

GENERAL DESCRIPTION

PT2202 is a highly integrated current mode PWM controller, providing low standby power and cost effective system solution for the sub 30W 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 enters 'Green Mode' operation to minimize switching loss and low standby power and high efficiency is thus achieved. PT2202 also features low VDD startup current which also contributes to low standby power. The built in LEB on the current sense input removes the signal glitch due to snubber circuit diode reverse recovery and will greatly reduce the external component count and system cost in the design.

Rich protection is implemented in PT2202 including cycle-by-cycle current limiting (OCP), over load protection (OLP), VDD over voltage clamp and under voltage lockout (UVLO). Gate drive output is clamped at 18V to protect the power MOSFET. By limiting the minimum frequency above 22 kHz eliminates the potential audible noise when the system works under light or no load conditions.

Excellent EMI performance is achieved with C.R.PowTech proprietary frequency Jittering technique together with soft driving control at totem pole gate drive output.

The PT2202 is available in SOT23-6, SOP-8 and DIP-8 packages.

FEATURES

- Frequency Jittering for Improved EMI Performance
- Green-Mode PWM for Improved Efficiency and Minimum standby power design
- Low start up current 20uA (Typ. 3uA) and Low operation current 2mA (Typ. 1mA)
- Current mode operation
- Leading-edge blanking on current sense input
- Programmable PWM frequency
- Constant output power limit for universal AC input
- Built-in power limit control (OLP)
- Cycle-by-cycle current limiting (OCP)
- Under voltage lockout (UVLO)
- GATE output maximum voltage clamped at 18V
- Totem pole output includes soft driving for better EMI

APPLICATIONS

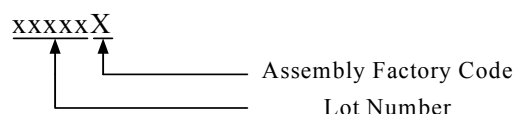
Offline AC/DC flyback converter for

- Power Adapter
- Open-frame SMPS
- Battery Charger Adapter

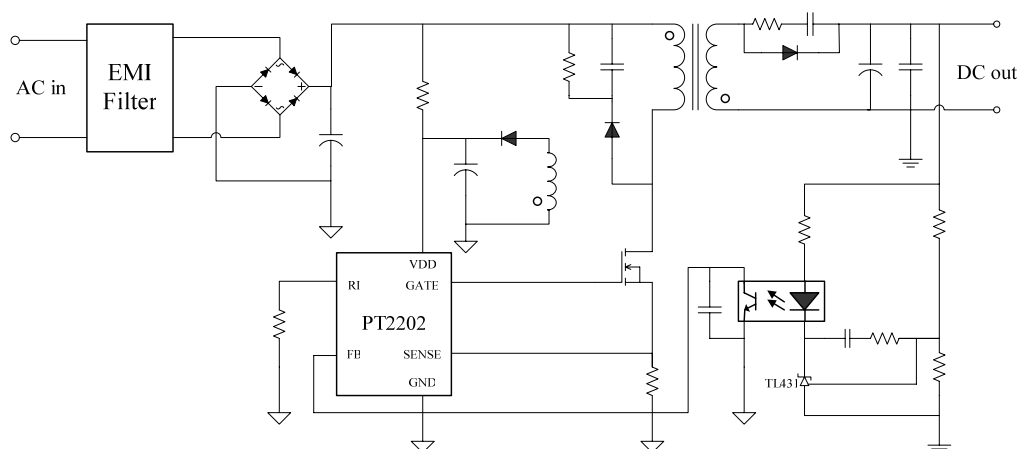
ORDERING INFORMATION

| PACKAGE | TEMPERATURE RANGE | ORDERING PART NUMBER | TRANSPORT MEDIA | MARKING |
|------------------|-------------------|----------------------|-----------------|------------------|
| SOT23-6, Pb free | -40°C to 85°C | PT2202T | Tape and Reel | 2202 |
| DIP8, Pb free | -40°C to 85°C | PT2202D | Tape and Reel | PT2202 xxxxxX |
| SOP8, Pb free | -40°C to 85°C | PT2202S | Tape and Reel | PT2202 xxxxxX |

