# PT4238E/PT4240E

## Non-isolated Buck LED driver with APFC

## GENERAL DESCRIPTION

The PT4238E/PT4240E is a high precision non-isolated and constant current buck type driver with active PFC, targeted at high brightness LED lighting applications.

The PT4238E/PT4240E integrates a high voltage power supply circuit, so it achieves fast start up, and the system reduces count of component.

The PT4238E/PT4240E works in quasi-resonant mode for low EMI, and low heat emission by reducing power MOSFET switching losses. Besides, excellent line, load and temperature regulation is achieved without external compensation.

The PT4238E/PT4240E includes LED string open/short circuit protection and over temperature regulation. Built-in soft start greatly reduces the inrush current during startup.

The PT4238E/PT4240E is available in a SOP-7 package.

## FEATURES

- High voltage power supply circuit
- Integrated High voltage Power MOSFET
- Constant Current Consistency (+/-3%)
- Tight Line/Load/Temperature Regulation without External Compensation
- High PFC (>0.9)
- High Efficiency (up to 95%)
- Quasi-Resonant Mode Operation
- Built-In Soft Start
- Cycle by Cycle Current Limit
- LED String Open/Short Circuit Protection
- Over Temperature Protection

## APPLICATIONS

- Retrofit Bulb/Tube/Par LED Lamps
- Downlight, Recess, Panel LED Lighting

## ORDERING INFORMATION

| PACKAGE | ORDERING PART NUMBER | TRANSPORT MEDIA | MARKING |
|---|---|---|---|
| SOP-7 | PT4238EESOG-AY | 4000/Tape and Reel | PT4238E<br>AY<br>xxxxxX |
| SOP-7 | PT4240EESOG-C | 4000/Tape and Reel | PT4240E<br>C<br>xxxxxX |

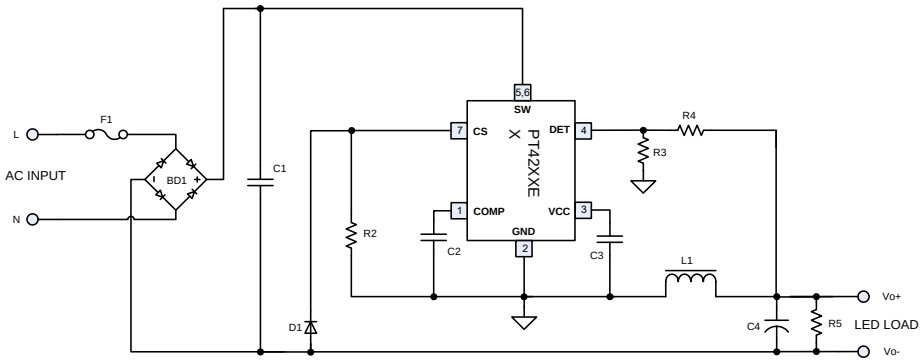
**Note:**

xxxxxX

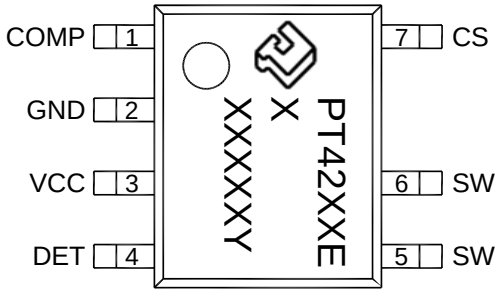
Assembly Factory Code

Lot Number

## TYPICAL APPLICATION CIRCUIT



## PIN ASSIGNMENT




SOP-7

## PIN DESCRIPTIONS

| PIN No. SOP-7 | PIN NAMES | DESCRIPTION |
|---|---|---|
| 1 | COMP | Compensation pin for constant current control loop. |
| 2 | GND | Ground. |
| 3 | VCC | Power supply pin for all internal circuit. |
| 4 | DET | Voltage sense pin to detect zero current of the inductor, and the voltage of the LED string. |
| 5,6 | SW | High voltage startup and Power MOSFET Drain side. |
| 7 | CS | Current sense Pin. |

