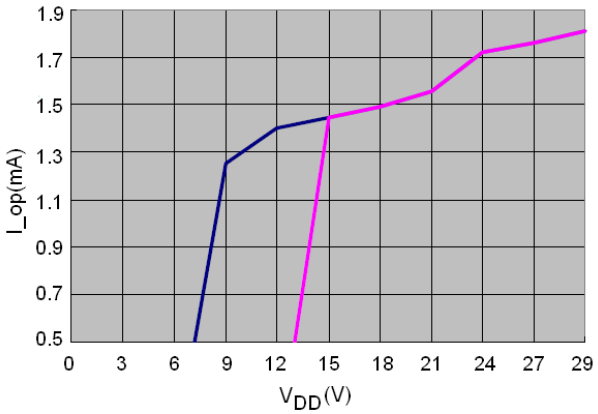
| Parameter | Symbol | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **Supply Voltage ($V_{CC}$)** | | | | | | |
| $V_{DD}$ Start up Current | I_$V_{DD}$_Startup | $V_{DD}$ =12.5V, RI=100K Measure Leakage current into $V_{DD}$ | - | 3 | 20 | uA |
| Operation Current | I_$V_{DD}$_Ops | $V_{DD}$=16V, RI=100Kohm, $V_{FB}$=3V | - | 1.4 | - | mA |
| $V_{DD}$ Under Voltage Lockout Enter | UVLO(ON) | | 7.8 | 8.8 | 9.8 | V |
| $V_{DD}$ Under Voltage Lockout Exit (Recovery) | UVLO(OFF) | | 13 | 14 | 15 | V |
| $V_{DD}$ Zener Clamp Voltage | $V_{DD}$_Clamp | I$V_{DD}$ = 5mA | - | 28 | - | V |
| **Feedback Input Section(FB Pin)** | | | | | | |
| PWM Input Gain | AVCS | $\Delta V_{FB}$ /$\Delta V_{CS}$ | - | 2.0 | - | V/V |
| $V_{FB}$ Open Loop Voltage | $V_{FB}$_Open | | - | 4.8 | - | V |
| FB pin short circuit current | IFB_Short | Short FB pin to GND and measure current | - | 1.2 | - | mA |
| Zero Duty Cycle FB Threshold Voltage | $V_{TH}$ _0D | $V_{DD}$ = 16V, RI=100Kohm | - | - | 0.75 | V |
| Power Limiting FB Threshold Voltage | VTH_PL | | - | 3.7 | - | V |
| Power limiting Debounce Time | TD_PL | | - | 35 | - | mSec |
| Input Impedance | ZFB_IN | | - | 4 | - | Kohm |
| Maximum Duty Cycle | DC_MAX | $V_{DD}$=18V, RI=100Kohm, FB=3V, CS=0 | - | 75 | - | % |

