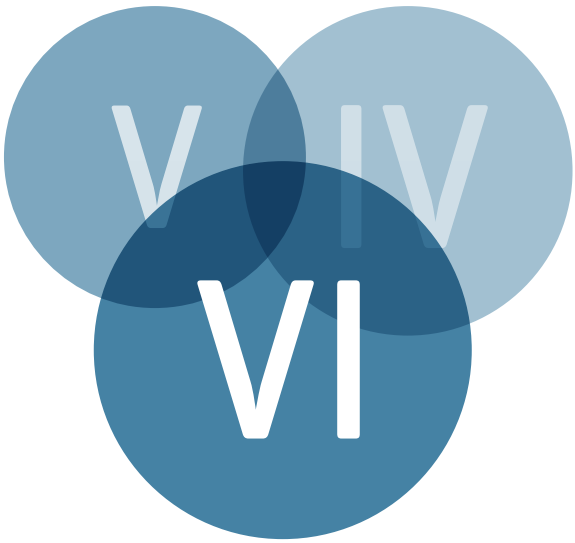
Efficiency Standards for External Power Supplies



FAVOTEK

The global regulatory environment surrounding the legislation of external power supply efficiency and no-load power draw has rapidly evolved over the past decade since the California Energy Commission (CEC) implemented the first mandatory standard in 2004. With the introduction of a new set of requirements by the United States Department of Energy (DOE) that became effective in February 2016, the landscape has again changed as regulators try to further reduce the amount of energy consumed by external power adapters.

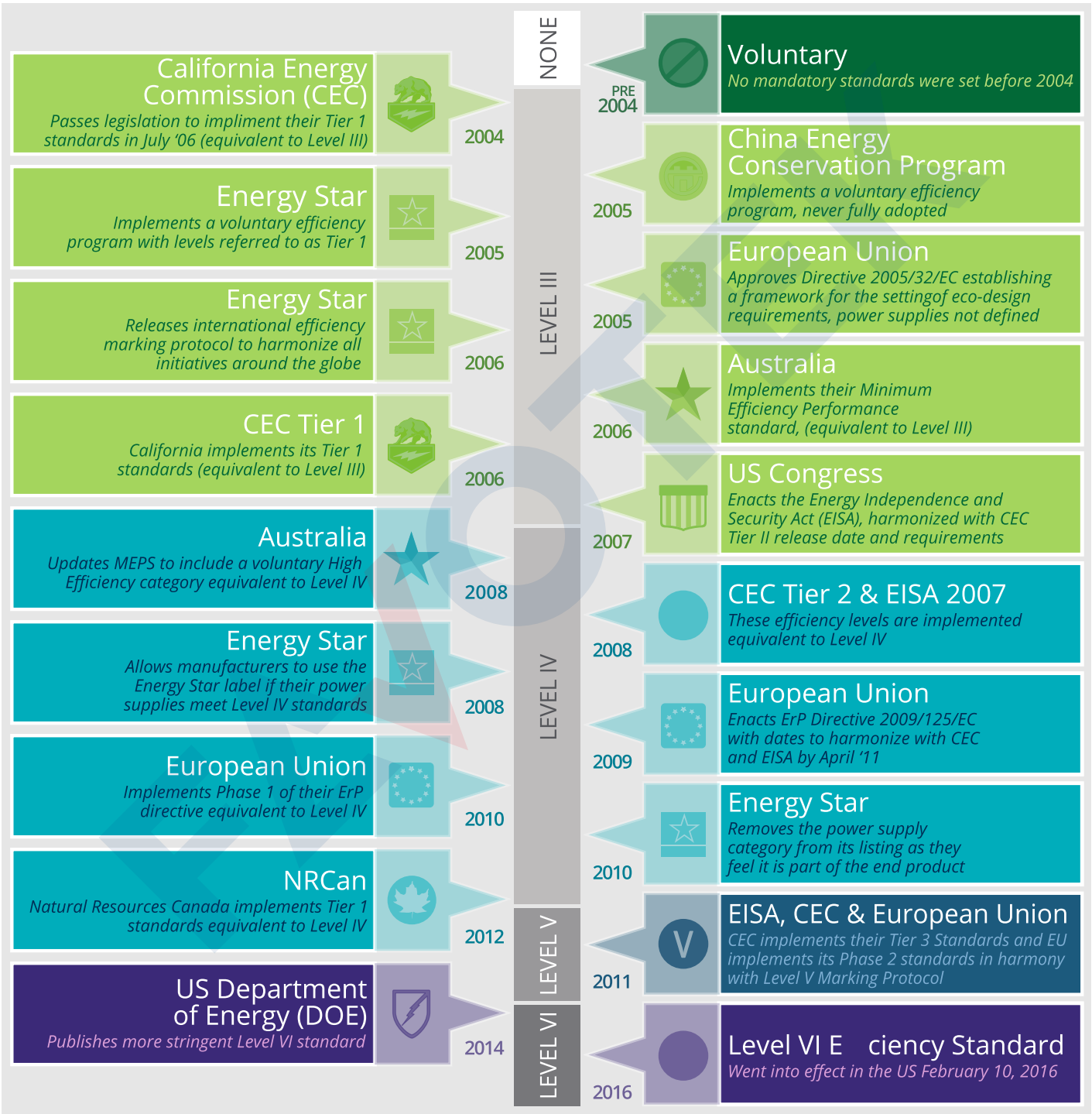
Mandating higher average efficiencies in external power supplies has undoubtedly had a real impact on global power consumption. However, with the benefit of a reduced draw on the power grid come challenges and uncertainties for the electronics industry as it tries to keep up with this dynamic regulatory environment.