## ABSOLUTE MAXIMUM RATINGS (note1)

| SYMBOL | PARAMETER | VALUE | UNIT |
|---|---|---|---|
| $V_{SW}$ | SW Pin Voltage Range(PT4238EAY) | -0.3~500 | V |
| | SW Pin Voltage Range(PT4240EC) | -0.3~650 | V |
| $I_{VCC\_MAX}$ | Maximum VCC Clamp Current | 10 | mA |
| $V_{I/O}$ | Other I/O PIN Input Voltage | -0.3~5 | V |
| $T_J$ | Junction Temperature Range | -40~150 | ℃ |
| $T_{STG}$ | Storage Temperature Range | -55~150 | ℃ |
| $\Theta_{JA}$ | SOP-7 | 145 | ℃/W |
| HBM | ESD Capability, HBM(note2) | 2 | kV |

**Note 1:** Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. 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.

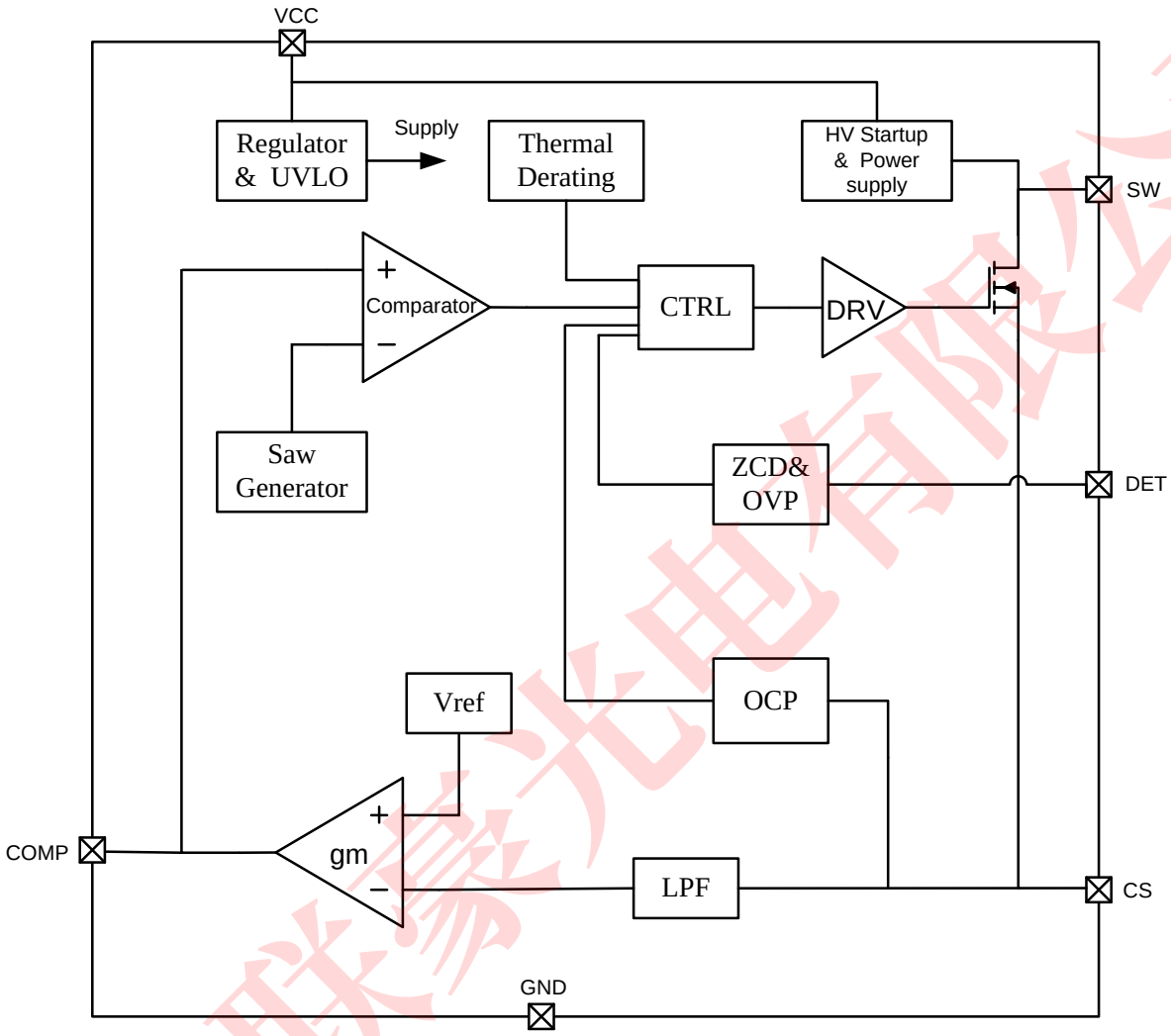
## ELECTRICAL CHARACTERISTICS

($T_A$=25℃, VCC=10V，unless specified otherwise)