| Parameter | Symbol | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **Current Sense Input(Sense Pin)** | | | | | | |
| Leading edge blanking time | T_blanking | $R_I$ = 100Kohm | - | 300 | - | ns |
| Input Impedance | ZSENSE_IN | | - | 40 | - | Kohm |
| Over Current Detection and Control Delay | $T_D$ _OC | $V_{DD}$ = 16V, CS>VTH_OC, $F_B$=3.3V | - | 75 | - | nSec |
| Over Current Threshold Voltage at zero Duty Cycle | $V_{TH}$ _OC | $F_B$=3.3V, $R_I$=100Kohm | 0.70 | 0.75 | 0.80 | V |
| Soft-start up time | $t_{SS}$ | | - | 2 | - | ms |
| **Oscillator** | | | | | | |
| Normal Oscillation Frequency | $F_{OSC}$ | $R_I$ = 100Kohm | 60 | 65 | 70 | KHz |
| Frequency Temperature Stability | Δf_Temp | $V_{DD}$ = 16V, $R_I$=100Kohm, $T_A$ -20℃ to 100℃ | - | 5 | - | % |
| Frequency Voltage Stability | $\Delta f\_V_{DD}$ | $V_{DD}$ = 12-25V, $R_I$=100Kohm | - | 5 | - | % |
| Operating RI Range | RI_range | | 50 | 100 | 150 | Kohm |
| RI open load voltage | V_RI_open | | - | 2 | - | V |
| Burst Mode Base Frequency | $F_{OSC}$_BM | $V_{DD}$ = 16V, $R_I$ = 100Kohm | - | 22 | - | KHz |
| **Gate Drive Output** | | | | | | |
| Output Low Level | $V_{OL}$ | $V_{DD}$=16V, $I_O$=-20mA | - | - | 0.8 | V |
| Output High Level | $V_{OH}$ | $V_{DD}$=16V, $I_O$=20mA | 10 | - | - | V |
| Output Clamp | V_Clamp | | - | 18 | - | V |
| Output Rising Time | T_r | $V_{DD}$=16V, $C_L$=1nf | - | 220 | - | nSec |
| Output Falling Time | T_f | $V_{DD}$=16V, $C_L$=1nf | - | 70 | - | nSec |
| **Frequency Shuffling** | | | | | | |
| Frequency | Δf_OSC | $R_I$=100K | -3 | - | 3 | % |
| Shuffling Frequency | f_shuffling | $R_I$=100K | - | 64 | - | Hz |

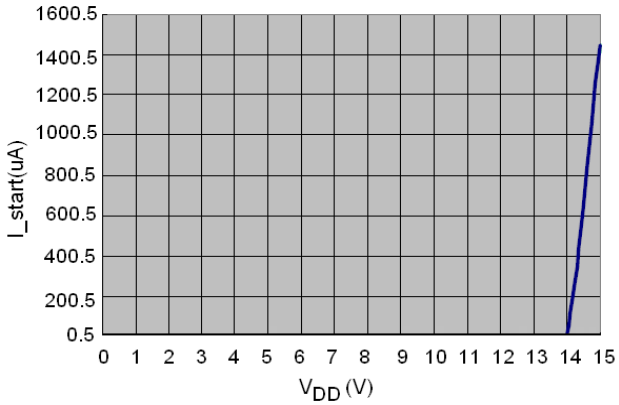
## TYPICAL PERFORMANCE CHARACTERISTICS

$V_{DD}$ = 16V, $R_I$ = 100Kohm, $T_A$ = 25℃ condition applies if not otherwise specified

