

GENERAL DESCRIPTION

OB2278 is a highly integrated current mode PWM control IC optimized for high performance, low standby power and cost effective offline flyback converter applications.

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.

VDD low startup current and low operating current contribute to a reliable power on startup design with OB2278. A large value resistor could thus be used in the startup circuit for reduced power loss.

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

OB2278 offers comprehensive protection coverage including Cycle-by-Cycle current limiting(OCP), VDD Under Voltage Lockout(UVLO), VDD Over Voltage Protection(OVP), VDD Clamp, Gate Clamp, Over Load protection(OLP) and Over Temperature protection (OTP), etc.

Different latch shutdown options are offered on OB2278 in different device version. T version supports both OVP and OTP latch shutdown. L version provides all OVP, OTP and OLP latch shutdown control.

Excellent EMI performance is achieved with soft switching control at the totem pole gate drive output.

OB2278 is offered in SOP-8 and DIP-8 packages.

FEATURES

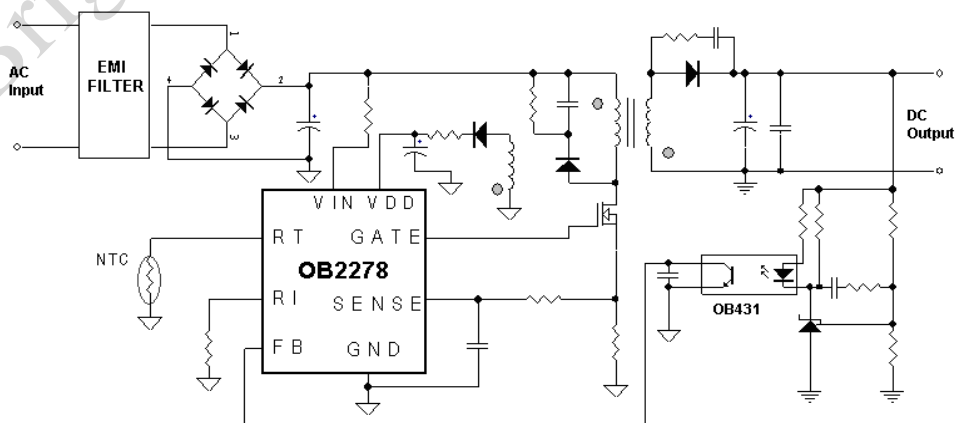
- Power On Soft Start
- Extended Burst Mode Control For Improved Efficiency and Minimum Standby Power Design
- Audio Noise Free Operation
- External Programmable PWM Switching Frequency
- Internal Synchronized Slope Compensation
- Low VIN/VDD Startup Current(3uA) and Low Operating Current (2.3mA)
- Leading Edge Blanking on Current Sense Input
- Complete Protection Coverage with selective protections for Latch Shutdown
 - VDD Over Voltage Protection(OVP) – Latch Shutdown
 - Over Temperature Protection(OTP) – Latch Shutdown
 - Over Load Protection. (OLP) – Auto recovery or Latch Shutdown
 - VDD Under Voltage Lockout with Hysteresis (UVLO)
 - Gate Output Voltage Clamp (16.5V)
 - Built-in OCP Compensation to Achieve Minimum OPP Variation over Universal AC Input Range.

APPLICATIONS

Offline AC/DC flyback converter for

- Adaptor
- Notebook Adaptor
- LCD Monitor/TV/PC/Set-Top Box Power Supplies
- Open-frame SMPS
- Printer Power

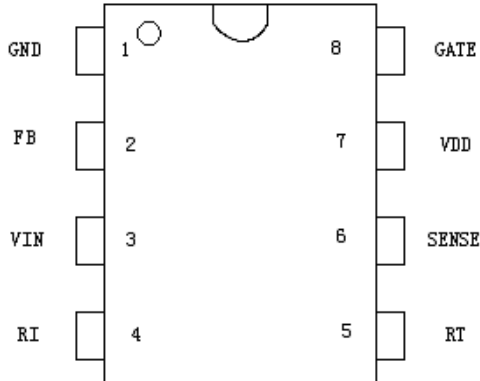
TYPICAL APPLICATION



GENERAL INFORMATION

Pin Configuration

The pin map of OB2278 in DIP8 and SOP8 package is shown as below.