| SYMBOL | PARAMETER | TEST CONDITION | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| **Supply Voltage & Current (VCC)** | | | | | | |
| $V_{VCC\_OP}$ | VCC Operating Voltage | VCC Rising | | 10.0 | | V |
| $V_{VCC\_OFF}$ | VCC Minimum Operating Voltage | VCC Falling | | 7.0 | | V |
| $V_{VCC\_CLAMP}$ | VCC Clamp Voltage | | | 12 | | V |
| $I_{VCC\_OPER}$ | VCC Supply Current | $F_{GATE\_AVG}$=5.7KHz | | 150 | | μA |
| **Error Amplifier** | | | | | | |
| $V_{REF}$ | Constant Current Control Reference Voltage | | 0.194 | 0.2 | 0.206 | V |
| $V_{COMP\_RANG}$ | COMP Operation Range | | 0.8 | | 3.0 | V |
| **Current Sense** | | | | | | |
| $T_{LEB}$ | Leading Edge Blanking Time | | | 300 | | ns |
| $V_{CS\_CLAMP}$ | Current Sense Clamp Voltage | | 1.35 | 1.5 | 1.65 | V |
| **DET Pin Sense** | | | | | | |
| $V_{ZCD}$ | Zero Current Detect Threshold Voltage | Falling edge | | 0 | | V |
| $V_{ZCD\_H}$ | Zero Current Detect Hysteretic Voltage | | | 0.2 | | V |
| $V_{DET\_OVP}$ | DET Over-Voltage Threshold | | 1.8 | 2.0 | 2.2 | V |
| $T_{ON\_MAX}$ | Maximum On Time | | | 25 | | μS |
| $T_{OFF\_MIN}$ | Minimum Off Time | | | 1.5 | | μS |
| $T_{OFF\_MAX}$ | Maximum Off Time | | | 175 | | μS |
| $F_{SW\_MAX}$ | Maximum Operation Switching Frequency | | 95 | 120 | 145 | KHz |
| **Power MOSFET** | | | | | | |
| $R_{DSON}$ | Drain-to-Source On-Resistance | PT4238EAY | | 5.0 | | Ω |
| | | PT4240EC | | 2.0 | | Ω |
| $BV_{DS}$ | Drain-to-Source | PT4238EAY | 500 | | | V |

| SYMBOL | PARAMETER | TEST CONDITION | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| | Breakdown Voltage ($I_D$=250uA) | PT4240EC | 650 | | | V |
| **HV JFET** | | | | | | |
| $I_{JFET}$ | JFET current | DRAIN of JFET to GND 20V | | 10 | | mA |
| $I_{DSS}$ | JFET shutdown leakage current | | | 40 | | uA |
| **Thermal Protection** | | | | | | |
| $T_{REG}$ | Thermal Regulation Temperature | | | 155 | | ℃ |

## SIMPLIFIED BLOCK DIAGRAM




## FUNCTIONAL DESCRIPTION

The PT4238E/PT4240E is a universal AC input buck, constant current driver with active PFC targeted at high brightness LED lighting applications.

**Start-up**

The PT4238E/PT4240E integrates a high voltage power supply circuit, so the VCC pin voltage gets charged quickly by the SW pin. Once the VCC pin voltage exceeds the threshold of $V_{VCC\_OP}$, the driver starts to deliver driving pulses to power MOSFET.

Since the ultra-narrow bandwidth of PFC control loop, it suffers from a long turn-on time and large output overshoot. PT4238E/PT4240E uses a dynamic loop bandwidth technique to achieve overshoot-free. The control loop regulates to its steady-state with fast speed.