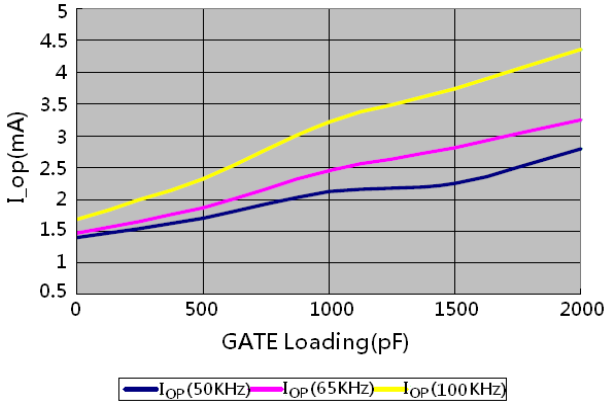
1. $V_{DD}$ UVLO and Operation Current



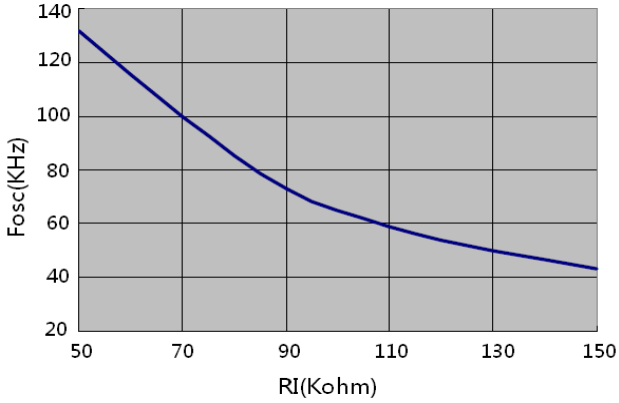

2. I_start vs. $V_{DD}$



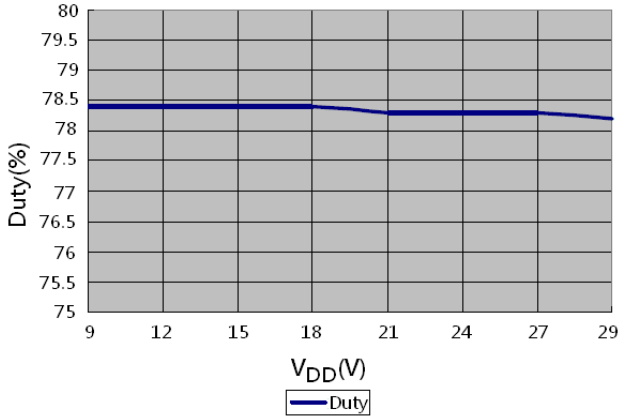

3. I_op vs. GATE Loading



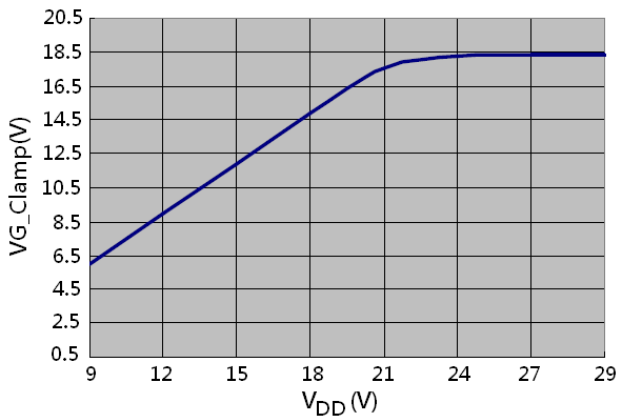

4. Fosc(KHz) vs $R_I$(Kohm)



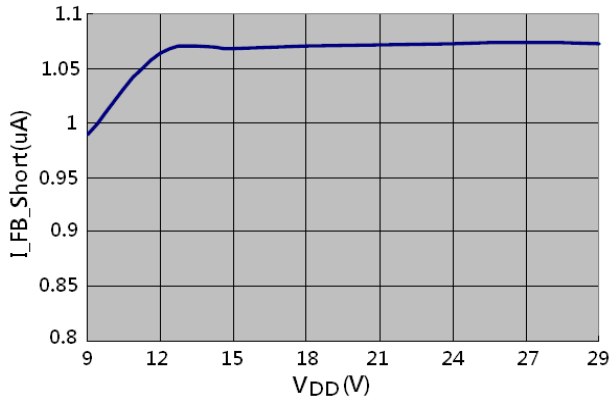

5. Duty vs.$V_{DD}$



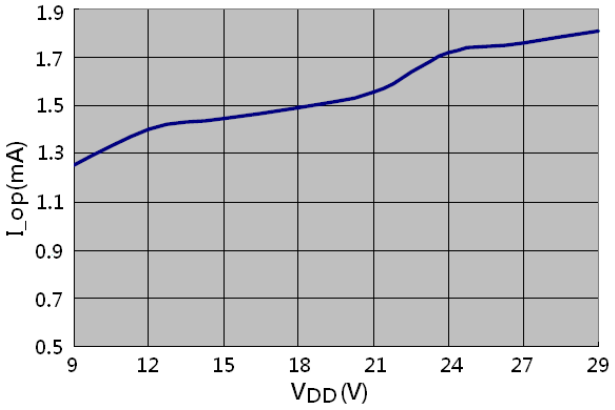

6. VG_Clamp vs. $V_{DD}$



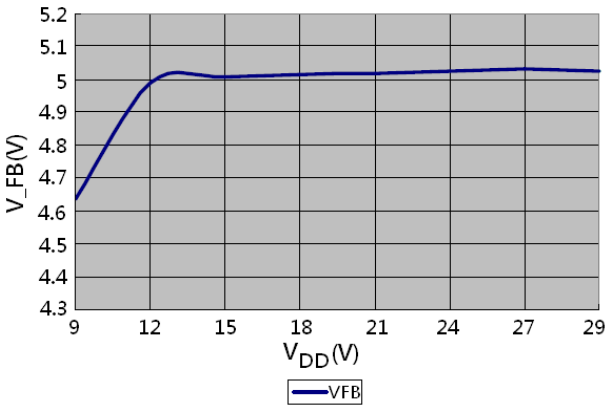
7. I_FB_Short vs.$V_{DD}$



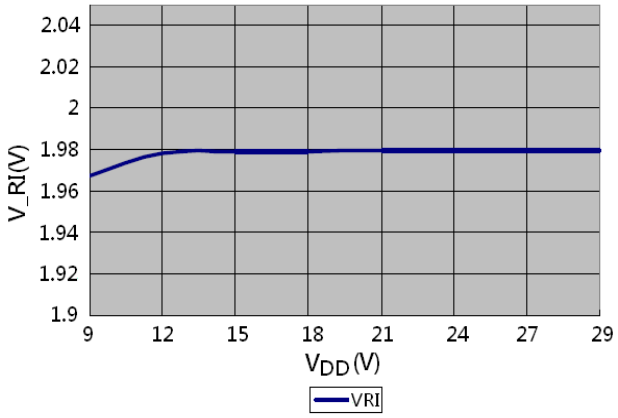

8. I_op vs. $V_{DD}$



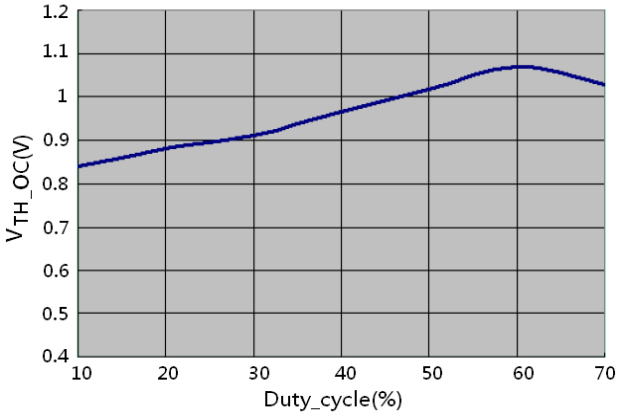

9. V_FB_open vs.$V_{DD}$



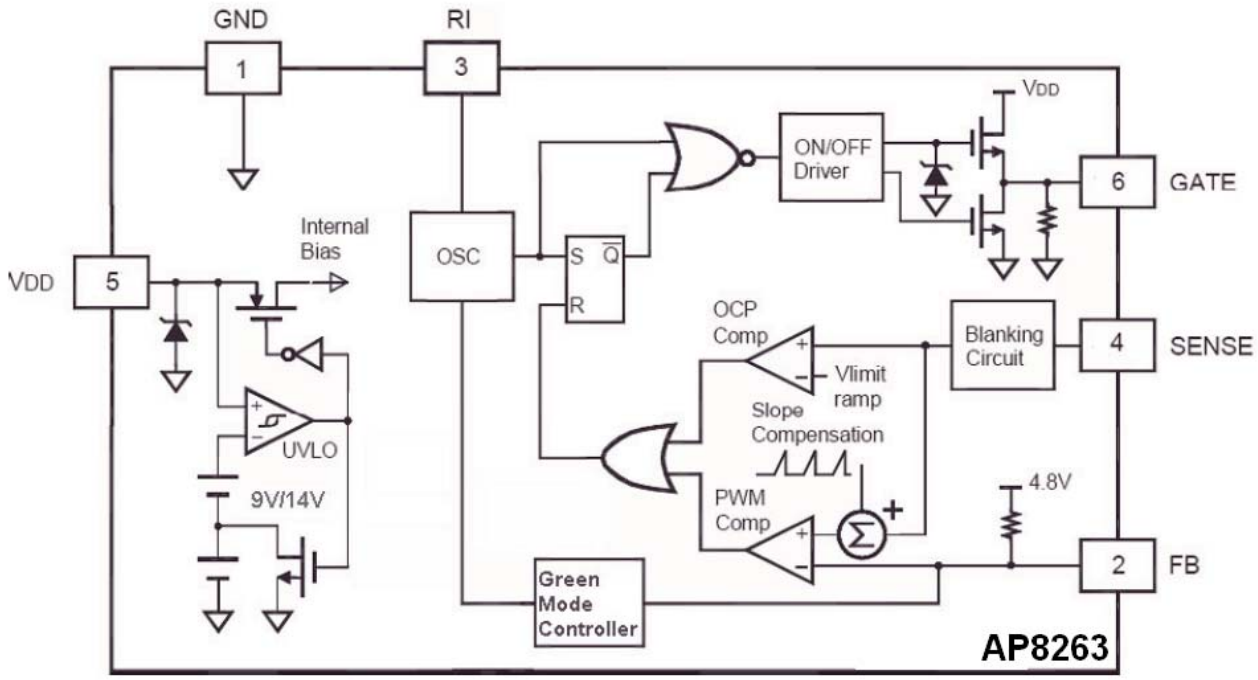

10. V_RI vs.$V_{DD}$




11. $V_{TH\_OC}$(V) vs Duty_cycle(%)



## BLOCK DIAGRAN



## DETAILED INFORMATION

The AP8263 is a highly integrated PWM controller IC optimized for offline flyback converter applications in sub 30W power range. The extended burst mode control greatly reduces the standby power consumption and helps the design easily meet the international power conservation requirements.