Ordering Information

| Part Number | Description |
|-------------|--|
| OB2278AP-T | DIP8, tube package, T version with OVP/OTP latch |
| OB2278AP-L | DIP8, tube package, L version with OVP/OTP/OLP latch |
| OB2278CP-T | SOP8, tube package, T version with OVP/OTP latch |
| OB2278CPA-T | SOP8, taping package, T version with OVP/OTP latch |
| OB2278CP-L | SOP8, tube package, L version with OVP/OTP/OLP latch |
| OB2278CPA-L | SOP8, taping package, L version with OVP/OTP/OLP latch |

Note: All Devices are offered in Pb-free Package if not otherwise noted.

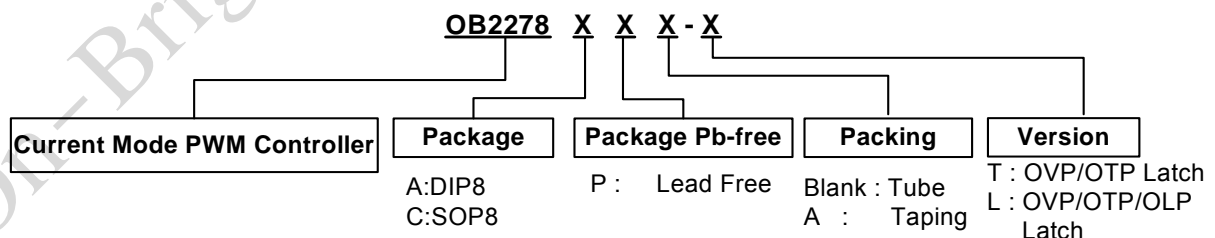
Package Dissipation Rating

| Package | R θ JA (°C/W) |
|---------|----------------------|
| DIP8 | 90 |
| SOP8 | 150 |

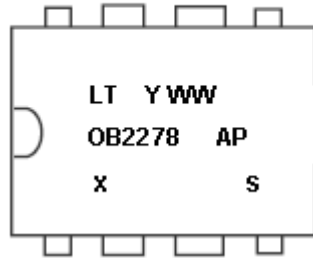
Absolute Maximum Ratings

| Parameter | Value |
|---|-----------------------------|
| VDD Clamp Voltage (V _{clamp}) | 35 V |
| VDD Clamp Continuous Current | 10 mA |
| VIN / VDD Input Voltage | -0.3V to V _{clamp} |
| FB Input Voltage | -0.3 to 7V |
| Sense Input Voltage | -0.3 to 7V |
| RT Input Voltage | -0.3 to 7V |
| RI Input Voltage | -0.3 to 7V |
| Min/Max Operating Junction Temperature T _J | -20 to 150 °C |
| Min/Max Storage Temperature T _{stg} | -55 to 150 °C |
| Lead Temperature (Soldering, 10 seconds) | 260 °C |

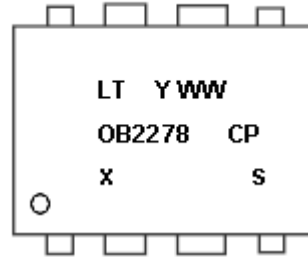
Note: Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute maximum-rated conditions for extended periods may affect device reliability.



Marking Information

DIP8


A: DIP8 Package
 P: Pb-free Package
 Y: Year Code(0-9)
 WW: Week Code(01-52)
 X: Version
 s: Internal Code