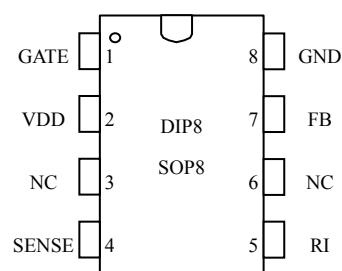
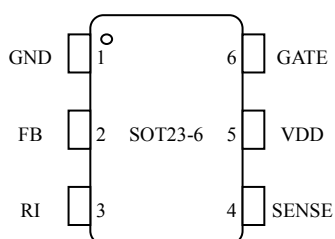
Note:



TYPICAL APPLICATIONS



PIN ASSIGNMENT



PIN DESCRIPTIONS

| NAMES | PIN No. (SOT23-6) | PIN No. (SOP8, DIP8) | DESCRIPTION |
|-------|----------------------|-------------------------|--|
| GND | 1 | 8 | Ground |
| FB | 2 | 7 | Feedback input pin. PWM duty cycle is determined by voltage level into this pin and SENSE pin voltage level. |
| RI | 3 | 5 | Internal Oscillator frequency setting pin. A resistor connected between RI and GND sets the PWM frequency. |
| SENSE | 4 | 4 | Current sense input pin. Connected to MOSFET current sensing resistor node. |
| VDD | 5 | 2 | DC power supply pin. |
| GATE | 6 | 1 | Totem-pole gate drive output for power MOSFET. |
| | | 3, 7 | No Connection |

ABSOLUTE MAXIMUM RATINGS(note1)

| SYM | PARAMETER | VALUE | UNIT |
|------------------------|---|---------|------|
| V _{DD} | V _{DD} DC Supply Voltage | 30 | V |
| V _{Clamp} | V _{DD} Clamp Voltage | 33 | V |
| I _{DD -Clamp} | V _{DD} DC Clamp Current | 10 | mA |
| V _{FB} | V _{FB} PIN Input Voltage | -0.3~7 | V |
| V _{SENSE} | V _{SENSE} Input Voltage | -0.3~7 | V |
| V _{RI} | V _{RI} Input Voltage | -0.3~7 | V |
| T _J | Min/Max Operating Junction Temperature T _J | -20~150 | °C |
| T _{STG} | Storage Temperature Range | -55~160 | °C |
| HBM | ESD Capability, HBM model(note 2) | 2.5 | KV |

PACKAGE DISSIPATION RATING

| SYM | PARAMETER | VALUE | UNIT |
|------------------|-----------|-------|------|
| R _{θJA} | DIP8 | 90 | °C/W |
| | SOP8 | 150 | °C/W |
| | SOT23-6 | 250 | °C/W |

OPERATING RANGE

| SYM | PARAMETER | VALUE | UNIT |
|-----------------|--------------------------------|--------|------|
| V _{DD} | V _{DD} Supply Voltage | 10~30 | V |
| RI | RI Resistor Value | 100 | Kohm |
| T _A | Operating Ambient Temperature | -20~85 | °C |

Note 1: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Recommended Operating Range indicates conditions for which the device is functional, but do not guarantee specific performance limits. Electrical Characteristics state DC and AC electrical specifications under particular test conditions which guarantee specific performance limits. This assumes that the device is within the Operating Range. Specifications are not guaranteed for parameters where no limit is given, however, the typical value is a good indication of device performance.

Note 2: Human body model, 100pF discharged through a 1.5kΩ resistor.

ELECTRICAL CHARACTERISTICS

(T_{OPT}=25°C, Unless Otherwise Noted.)