### Startup Current and Start up Control

Startup current of AP8263 is designed to be very low so that $V_{DD}$ could be charged up above UVLO threshold level and device starts up quickly. A large value startup resistor can therefore be used to minimize the power loss yet provides reliable startup in application. For AC/DC adaptor with universal input range design, a 2 MΩ, 1/8 W startup resistor could be used together with a $V_{DD}$ capacitor to provide a fast startup and low power dissipation solution.

### Operating Current

The Operating current of AP8263 is low at 1.4mA. Good efficiency is achieved with AP8263 low operating current together with extended burst mode control features.

### Soft-Start up

During the converter start up time, the primary current limitation is progressively increased to the maximum value. In this way the stress on the secondary diode is considerably reduced. it also help to prevent transformer saturation. The soft-start up time lasts 2 ms and the featuer is implemented for every attempt of start up converter.

### Frequency shuffling for EMI improvement

The frequency Shuffling/jittering (switching frequency modulation) is implemented in AP8263. The oscillation frequency is modulated with a random source so that the tone energy is spread out. The spread spectrum minimizes the conduction band EMI and therefore reduces system design challenge.

### Extended Burst Mode Operation

At zero load or light load condition, majority of the power dissipation in a switching mode power supply is from switching loss on the MOSFET transistor, the core loss of the transformer and the loss on the snubber circuit. The magnitude of power loss is in proportion to the number of switching events within a fixed period of time. Reducing switching events leads to the reduction on the power loss and thus conserves the energy.

AP8263 self adjusts the switching mode according to the loading condition. At from no load to light/medium load condition, the FB input drops below burst mode threshold level. Device enters Burst Mode control. The Gate drive output switches only when $V_{DD}$ voltage drops below a preset level and FB input is active to output an on state. Otherwise the gate drive remains at off state to minimize the switching loss and reduces the standby power consumption to the greatest extend. The frequency control also eliminates the audio noise at any loading conditions.