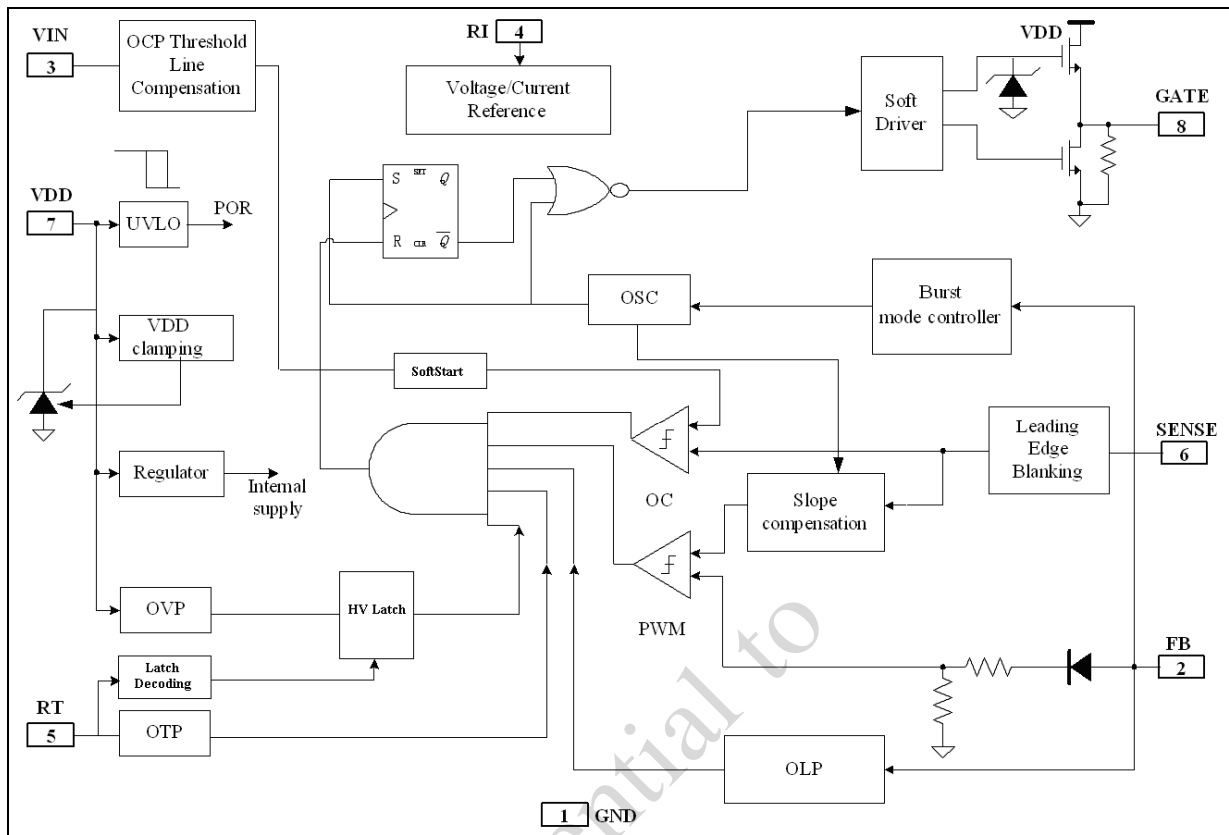
SOP8


C: SOP8 Package
 P: Pb-free Package
 Y: Year Code(0-9)
 WW: Week Code(01-52)
 X: Version
 s: Internal Code

TERMINAL ASSIGNMENTS

| Pin Num | Pin Name | I/O | Description |
|---------|----------|-----|--|
| 1 | GND | P | Ground |
| 2 | FB | I | Feedback input pin. PWM duty cycle is determined by voltage level into this pin and current-sense signal level at Pin 6. |
| 3 | VIN | I | Connected through a large value resistor to rectified line input for startup and line voltage sensing. |
| 4 | RI | I | Internal oscillator frequency setting pin. A resistor connected between RI and GND sets the PWM frequency. |
| 5 | RT | I | Dual function pin. Either connected through a NTC resistor to GND for over temperature shutdown control or used as latch shutdown control input. |
| 6 | SENSE | I | Current sense input pin. Connected to MOSFET current sensing resistor node. |
| 7 | VDD | P | DC power supply pin. |
| 8 | GATE | O | Totem-pole gate drive output for power MOSFET. |

BLOCK DIAGRAM



RECOMMENDED OPERATING CONDITION

| Symbol | Parameter | Min | Max | Unit |
|----------------|-------------------------------|------|-----|------|
| VDD | VDD Supply Voltage | 11.5 | 25 | V |
| T _A | Operating Ambient Temperature | -20 | 85 | °C |