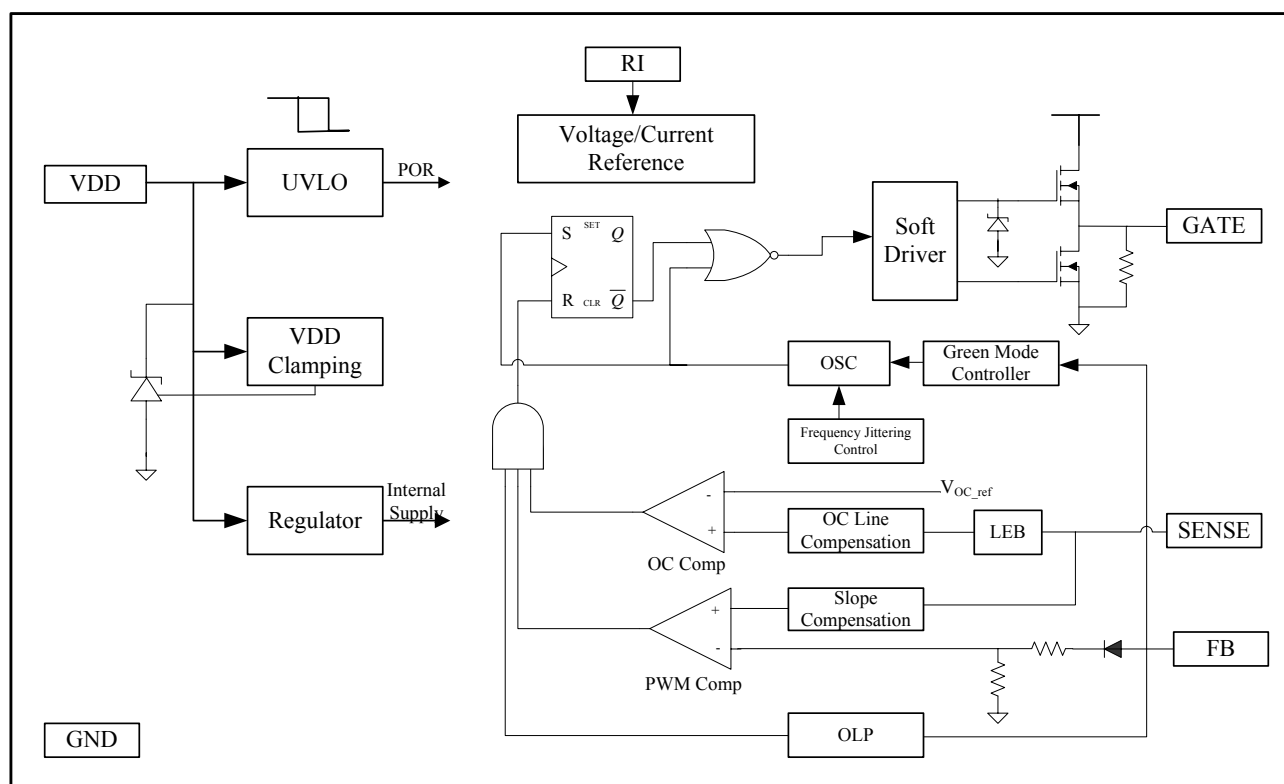
| SYMBOL | PARAMETERS | TEST CONDITIONS | MAX | TYP | MIN | UNIT |
|--|--|--|------|------|------|------|
| Supply Voltage (V_{DD}) | | | | | | |
| I _{VDD_START} | V _{DD} Start up Current | V _{DD} =15V, RI=100Kohm Measure current into V _{DD} | | 3 | 20 | uA |
| I _{VDD_OPER} | V _{DD} Operation Current | V _{DD} =16V, RI=100Kohm V _{FB} =3V, Gate floating | | 1 | | mA |
| UVLO (Enter) | V _{DD} Under Voltage Lockout Enter | | 10 | 11 | 12 | V |
| UVLO (Exit) | V _{DD} Under Voltage Lockout Exit (Startup) | | 15.5 | 16.5 | 17.5 | V |
| V _{DD_Clamp} | V _{DD} Zener Clamp Voltage | I(V _{DD})=10mA | | 33 | | V |

ELECTRICAL CHARACTERISTICS (Continued)

(TOPT=25°C, Unless Otherwise Noted.)