### Oscillator Operation

A resistor connected between RI and GND sets the constant current source to charge/discharge the internal cap and thus the PWM oscillator frequency is determined. The relationship between RI and switching frequency follows the below equation within the specified RI in Kohm range at nominal loading operational condition.

$$F_{osc} = \frac{6500}{RI(Kohm)}(Khz)$$

### Current Sensing and Leading Edge Blanking

Cycle-by-Cycle current limiting is offered in AP8263 current mode PWM control. The switch current is detected by a sense resistor into the sense pin. An internal leading edge blanking circuit chops off the sense voltage spike at initial MOSFET on state due to Snubber diode reverse recovery so that the external RC filtering on sense input is no longer required. The current limit comparator is disabled and thus cannot turn off the external MOSFET during the blanking period. PWM duty cycle is determined by the current sense input voltage and the FB input voltage.

### Internal Synchronized Slope Compensation

Built-in slope compensation circuit adds voltage ramp onto the current sense input voltage for PWM generation. This greatly improves the close loop stability at CCM and prevents the sub-harmonic oscillation and thus reduces the output ripple voltage.

### Gate Drive

AP8263 Gate is connected to an external MOSFET gate for power switch control. Too weak the gate drive strength results in higher conduction and switch loss of MOSFET while too strong gate drive output compromises the EMI. A good tradeoff is achieved through the built-in totem pole gate design with right output strength and dead time control. The low idle loss and good EMI system design is easier to achieve with this

dedicated control scheme. An internal 18V clamp is added for MOSFET gate protection at higher than expected $V_{DD}$ input.

### Protection Controls

Good power supply system reliability is achieved with its rich protection features including Cycle-by- Cycle current limiting (OCP), Over Load Protection (OLP) and over voltage clamp, Under Voltage Lockout on $V_{DD}$ (UVLO).

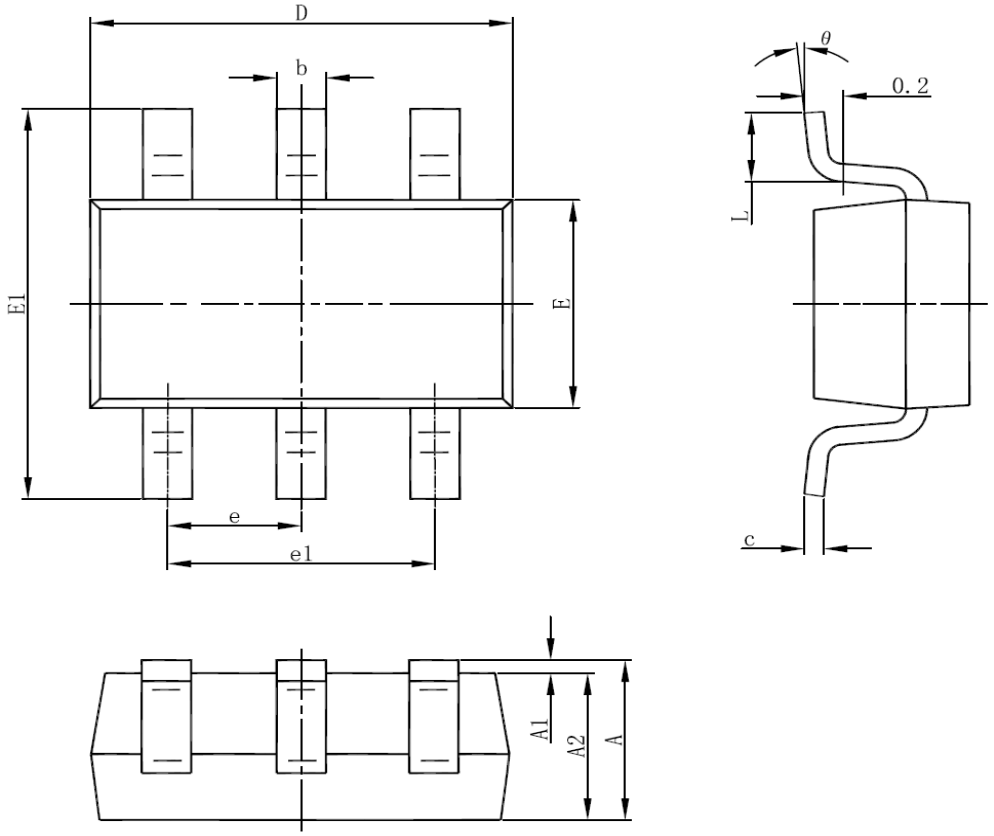
With Proprietary technology, the OCP threshold tracks PWM Duty cycles and is line voltage compensated to achieve constant output power limit over the universal input voltage range with recommended reference design.