ELECTRICAL CHARACTERISTICS

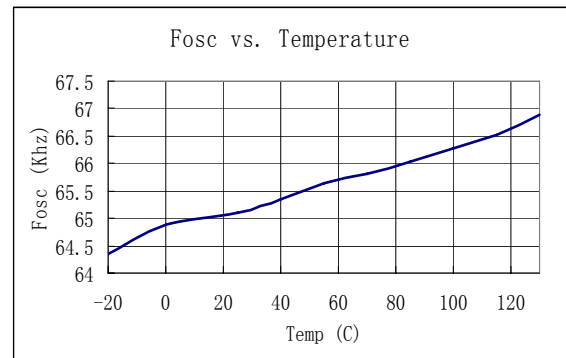
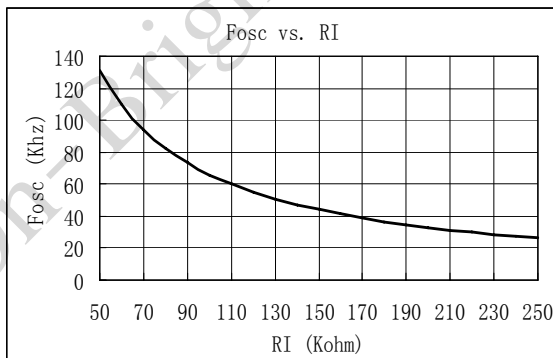
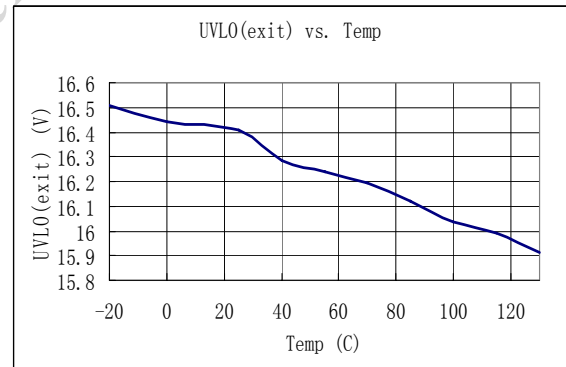
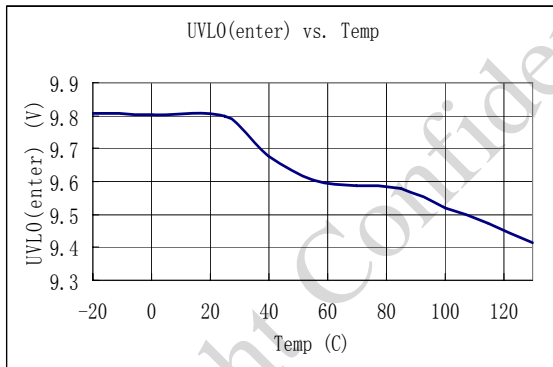
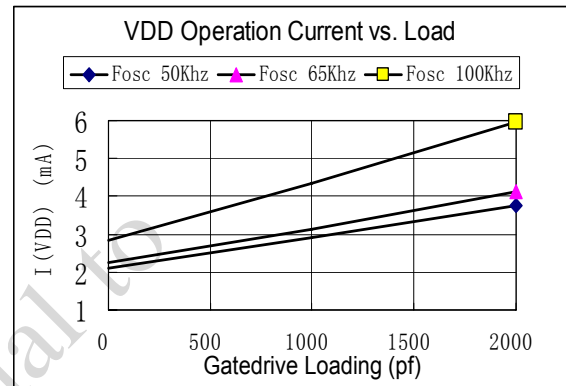
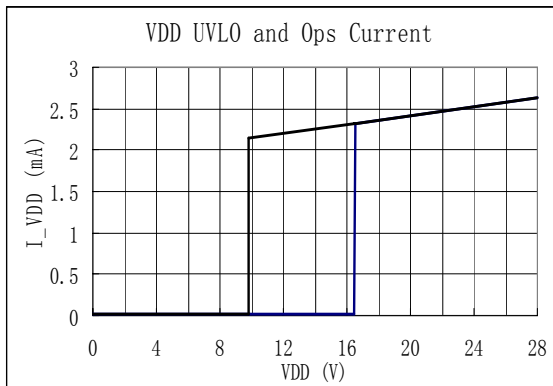
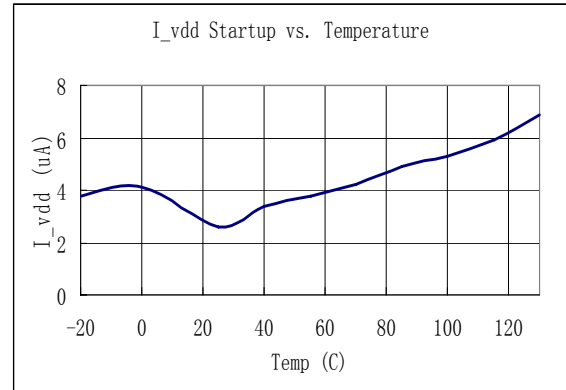
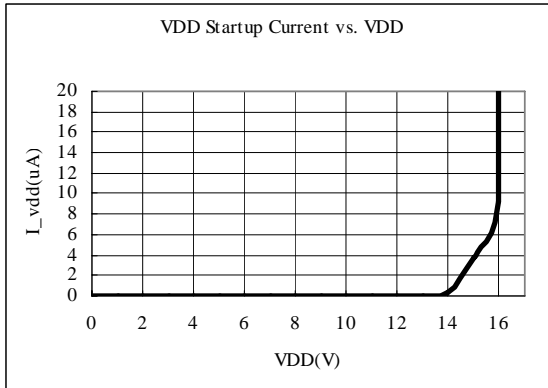
(TA = 25°C, RI=100K ohm, VDD=16V, if not otherwise noted)

