# Offline Inductor-less AC Linear Regulator

喬懌電子科技股份有限公司
*Chau Yi In Circuit Design Technology Co., Ltd*

**CY4230**

## General Description

CY4230 is a compact, inductor-less, offline linear regulator. It steps down the AC line voltage to 3.3V/ 5V. It is a simple solution to provide a bias voltage in offline applications. CY4230 integrates a 500V power MOSFET, startup controller, voltage control circuit, AC synchronous circuit, low dropout regulator, etc. CY4230 also integrates smart control system uses AC line power when necessary, thus minimizing device losses to achieve good efficiency. CY4230 can help system designs meeting new standby power specifications. CY4230 integrates functions and protections of Under Voltage Lockout (UVLO), VDD over Voltage Protection (VDD OVP), On Chip Thermal Shutdown (OTP), etc.
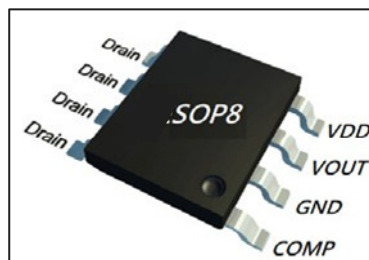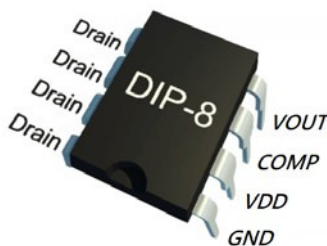
## Features

◆High Output Voltage Accuracy: 3%
◆Fixed Output: 3.3V/5V
◆Smart Control to Maximize Efficiency
◆Universal Input Range: 80~305VAC
◆No Inductor Required
◆No Bulk Capacitor Required
◆Less Components and Low Cost
◆Fast Line and Load Transient Response
◆Short Load Protection
◆On Chip Thermal Shutdown (OTP)
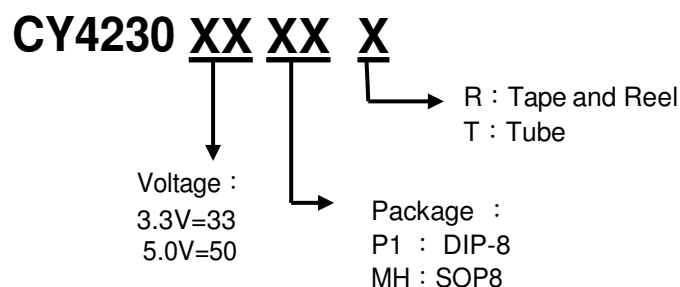◆Provide Power Good Signal
◆Available with DIP8、SOP8 Package

## Applications

◆Non Isolation AC/DC Converter
◆Home Appliance
◆Wall Switches and Dimmers

## Pin Configuration



## Ordering / Marking Information

CY4230 XX XX X

Voltage：
3.3V=33
5.0V=50

Package ：
P1 ： DIP-8
MH ： SOP8

R：Tape and Reel
T：Tube

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| Ordering Number | Marking | Package | Marking Information |
|---|---|---|---|
| CY4230XXMHR | EC4230 LLLLL YYWW | SOP8 | LLLL：Lot No YYWW：Date Code |
| CY4230XXP1T | EC4230P LLLLL YYWW | DIP-8 | P：DIP LLLL：Lot No YYWW：Date Code |