At overload condition when FB input voltage exceeds power limit threshold value for more than TD_PL, control circuit reacts to shut down the output power MOSFET. Device restarts when $V_{DD}$ voltage drops below UVLO limit.

$V_{DD}$ is supplied by transformer auxiliary winding output. It is clamped when $V_{DD}$ is higher than threshold value. The power MOSFET is shut down when $V_{DD}$ drops below UVLO limit and device enters power on start-up sequence thereafter.

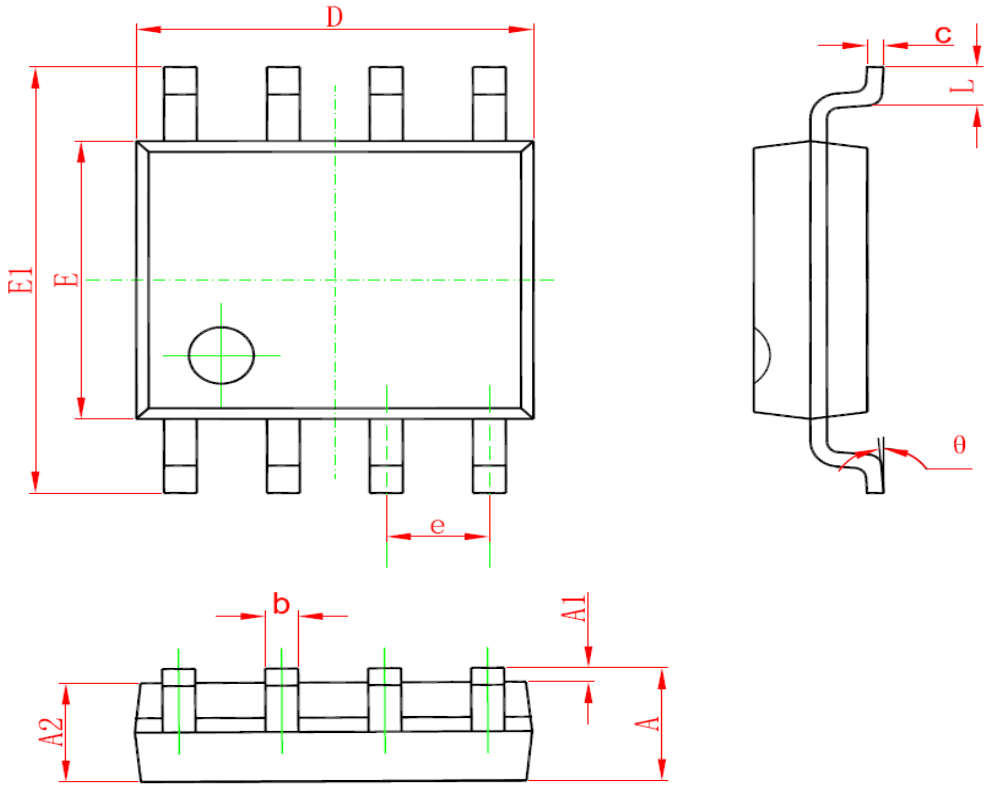
## PACKAGE INFORMATION

Dimension in SOT-26 (Unit: mm)