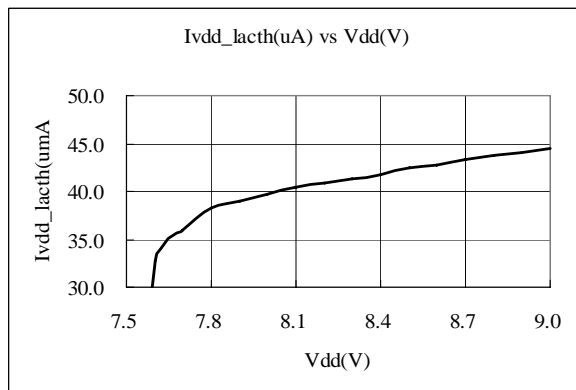
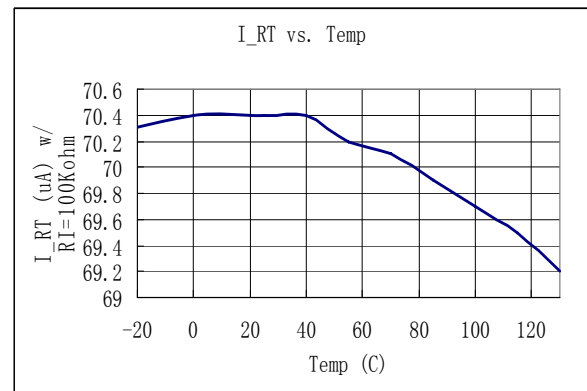
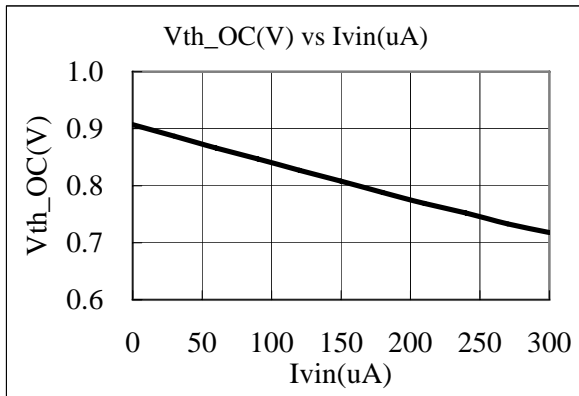
| Symbol | Parameter | Test Conditions | Min | Typ | Max | Unit |
|---------------------------------------|--|--------------------------------------|------|------|------|------|
| Supply Voltage (VDD) | | | | | | |
| I_VDD_Startup | VDD Start up Current | VDD =15V Measure current into VDD | | 3 | 20 | uA |
| I_VDD_Ops | Operation Current | V _{FB} =3V | | 2.3 | | mA |
| UVLO(Enter) | VDD Under Voltage Lockout Enter | | 8.8 | 9.8 | 10.8 | V |
| UVLO(Exit) | VDD Under Voltage Lockout Exit (Startup) | | 15.5 | 16.5 | 17.5 | V |
| OVP(Latch) | VDD Over Voltage Latch Trigger | | 26.5 | 28 | 29.5 | V |
| OVP(De-Latch) | VDD Latch Release Voltage Threshold | | | 7.5 | | V |
| I(Vdd)_latch | VDD bleeding current at latch shutdown when VDD = 9V | | | 45 | | uA |
| T _{D_OVP} | VDD OVP Debounce time | | | 80 | | uSec |
| V _{DD_Clamp} | V _{DD} Zener Clamp Voltage | I(V _{DD}) = 5 mA | | 35 | | V |
| T_Softstart | Soft Start Time | | | 3 | | mSec |
| Feedback Input Section(FB Pin) | | | | | | |
| A _{VCS} | PWM Input Gain | $\Delta V_{FB}/\Delta V_{cs}$ | | 2.8 | | V/V |
| V _{FB_Open} | V _{FB} Open Voltage | | | 6.2 | | V |
| I _{FB_Short} | FB pin short circuit current | Short FB pin to GND, measure current | | 0.75 | | mA |
| V _{TH_0D} | Zero Duty Cycle FB Threshold Voltage | | | | 0.95 | V |
| V _{TH_BM} | Burst Mode FB Threshold Voltage | | | 1.6 | | V |
| V _{TH_PL} | Power Limiting FB Threshold Voltage | | | 4.4 | | V |
| T _{D_PL} | Power limiting Debounce Time | | | 80 | | mSec |
| Z _{FB_IN} | Input Impedance | | | 9.0 | | Kohm |
| Current Sense Input(Sense Pin) | | | | | | |
| T _{blanking} | Sense Input Leading Edge Blanking Time | | | 300 | | nSec |
| Z _{SENSE_IN} | Sense Input Impedance | | | 30 | | Kohm |
| T _{D_OC} | Over Current Detection and Control Delay | CL=1nf at GATE, | | 70 | | nSec |
| V _{TH_OC_0} | Current Limiting Threshold at No Compensation | I(VIN) = 0uA | 0.85 | 0.90 | 0.95 | V |
| V _{TH_OC_1} | Current Limiting Threshold at Compensation | I(VIN) = 150uA | | 0.80 | | V |
| Oscillator | | | | | | |
| F _{osc} | Normal Oscillation Frequency | | 60 | 65 | 70 | KHZ |
| Δf_{Temp} | Frequency Stability Temperature | -20°C to 100 °C | | 3 | | % |
| Δf_{VDD} | Frequency Stability Voltage | VDD = 12-28V, | | 3 | | % |