**Output Current Setting and line regulation compensation**

Output current can be set by the following equation.

$$I_{OUT} = \frac{V_{ref}}{R_{CS}}$$

Where,

Vref:Internal reference voltage, fixed at 200mV.

$R_{CS}$:The current sensing resistor.

**Valley Turn-on Mode**

PT4238E/PT4240E works in quasi-resonant mode to reduce the power MOSFET switching loss. After inductor current falls to zero, LC(inductor L1 and Cds of power MOSFET) resonant occurs at the drain of power MOSFET. Power MOSFET will switch on at the first bottom point of the drain side of the power MOSFET.

**Cycle-by-cycle Current Limit**

The current limit circuit senses the current in the power MOSFET via CS pin. When CS pin voltage exceeds the internal threshold $V_{CS\_CLAMP}$, the power MOSFET turns off for the rest of that cycle.

**Output Open Circuit Protection**

Output open protection circuitry will shut down the IC when the feedback pin DET voltage is above 2V for 3 consecutive switching cycles. In this condition, the driver enters hiccup mode operation. The hiccup behavior will continue until the output open circuit condition is removed.

The ratio of DET upper resistor to lower resistor can be set by the following equation.

$$\frac{R_{DET\_L}}{R_{DET\_L} + R_{DET\_H}} = \frac{2.0}{V_{OVP}}$$

Where,

$R_{DET\_L}$:The lower resistor of the feedback network

$R_{DET\_H}$:The upper resistor of the feedback network

$V_{OVP}$:Output over voltage setting point.

**Output Short Circuit Protection**

During the output short circuit period, the power MOSFET will switch at frequency of about 5.7 kHz to reduce short-circuit state power dissipation.

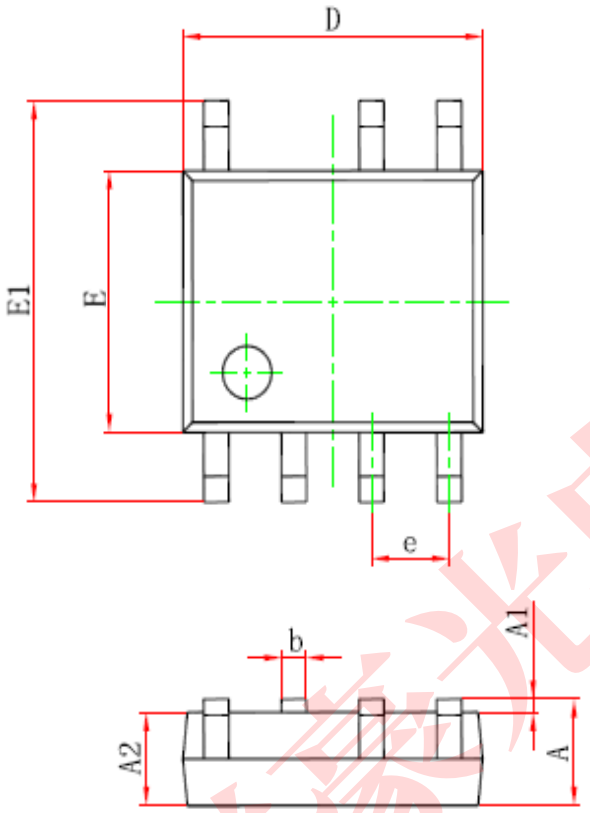
**Over Temperature Protection**

The thermal shutdown circuitry senses the junction temperature of the die. If the junction temperature exceeds $T_{REG}$, the device will reduce output current to avoid system cause to damage.

## PACKAGE INFORMATION

**SOP-7**

### SOP7 PACKAGE OUTLINE DIMENSIONS




| Symbol | Millimeters | | Inches | |
|---|---|---|---|---|
| | Min | Max | Min | Max |
| A | 1.350 | 1.750 | 0.053 | 0.069 |
| A1 | 0.100 | 0.250 | 0.004 | 0.010 |
| A2 | 1.250 | 1.650 | 0.049 | 0.065 |
| b | 0.330 | 0.510 | 0.013 | 0.020 |
| c | 0.170 | 0.250 | 0.007 | 0.010 |
| D | 4.700 | 5.100 | 0.185 | 0.201 |
| 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° |

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