## Pin Description
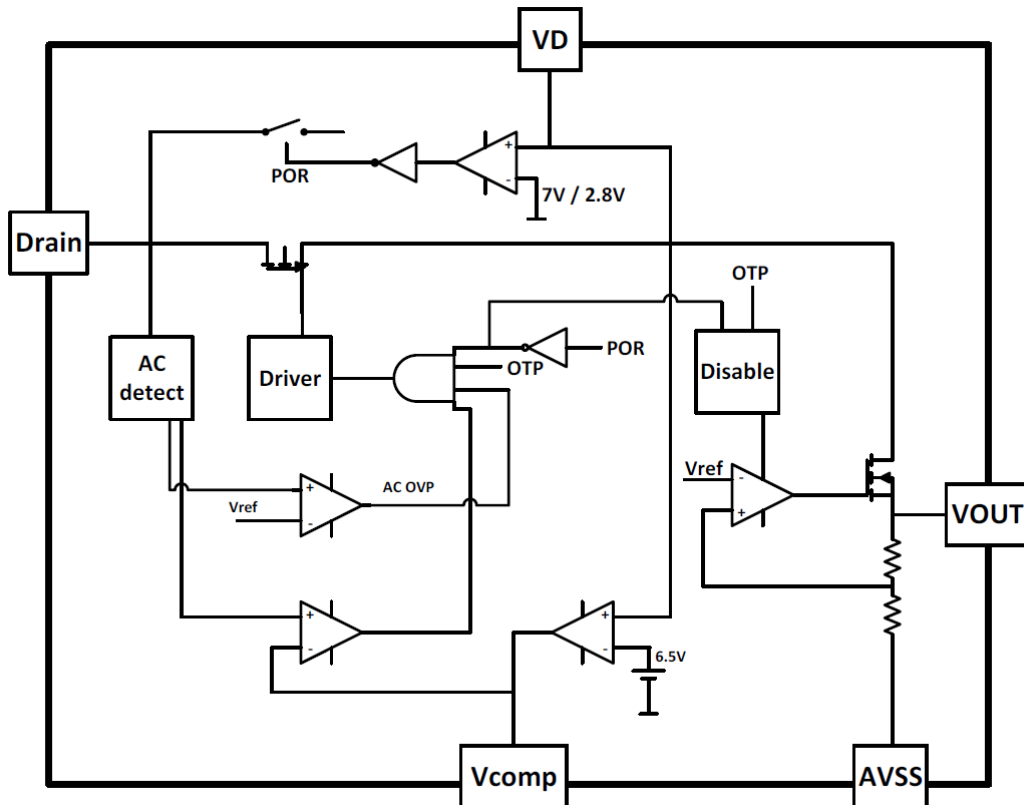
| Pin Number | Pin Name | I/O | Description |
|---|---|---|---|
| 1 | COMP | I | Compensation for load |
| 2 | GND | P | The ground of the IC |
| 3 | VOUT | O | LDO output pin |
| 4 | VDD | P | Energy storage. Connect to GND with a capacitor to buffer energy for the output LDO stage. |
| 5,6,7,8 | Drain | P | Internal power MOSFET drain pin. Provide energy when the voltage falls within the charging window. |