| | | | | | | |
|------------------------------------|----------------------------|------------|-------|-------|-------|------|
| RI_range | Operating RI Range | | 50 | 100 | 250 | Kohm |
| V_RI_open | RI open voltage | | | 2.0 | | V |
| F_BM | Burst Mode Base Frequency | | | 20 | | KHZ |
| Gate Drive Output | | | | | | |
| VOL | Output Low Level | Io = 20 mA | | | 0.3 | V |
| VOH | Output High Level | Io = 20 mA | 11 | | | V |
| VG_Clamp | Output Clamp Voltage Level | | | 16.5 | | V |
| T_r | Output Rising Time | CL = 1nf | | 120 | | nSec |
| T_f | Output Falling Time | CL = 1nf | | 50 | | nSec |
| Over Temperature Protection | | | | | | |
| I_RT | Output Current of RT pin | | | 70 | | uA |
| V _{TH_OTP} | OTP Threshold Voltage | | 1.015 | 1.065 | 1.115 | V |
| T _{D_OTP} | OTP De-bounce Time | | | 100 | | uSec |
| V_RT_Open | RT Pin Open Voltage | | | 3.7 | | V |

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CHARACTERIZATION PLOTS





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OPERATION DESCRIPTION

OB2278 is a highly integrated PWM controller IC optimized for offline flyback converter applications with requirement in latch shutdown or auto recovery. 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 OB2278 is designed to be very low so that VDD could be charged up above UVLO(exit) threshold level and device starts up quickly. A large value startup resistor can therefore be used to minimize the power loss yet reliable startup in application. For a typical AC/DC adaptor with universal input range design, a 2 M Ω , 1/8 W startup resistor could be used together with a VDD capacitor to provide a fast startup and yet low power dissipation design solution.

● Operating Current

The Operating current of OB2278 is low at 2.3mA. Good efficiency is achieved with OB2278 low operating current together with extended burst mode control schemes.

● Burst Mode Operation

At zero load or light load condition, most of the power dissipation in a switching mode power supply is from switching loss of the MOSFET transistor, the core loss of the transformer and the loss in 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. OB2278 self adjusts the switching mode according to the loading condition. At no load or light load condition, the FB input drops below burst mode threshold level. Device enters Burst Mode control. The Gate drive output switches only when VDD voltage drops below a preset level and FB input is activated to output an on state. Otherwise the gate drive remains at off state to minimize the switching loss thus reduce the standby power consumption to the greatest extent. The nature of high frequency switching also reduces 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 OB2278 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 needed. The current limit comparator is disabled and cannot turn off the external MOSFET during the blanking period. The 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.

● Over Temperature Protection with Latch Shutdown

A NTC resistor in series with a regular resistor should be connected between RT and GND for temperature sensing and protection. NTC resistor value becomes lower when the ambient temperature rises. With the fixed internal current I_{RT} flowing through the resistors, the voltage at RT pin becomes lower at high temperature. The internal OTP circuit is triggered and shutdown the MOSFET when the sensed input voltage is lower than V_{TH_OTP} .

OTP is a latched shutdown.

● RT Pin Used as Latch Shutdown Input Control

RT pin could also be used as a control input to implement system latch shutdown function.