| SYMBOL | PARAMETERS | TEST CONDITIONS | MAX | TYP | MIN | UNIT |
|--|---|---|------|------|------|------|
| Feedback Input Section (FB Pin) | | | | | | |
| A _{VCS} | PWM Input Gain | $\Delta V_{FB}/\Delta V_{CS}$ | | 2.0 | | V/V |
| V _{FB_Open} | V _{FB} Open Voltage | | | 4.8 | | V |
| I _{FB_Short} | FB pin Short Circuit Current | Short FB pin to GND, measure current | | 0.8 | | mA |
| V _{TH_ZD} | Zero Duty Cycle FB Threshold Voltage | V _{DD} =16V, RI=100Kohm | | | 0.60 | V |
| V _{TH_BM} | Burst Mode FB threshold voltage | | | 1.6 | | V |
| V _{TH_PL} | Power Limiting FB Threshold Voltage | | | 3.7 | | V |
| V _{D_PL} | Power Limiting Debounce Time | V _{DD} =16V, RI=100Kohm | | 32 | | ms |
| Z _{FB_IN} | Input Impedance | | | 6.0 | | Kohm |
| DC_MAX | Maximum Duty Cycle | V _{DD} =18V, RI=100Kohm, FB=3V, CS=0V | | 75 | | % |
| Current Sense Input (SENSE Pin) | | | | | | |
| T _{Blanking} | Sense Input Leading Edge Blanking time | RI=100kohm | | 300 | | ns |
| Z _{SENSE_IN} | Sense Input Impedance | | | 40 | | Kohm |
| T _{D_OC} | Over Current Detection and Control Delay | V _{DD} =16V, FB=3.3V, CS> V _{TH_OC} | | 75 | | nS |
| V _{TH_OC} | Current Limiting Threshold Voltage at Zero Duty Cycle | FB=3.3V, RI=100Kohm | 0.75 | 0.80 | 0.85 | V |
| Oscillator | | | | | | |
| F _{osc} | Normal Oscillation Frequency | RI=100Kohm | 60 | 65 | 70 | kHz |
| ΔF_{temp} | Frequency Temperature Stability | V _{DD} =16V, RI=100Kohm -20°C to 100°C | | 5 | | % |
| $\Delta F_{V_{DD}}$ | Frequency Voltage Stability | V _{DD} =12-25V, RI=100Kohm | | 5 | | % |
| RI_range | Operating RI Range | | 50 | 100 | 150 | Kohm |
| F _{BM} | Burst Mode Base Frequency | V _{DD} =16V, RI=100Kohm | | 22 | | kHz |
| Gage Drive Output | | | | | | |
| V _{OL} | Output Low Level | V _{DD} =16V, Io=-20mA | | | 0.8 | V |
| V _{OH} | Output High Level | V _{DD} =16V, Io=20mA | 10 | | | V |
| V _{G_Clamp} | Output Clamp Voltage Level | | | 18 | | V |
| T _r | Output Rising Time | V _{DD} =16V, CL=1nF | | 220 | | nS |
| T _f | Output Falling Time | V _{DD} =16V, CL=1nF | | 70 | | nS |
| Frequency Shuffling | | | | | | |
| ΔF_{OSC} | Frequency Modulation Range/Base Frequency | RI=100Kohm | -3 | | 3 | % |
| F _{Shuffling} | Shuffling Frequency | RI=100Kohm | | 32 | | Hz |

SIMPLIFIED BLOCK DIAGRAM



OPERATION DESCRIPTION

The PT2202 is a highly integrated current mode PWM controller IC optimized for low-power switching mode power supplies. The green mode control plus complete protection greatly helps the design of low power conservation and cost effective power supplier.

1. Startup Current

The typical target start up current of PT2202 is smaller than 5uA so that a high resistance, and low-wattage, start-up resistor can therefore be used. For an AC-DC adaptor with universal input range, a 2M, 0.25W startup resistor could be used together with a VDD capacitor to provide a fast startup and low power dissipation solution.

2. Operating Current

The operating current of PT2202 is low at 1mA. Good efficiency can be achieved with PT2202 low operating current plus green mode control.

3. Frequency Jittering for EMI Improvement

The frequency jittering (switching frequency modulation) is implemented in PT2202. The oscillation

frequency is modulated so that the tone energy is spread out. The spread spectrum minimizes the conduction band EMI and therefore reduces system design challenge.

4. Green 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. PT2202 will automatically decrease switching frequency with light load condition where V_{FB} voltage drops below a predefined level. But minimum operating frequency will not below 20kHz so audible noise therefore be removed. At no load condition, the V_{FB} drops below the preset level typically 0.6v, the Gate drive output will be shunt down, device enters Burst

Operating mode.