## Typical Application Circuit
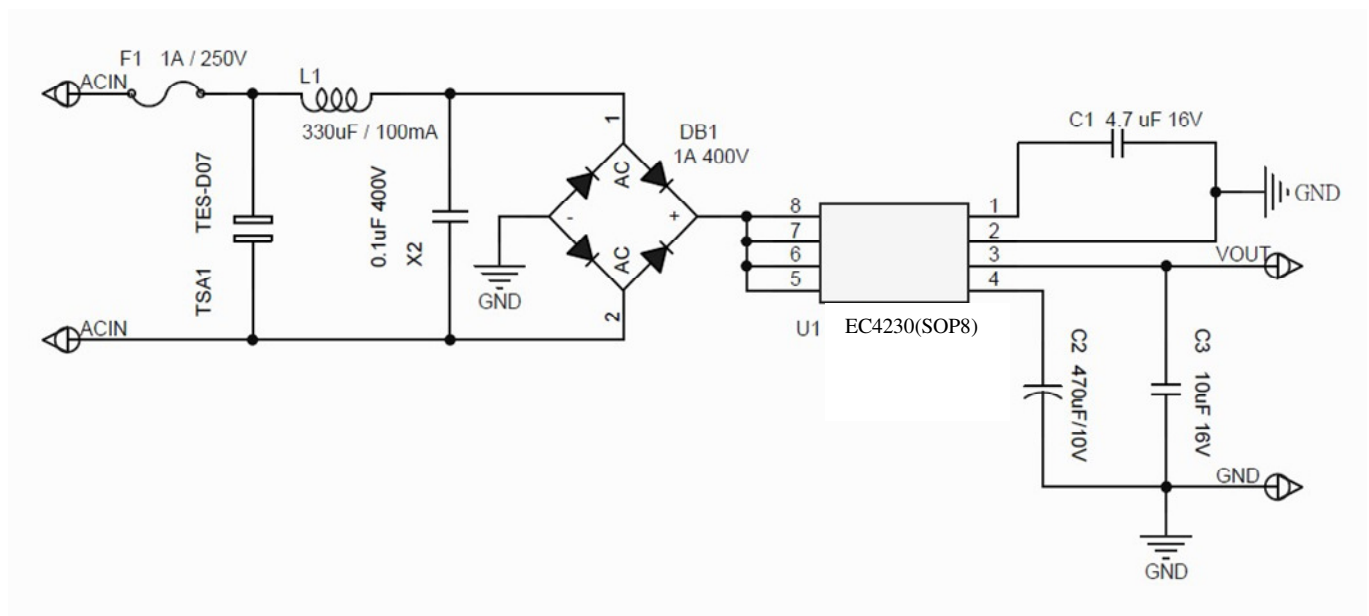
## Block Diagram



## Absolute Maximum Ratings (Note 1)

| Parameter | Value | Unit |
|---|---|---|
| Drain Voltage | 500 | V |
| VDD DC Supply Voltage | 9 | V |
| VDD DC Clamp Current | 10 | mA |
| VOUT, COMP Voltage Range | -0.3 to 7 | V |
| Package Thermal Resistance (SOP8) | 100 | ˚C/W |
| Maximum Junction Temperature | 150 | ˚C |
| Operating Temperature Range | -40 to 85 | ˚C |
| Storage Temperature Range | -65 to 150 | ˚C |
| Lead Temperature (Soldering, 10sec.) | 260 | ˚C |
| ESD Capability, HBM (Human Body Model) | 2 | KV |
| ESD Capability, MM (Machine Model) | 400 | V |

## Recommended Operation Conditions (Note 2)

| Parameter | Value | Unit |
|---|---|---|
| Operating Ambient Temperature | -40 to 85 | ˚C |

## Electrical Characteristics $(T_A = 25°C,$ if not otherwise noted)

| Symbol | Parameter | Test Conditions | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|
| High Voltage Startup Section (Drain Pin) | | | | | | |
| IHV | HV Current Source | HV=500V, VDD=3V, IOUT=1mA | 5 | 10 | | mA |
| VBR | Power MOSFET Drain Source Breakdown Voltage | | 500 | | | V |
| Supply Voltage Section (VDD Pin) | | | | | | |
| IVDD_Op | Operation Current | Iout=1mA | | 1.4 | | mA |
| VDD_ON | VDD Under Voltage Lockout Exit | | 7.6 | 7.8 | 8 | V |
| VDD_OFF | VDD Under Voltage Lockout Enter | | | 2.8 | | V |
| VDD_OVP | VDD OVP Threshold | | 7.6 | 7.8 | 8 | V |
| VOUT Section (VOUT Pin) | | | | | | |
| VOUT_3.3V | Output Voltage | Iout=2mA | 3.2 | 3.3 | 3.4 | V |
| VOUT_5V | | | 4.85 | 5.0 | 5.15 | |
| ΔVOUT(VIN) | Line Regulation dVout/dVin | Iout=100uA | | 0.2 | | %/V |
| PSRR | Power Supply Rejection Ratio | Iout=30mA, Cout=4.7uF, f=10Hz to 60KHz | | 60 | | dB |
| On-Chip Thermal Shutdown | | | | | | |
| TSD | Thermal Shutdown | (Note 3) | --- | 160 | -- | °C |
| TRC | Thermal Recovery | (Note 3) | | 80 | -- | °C |

**Note1**. Stresses listed as the above "Maximum Ratings" may cause permanent damage to the device. These are for stress ratings. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to maximum rating conditions for extended periods may remain possibility to affect device reliability.
**Note2**. The device is not guaranteed to function outside its operating conditions.
**Note3**. Guaranteed by the Design.