An example is to implement system OVP protection with a latch shutdown function through

a photo coupler and affiliated circuits. When OVP detection signal connected to RT is lower than V_{TH_OTP} , OB2278 controls system into latch shutdown. The recovery of the AC/DC system could only start by resetting internal latch when VDD voltage drops below VDD_De-latch value. This could be achieved by unplugging/re-plugging of AC source in AC start-up configuration.

- **Gate Drive**

OB2278 Gate is connected to the Gate of an external MOSFET 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. Good tradeoff is achieved through the built-in totem pole gate drive 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 16.5V clamp is added for MOSFET gate protection at higher than expected VDD input.

- **Protection Controls**

Good system reliability is achieved with OB2278's rich protection features including Cycle-by-Cycle current limiting (OCP), Over Load Protection (OLP) with auto-recovery(T version) or latch shutdown(L

version), over temperature protection (OTP) with latch shutdown, on-chip VDD over voltage protection (OVP) with latch shutdown and under voltage lockout (UVLO).

The OCP threshold value is self adjusted lower at higher current into VIN pin. This OCP threshold slope adjustment helps to compensate the increased output power limit at higher AC voltage caused by inherent Over-Current sensing and control delay. A constant output power limit is achieved with recommended OCP compensation scheme.

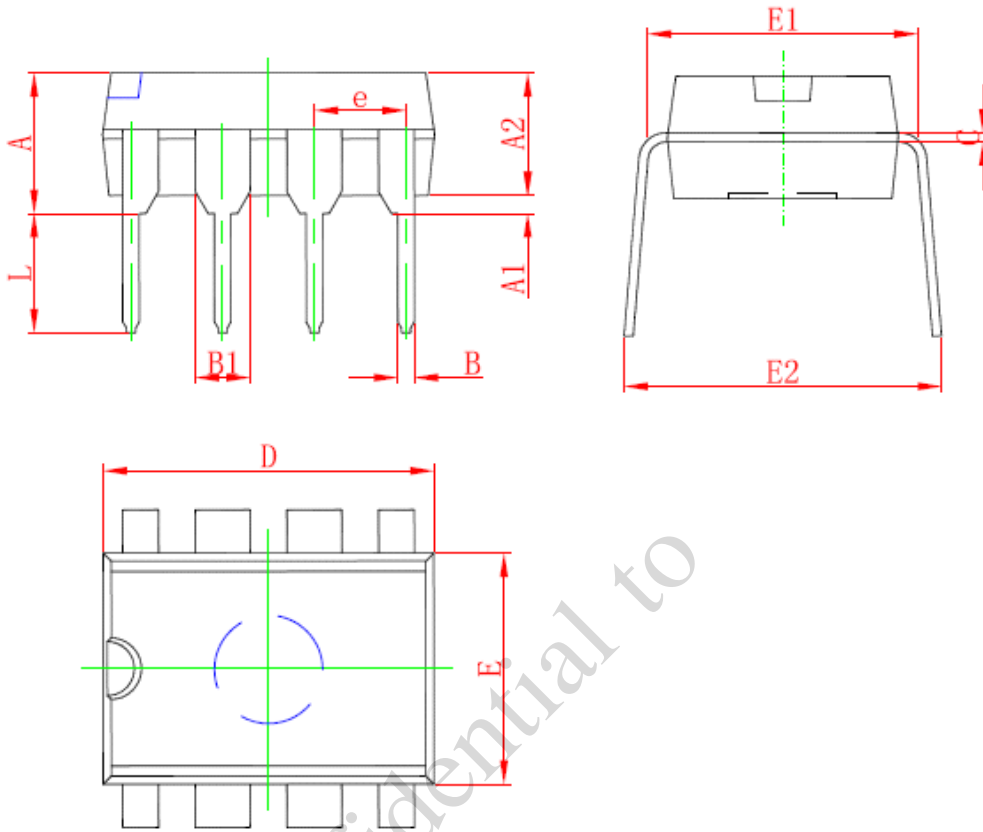
At output overload condition, FB voltage is set higher. When FB input exceeds power limit threshold value for more than 80mS, control circuit reacts to turnoff the power MOSFET. This is so called OLP shutdown. It is either auto-recovery or latched shutdown depending on version of OB2278.

Similarly, control circuit shuts down the power MOSFET when an Over Temperature condition is detected. This shutdown is latched.

VDD is supplied with transformer auxiliary winding output. It is clamped when VDD is higher than 35V. MOSFET is shut down when VDD drops below UVLO(enter) limit and device enters power on start-up sequence thereafter.