5. Programmable Oscillator Frequency

A resistor connected between RI and GND sets the constant current source to charge/discharge the internal cap and thus the PWM oscillator frequency can be programmed by setting the value of this resistor. The nominal operating frequency is determined by following expression with RI in Kohm.

$$F_{osc} = \frac{65000}{RI} (Khz)$$

6. Current Sensing and Leading Edge Blanking

Cycle-by-cycle current limiting is implemented in PT2202. The current flowing through the power switch is detected by an external sense resistor connected to 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. PWM duty cycle is determined by the voltage at the current sense pin and the FB input voltage.

7. 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.

8. Gate Drive

The output driver is a fast totem-pole type driver with non-overlapping driving to the top and bottom FET. The output driver is clamped by an internal 18V zener diode so that power MOSFET transistors can be

protected against undesirable gate over voltage. A soft driving is implemented to help minimizing EMI stemming from rapid voltage change on gate terminal.

9. Overload Protection (OLP) and Under Voltage Lock Out (UVLO)

When the output of power supply is shorted or overloaded, the FB voltage will increase. If the FB voltage is higher than a threshold for a predefined period of time, the PWM output will then be turned off. VDD will then drops due to internal power consumption. When VDD drops below the UVLO turn-off threshold, the PT2202 will be totally shut down. When this happens, the start up sequence will kick in and VDD is charging up again. When VDD is charged to above the UVLO turn-on threshold, PT2202 is turned on again. This protection will take place repeatedly until the over loading condition is removed. This will prevent the power supply from being overheated under over loading condition.

