APPLICATION BRIEF

# Energy - Improving the Efficiency of External Power Supplies (EPS)

## Situation

- Energy efficiency is driving changes in how External Power Supplies (EPS) are designed and operated. The latest regulations from the U.S. Department of Energy (DOE) not only increase the minimum energy efficiency requirement of EPS from Level IV to Level VI, but also extend their scope to encompass lower voltage AC- or DC-output EPS, multiple-voltage EPS and EPS with nameplate output power exceeding 250 watts.
- Through 2030, these standards are projected to cut consumer and industrial electricity bills by hundreds of billions of dollars, and save enough electricity to power more than 85 million homes for two years. It is also estimated that increasing EPS efficiency can reduce carbon output by at least 3 billion metric tons cumulatively — equivalent to nearly one-half of the carbon output from the entire U.S. energy sector for one year.

**EPS Class VI Efficiency Requirements**

| Nameplate Output Power ($P_{no}$)[1] | No-Load Mode Power | Nameplate Output Power ($P_{no}$) | Average Efficiency in Active Mode[2] |
|---|---|---|---|
| 0 to ≤ 49 W | AC/DC: ≤ 0.100<br>AC/AC: ≤ 0.210 | 0 to ≤ 1 W | Basic Voltage: ≥ 0.5 * $P_{no}$ + 0.16<br>Low Voltage3: ≥ 0.517 * $P_{no}$ + 0.087 |
| | | > 1 to ≤ 49 W | Basic Voltage: ≥ 0.071 * ln ($P_{no}$) – 0.0014 * $P_{no}$ + 0.67<br>Low Voltage 3: ≥ 0.0834 * ln ($P_{no}$) – 0.0014 * $P_{no}$ + 0.609 |
| > 49 to ≤ 250 W | ≤ 0.210 | > 49 to ≤ 250 W | Basic Voltage: ≥ 0.880<br>Low Voltage 3: ≥ 0.870 |
| > 250 W | ≤ 0.500 | > 250 W | ≥ 0.875 |

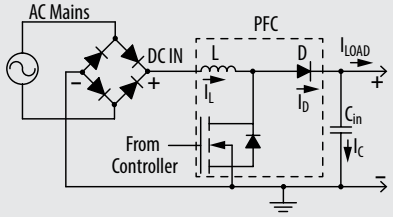
*[1] $P_{no}$ is the Nameplate Output Power of the unit under test*
*[2] "ln" refers to the natural logarithm*
*[3] A low-voltage model is an EPS with nameplate output voltage < 6 V and output current ≥ 550 mA.*

- Systems that have a low (uncorrected) power factor (PF) impact losses in the local power conversion system and electrical distribution system. Power utilities typically expect an industrial facility to meet a PF requirement of greater than 85 % or additional fees will be charged. By improving the Power Factor, both system efficiency and utility distribution losses can be reduced while increasing capacity with additional load to your system. With the current rise in the cost of energy, increased facility efficiency is very desirable.
- This application brief presents solutions from Bourns to increases the efficiency of switching power supply designs to meet DOE Class VI requirements.

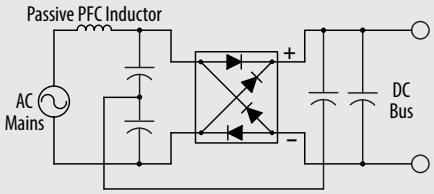
## Solution

- Using Power Factor correction and synchronous rectification methods, lower losses can be realized to make efficiency gains possible.

**Power Factor Correction (PFC)**

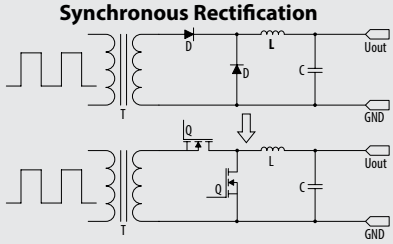



**Passive PFC inductor provides 70 - 80 % PF**

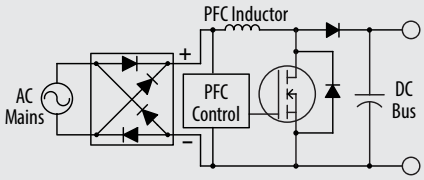



- Bourns offers a wide range of products designed to be low loss through material selection and improved shielding. These products can help the circuit designer reach their goal of efficiency.

**Synchronous Rectification**




**Active PFC circuit provides 90 - 99.9 % PF**




- EPS designs that use Power Factor correction and synchronous rectification methods require low loss components to meet active mode efficiency mandates of greater than 87 %. Bourns offers a combination low loss solution consisting of the following components:
  - Switching Transformer/PFC Inductor/ Output Inductor: Bourns® Model SM91047EL/2124-RC/SRR1280-560M
  - Diode Bridge/PFC Rectifier: Bourns® Model CD-MBL210SL/CD1408-FF1200
  - Current Sense Resistor: Bourns® Model CRM2010-FX-R100ELF / CRF1206-FZ-R050ELF

## Benefits

- Bourns' low loss components and switching topologies create a path for EPS energy savings and the reduction of residential/industrial carbon footprints.
- Bourns® magnetics, rectification, and precision current measurement solutions are designed to meet minimum energy efficiency standards to help EPS developers satisfy challenging Level VI, lower voltage and power output requirements.
- As the standards and requirements for efficiency in all power systems increases, circuit designers will need to utilize Power Factor correction to meet electrical distribution requirements and DOE mandates.

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