## Characterization Plot

**V$_{DD\_ON}$ vs Temperature**



**V$_{DD\_OVP}$ vs Temperature**



**V$_{OUT\_5V}$ vs Temperature**
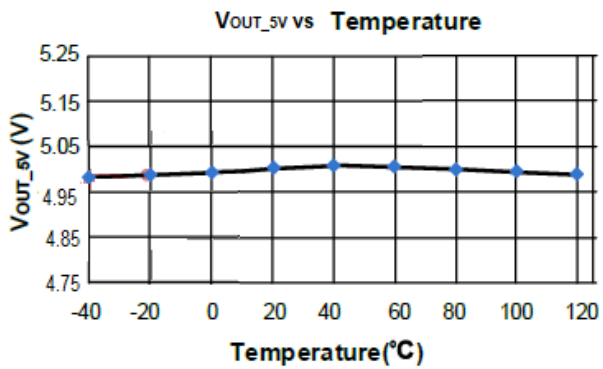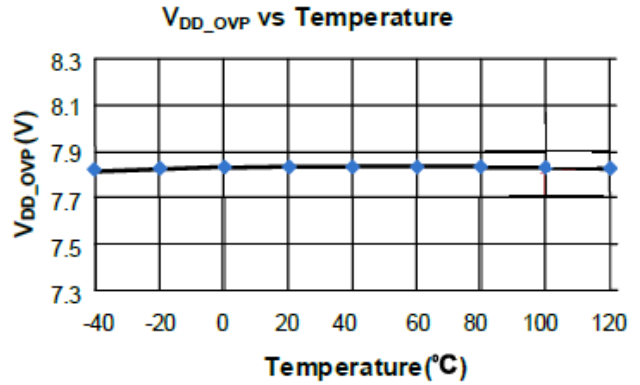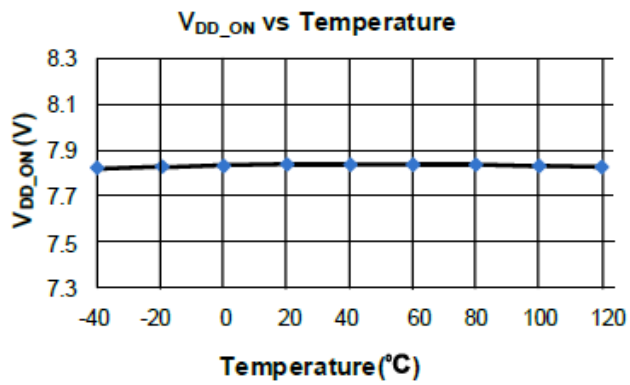
## Operation Description

CY4230 is a compact, inductor free, and highly monolithic AC/DC linear converter which is designed for non-isolated AC/DC converter and home appliances. CY4230 covers universal AC voltage input to provide programmable DC output voltage with current limit for the non-isolated AC/DC converter.

### Startup Current

During CY4230 startup, the internal high voltage current source (10mA) charges the VDD capacitor though the rectifier and Drain pin. CY4230 remains off until the VDD voltage is larger than VDD ON and the output voltage is built up at the same time. After the IC turns on, the internal high voltage current source is disabled by the control loop. The major energy path changes from the high voltage current source to the inner power MOSFET.

### VDD Over Voltage Protection (VDD OVP)

After startup, CY4230 turns on the OVP function. During conduction angle interval, the VDD voltage has two kinds of behavior. One is that if the VDD capacitor recharges to OVP trigger point (7.8V typical), CY4230 turns off the internal power MOSFET to limit the maximum VDD voltage. The other is that if the voltage of VDD cannot recharge to the OVP level during the conduction interval, the power MOSFET is turned off by AC synchronous signal and continuously recharges VDD capacitor at next duration. Using this technique, energy is drawn from the AC mains only during the low voltage portions of each half cycle. During the power MOSFET turn-on, the current provided by the commutated AC voltage is used to supply the loads and to charge the VDD capacitor. In this way, when the power MOSFET switches off, the loads receive the required currents by the capacitor discharge. For the VDD capacitor selection, during the conduction angle interval, the energy is drawn from commutated AC bus, which not only meets the output load requirement but also recharges the VDD capacitor to OVP level. Outside of conduction angle, the VDD capacitor can is determined by the maximum loading current:

$$C_{VDD} \approx 0.01 \times I_{LOAD} \ (unit = F)$$

### Surge Protection

When Surge happens, AC voltage couples a very high spike voltage. If this spike voltage is higher than 100Vdc and occurs within the AC charging window, Surge Protection is triggered, the power MOSFET shuts down quickly and enters Auto-Restart progress.