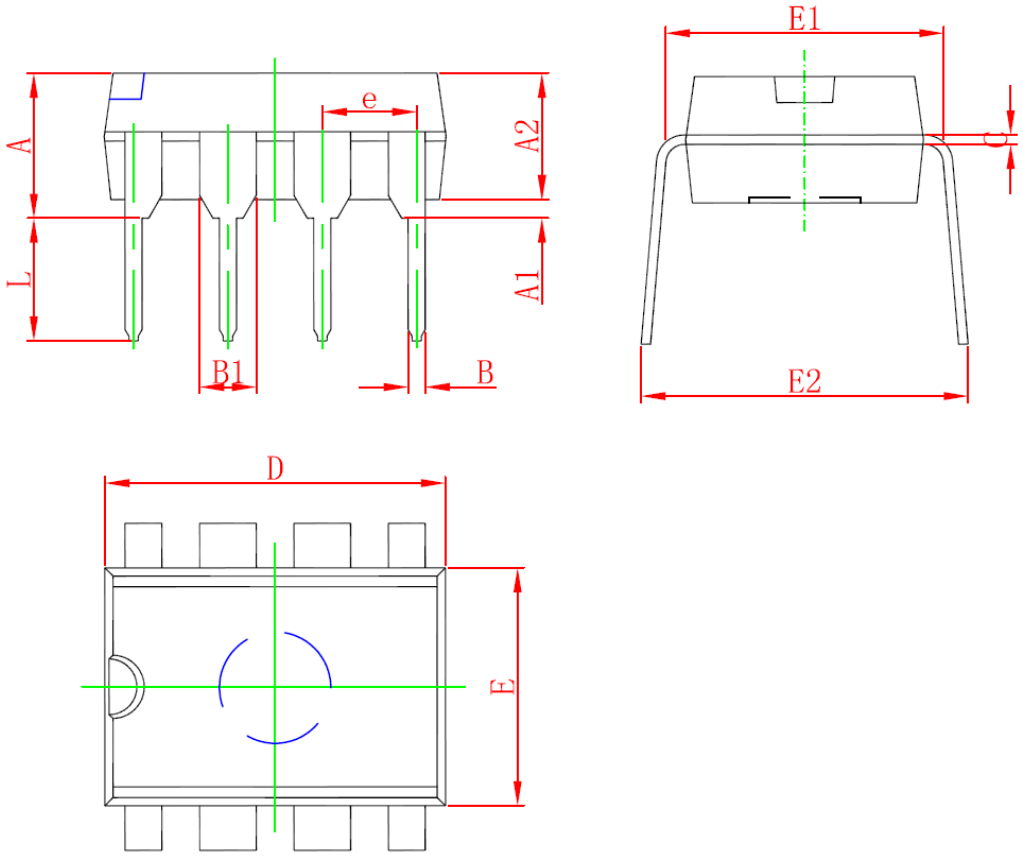

| Symbol | Min | Max |
|---|---|---|
| A | 1.050 | 1.250 |
| A1 | 0.000 | 0.100 |
| A2 | 1.050 | 1.150 |
| b | 0.300 | 0.500 |
| c | 0.100 | 0.200 |
| D | 2.820 | 3.020 |
| E | 1.500 | 1.700 |
| E1 | 2.650 | 2.950 |
| e | 0.950(BSC) | |
| e1 | 1.800 | 2.000 |
| L | 0.300 | 0.600 |
| θ | 0° | 8° |

Dimension in SOP-8 (Unit: mm)




| Symbol | Min | Max |
|---|---|---|
| A | 1.350 | 1.750 |
| A1 | 0.100 | 0.250 |
| A2 | 1.350 | 1.550 |
| b | 0.330 | 0.510 |
| c | 0.170 | 0.250 |
| D | 4.700 | 5.100 |
| E | 3.800 | 4.000 |
| E1 | 5.800 | 6.200 |
| e | 1.270(BSC) | |
| L | 0.400 | 1.270 |
| θ | 0° | 8° |

Dimension in DIP8 (Unit: mm)




| Symbol | Min | Max |
|---|---|---|
| A | 3.710 | 4.310 |
| A1 | 0.510 | - |
| A2 | 3.200 | 3.600 |
| B | 0.380 | 0.570 |
| B1 | 1.524(BSC) | |
| C | 0.204 | 0.360 |
| D | 9.000 | 9.400 |
| E | 6.200 | 6.600 |
| E1 | 7.320 | 7.920 |
| e | 2.540(BSC) | |
| L | 3.000 | 3.600 |
| E2 | 8.400 | 9.000 |

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