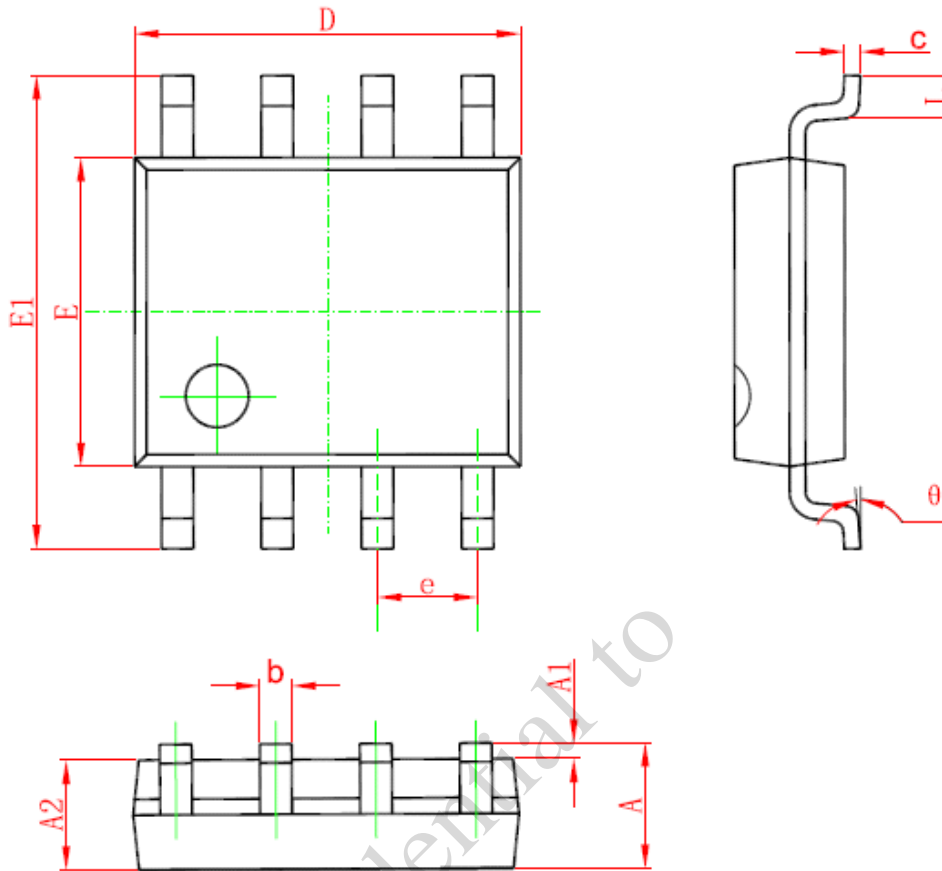
PACKAGE MECHANICAL DATA

8-Pin Plastic DIP



| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|--------|---------------------------|--------|----------------------|-------|
| | Min | Max | Min | Max |
| A | 3.710 | 5.334 | 0.146 | 0.210 |
| A1 | 0.381 | | 0.015 | |
| A2 | 2.921 | 4.953 | 0.115 | 0.195 |
| B | 0.350 | 0.650 | 0.014 | 0.026 |
| B1 | 1.524 (BSC) | | 0.06 (BSC) | |
| C | 0.200 | 0.360 | 0.008 | 0.014 |
| D | 9.000 | 10.160 | 0.354 | 0.400 |
| E | 6.096 | 7.112 | 0.240 | 0.280 |
| E1 | 7.320 | 8.255 | 0.288 | 0.325 |
| e | 2.540 (BSC) | | 0.1 (BSC) | |
| L | 2.921 | 3.810 | 0.115 | 0.150 |
| E2 | 7.620 | 10.920 | 0.300 | 0.430 |

8-Pin Plastic SOP



| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|--------|---------------------------|-------|----------------------|-------|
| | Min | Max | Min | Max |
| A | 1.350 | 1.750 | 0.053 | 0.069 |
| A1 | 0.050 | 0.250 | 0.002 | 0.010 |
| A2 | 1.250 | 1.650 | 0.049 | 0.065 |
| b | 0.310 | 0.510 | 0.012 | 0.020 |
| c | 0.100 | 0.250 | 0.004 | 0.010 |
| D | 4.700 | 5.150 | 0.185 | 0.203 |
| E | 3.800 | 4.000 | 0.150 | 0.157 |
| E1 | 5.800 | 6.200 | 0.228 | 0.244 |
| e | 1.270 (BSC) | | 0.050 (BSC) | |
| L | 0.400 | 1.270 | 0.016 | 0.050 |
| θ | 0° | 8° | 0° | 8° |

IMPORTANT NOTICE

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