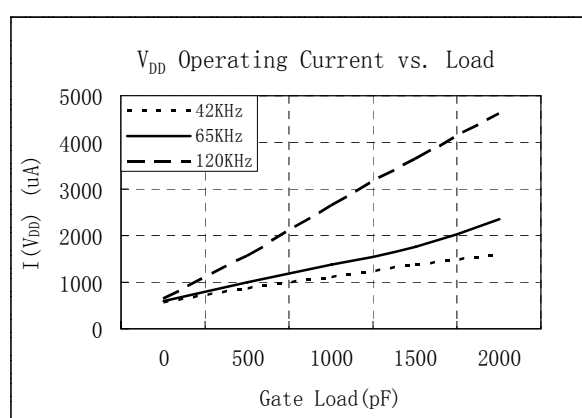
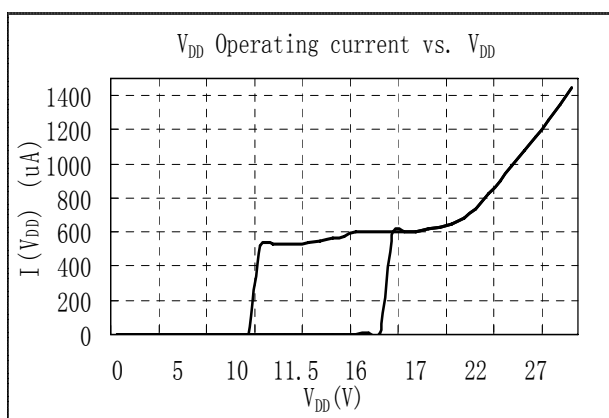
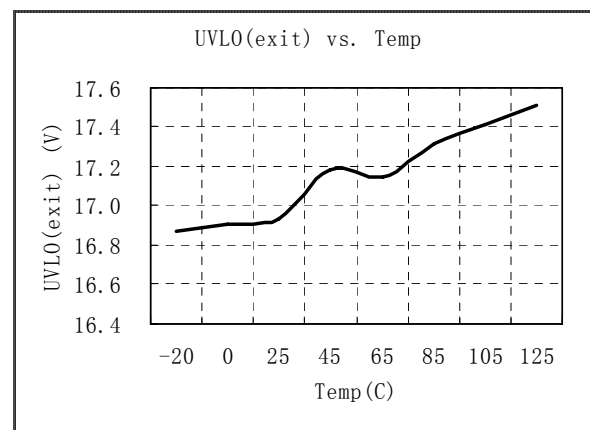
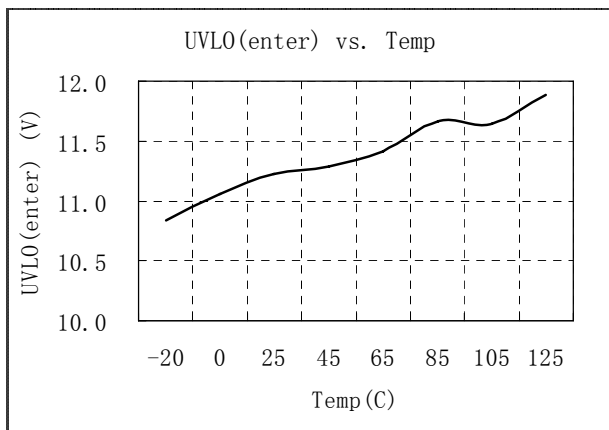
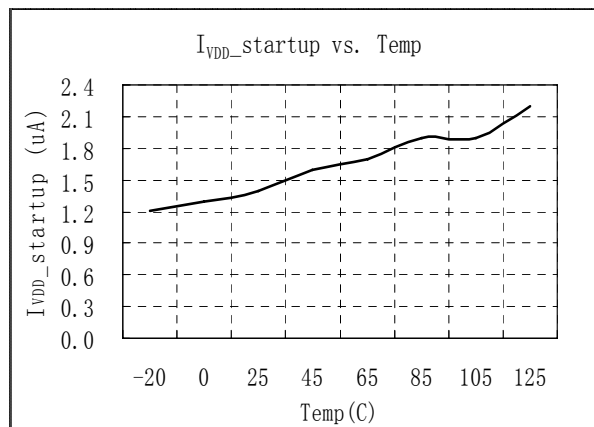
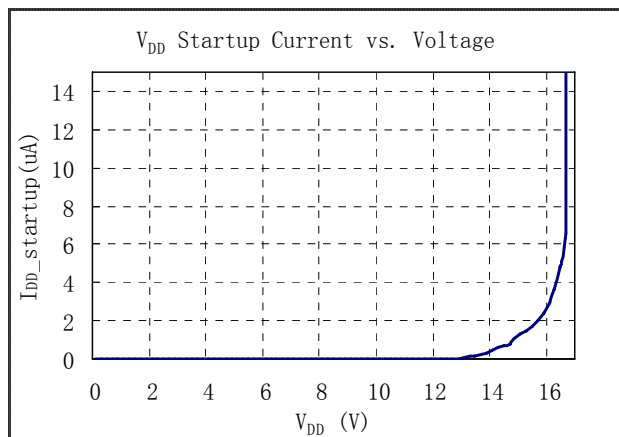
10. Constant Power Limit (CPP)

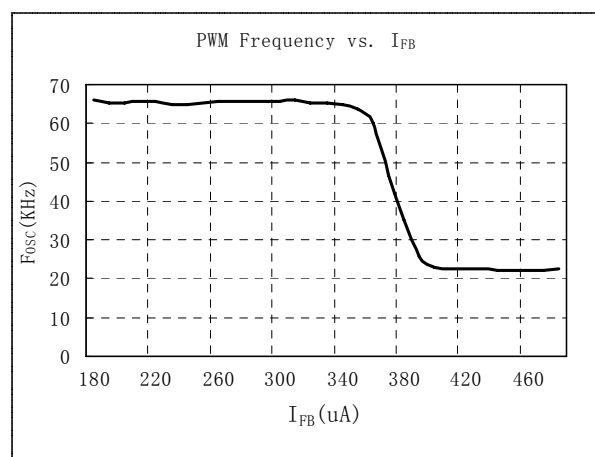
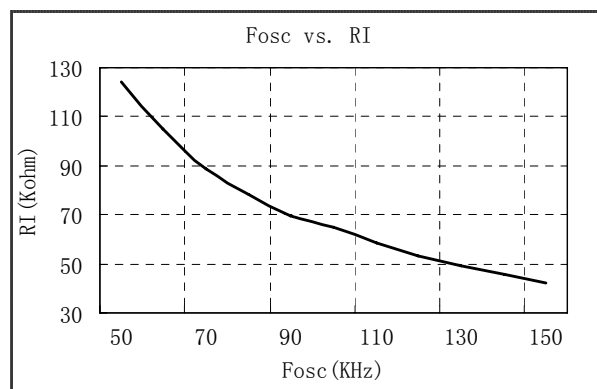
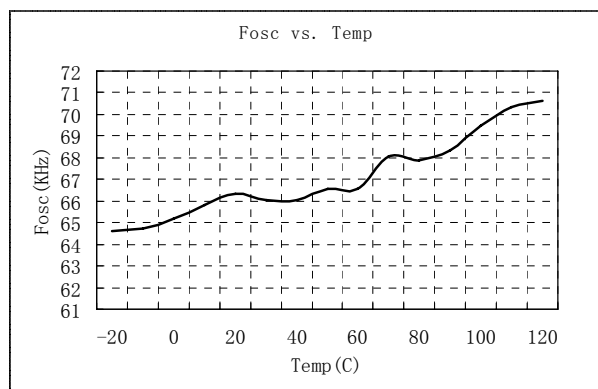
At each duty cycle, when the voltage of SENSE input reaches the OCP threshold level, PT2202 will turn off the Gate drive after a short delay time.