### On Chip Thermal Shutdown (OTP)

When CY4230's temperature is over 160°C, it shuts down. Only when the temperature drops to 80°C, CY4230 will enter Auto-Restart progress.

### Protections with Auto-Restart

In the event of protections such as OTP, Surge Protection, CY4230 enters auto-restart and an internal timer begins counting, where in the power MOSFET is disabled. When VDD<2.8V, CY4230 will reset and start up the system again. However, if the fault still exists, the system will experience the above-mentioned process.
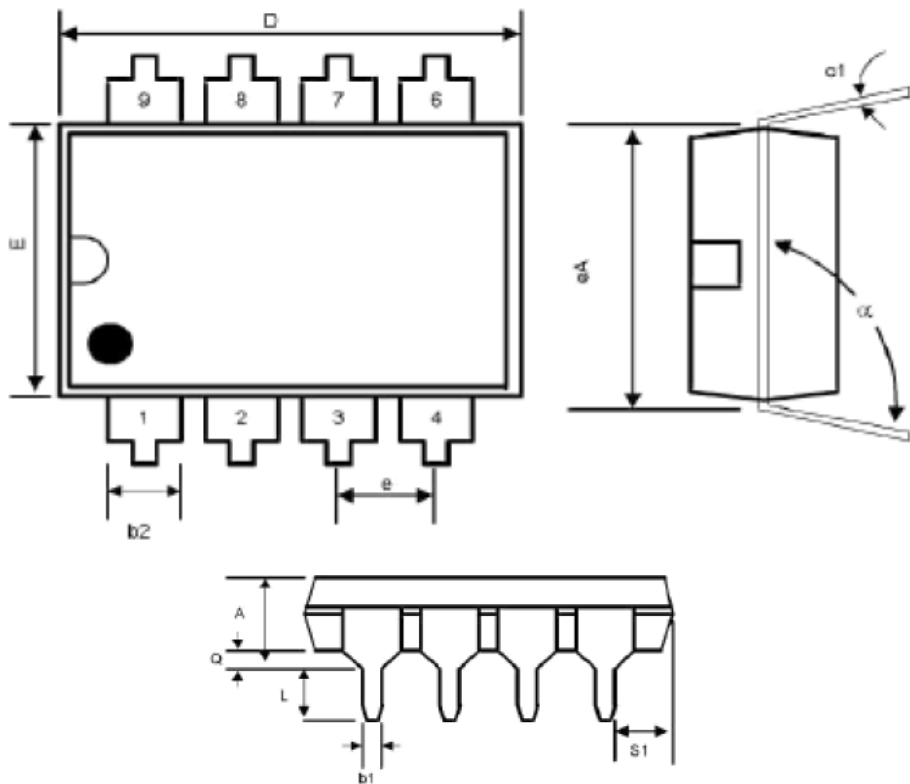
### Auto Power Compensation (VCOMP)