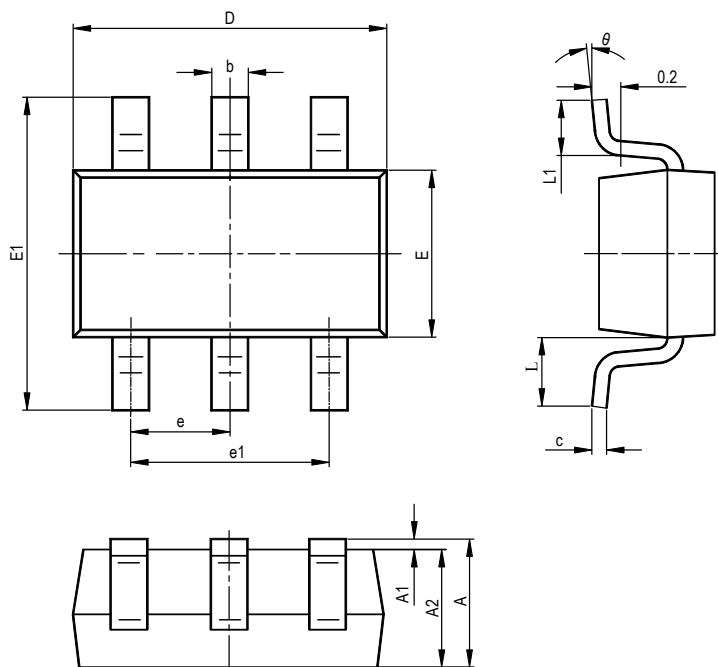
OCP threshold tracks PWM duty cycles and is line voltage compensated to achieve constant output power limit over the universal input voltage range of 90VAC to 264VAC with recommended reference design.

TYPICAL PERFORMANCE CHARACTERISTICS

$V_{DD}=16V$, $R_I=100K\Omega$, $T_A=25^{\circ}C$ if not otherwise noted



TYPICAL PERFORMANCE CHARACTERISTICS


PACKAGE INFORMATION
SOT23-6


| SYMBOL | MILLIMETERS | | INCHES | |
|--------|-------------|-------|----------|-------|
| | MIN | MAX | MIN | MAX |
| A | 1.050 | 1.250 | 0.041 | 0.049 |
| A1 | 0.000 | 0.100 | 0.000 | 0.004 |
| A2 | 1.050 | 1.150 | 0.041 | 0.045 |
| b | 0.300 | 0.400 | 0.012 | 0.016 |
| c | 0.100 | 0.200 | 0.004 | 0.008 |
| D | 2.820 | 3.020 | 0.111 | 0.119 |
| E | 1.500 | 1.700 | 0.059 | 0.067 |
| E1 | 2.650 | 2.950 | 0.104 | 0.116 |
| e | 0.950TYP | | 0.037TYP | |
| e1 | 1.800 | 2.000 | 0.071 | 0.079 |
| L | 0.700REF | | 0.028REF | |
| L1 | 0.300 | 0.600 | 0.012 | 0.024 |
| θ | 0° | 8° | 0° | 8° |