When the loading is changed, CY4230 can adjust Vac accordingly for the changes in Output Power. It can achieve best efficiency.
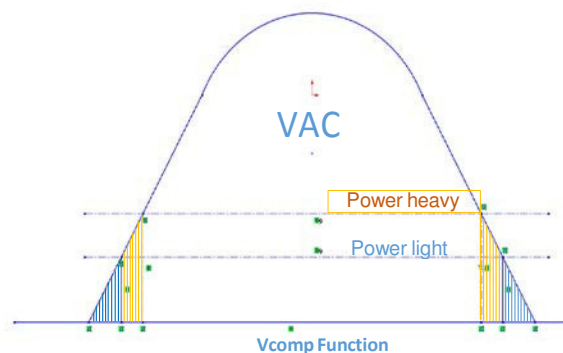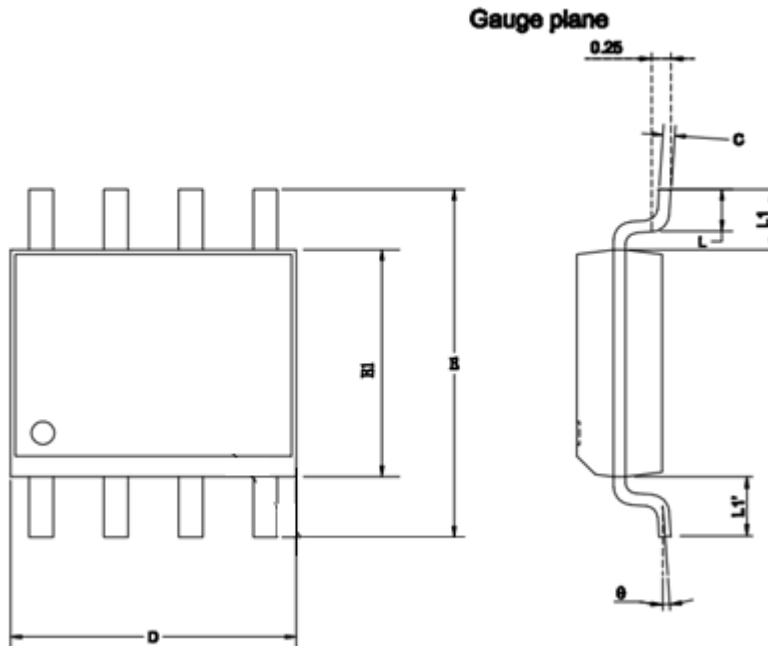
## Package Dimension
**DIP8**



| SYMBOL | INCHES | | MILLIMETERS | | NOTES |
|--------|--------|--------|--------|--------|-------|
| | MIN | MAX | MIN | MAX | |
| A | - | 0.200 | - | 5.08 | - |
| b1 | 0.014 | 0.023 | 0.36 | 0.58 | - |
| b2 | 0.045 | 0.065 | 1.14 | 1.65 | - |
| c1 | 0.008 | 0.015 | 0.20 | 0.38 | - |
| D | 0.355 | 0.400 | 9.02 | 10.16 | - |
| E | 0.220 | 0.310 | 5.59 | 7.87 | - |
| e | 0.100 BSC | | 2.54 BSC | | - |
| eA | 0.300 BSC | | 7.62 BSC | | |
| L | 0.125 | 0.200 | 3.18 | 5.08 | - |
| Q | 0.015 | 0.060 | 0.38 | 1.52 | - |
| s1 | 0.005 | - | 0.13 | - | - |
| $\alpha$ | $90^0$ | $105^0$ | $90^0$ | $105^0$ | - |

**SOP8**



| SYMBOLS | DIMENSIONS IN MILLIMETERS | | | DIMENSIONS IN INCHES | | |
|---|---|---|---|---|---|---|
| | MIN | NOM | MAX | MIN | NOM | MAX |
| A | 1.40 | 1.50 | 1.60 | 0.055 | 0.059 | 0.063 |
| A1 | 0.00 | —— | 0.10 | 0.000 | —— | 0.004 |
| A2 | —— | 1.45 | —— | —— | 0.057 | —— |
| B | 0.33 | —— | 0.51 | 0.013 | —— | 0.020 |
| C | 0.19 | —— | 0.25 | 0.007 | —— | 0.010 |
| D | 4.80 | —— | 5.00 | 0.189 | —— | 0.197 |
| E1 | 3.80 | 3.90 | 4.00 | 0.150 | 0.153 | 0.157 |
| e | —— | 1.27 | —— | —— | 0.050 | —— |
| E | 5.80 | 6.00 | 6.20 | 0.228 | 0.236 | 0.244 |
| L | 0.40 | —— | 1.27 | 0.016 | —— | 0.050 |
| y | —— | —— | 0.10 | —— | —— | 0.004 |
| θ | 0° | —— | 8° | 0° | —— | 8° |
| \|L1-L1'\| | —— | —— | 0.12 | —— | —— | 0.005 |
| L1 | 1.04REF | | | 0.041REF | | |