Original Equipment Manufacturers (OEMs) who design external power supplies into their products must continue to monitor the latest regulations to ensure that they are in compliance in each region where their product is sold. The goal of this paper is to provide an up-to-date summary of the most current regulations worldwide.

A BRIEF HISTORY

In the early 90s, it was estimated that there were more than one billion external power supplies active in the United States alone. The efficiency of these power supplies, mainly utilizing linear technology, could be as low as 50% and still draw power when the application was turned off or not even connected to the power supply (referred to as no-load condition). Experts calculated that without efforts to increase efficiencies and reduce no-load power consumption, external power supplies would account for around 30% of total energy consumption in less than 20 years. As early as 1992, the US Environmental Protection Agency started a voluntary program to promote energy efficiency and reduce pollution which eventually became the Energy Star program. However, it was not until 2004 that the first mandatory regulation dictating efficiency and no-load power draw minimums was put in place. Figure 1 demonstrates just how dynamic the regulatory environment has been over the past decade. It also traces the path from the CECs 2004 regulation up to the new Level VI standards that became effective in February 2016.

Figure 1: The image below traces the path from the CECs 2004 regulation up to the new Level VI standards that took effect in February 2016

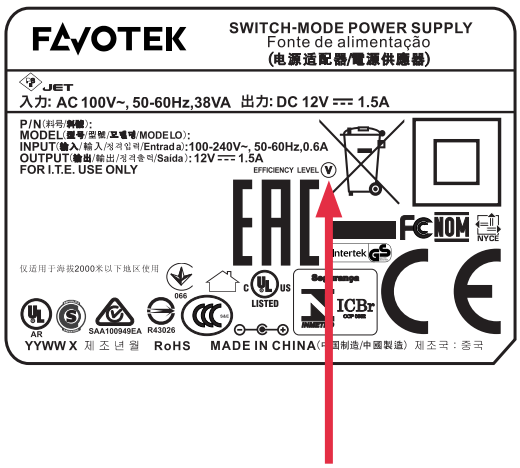


THE CURRENT REGULATORY ENVIRONMENT

As different countries and regions enact stricter requirements and move from voluntary to mandatory programs, it has become vital that OEMs continually track the most recent developments to ensure compliance and avoid costly delays or fines. While many countries are establishing voluntary programs harmonized to the international efficiency marking protocol system first established by Energy Star, the following countries and regions now have regulations in place mandating that all external power supplies shipped across their borders meet the specified efficiency level:

Power supply manufacturers indicate compliance by placing a Roman Numeral (I, II, III, IV, V or VI) on the power supply label as specified by the International Efficiency Marking Protocol for External Power Supplies Version 3.0, updated in September 2013. This latest version of the Protocol provides additional flexibility on where the marking may be placed.

While the United States is currently the only government to enforce compliance to the Level VI standard, most external power supply manufactures have adjusted their product portfolios to meet these requirements. Today, Level VI will meet or exceed the requirements of any governing body around the world. The adjustments are a direct response to the needs of OEMs to have a universal power supply platform for their products that ship globally.



PERFORMANCE THRESHOLDS

Figure 2 summarizes past performance thresholds as they were established over time.

The internationally approved test method for determining efficiency has been published by the IEC as AS/NZS 4665 Part 1 and Part 2. The approach taken to establish an efficiency level is to measure the input and output power at 4 defined points: 25%, 50%, 75% and 100% of rated power output. Data for all 4 points are separately reported as well as an arithmetic average active efficiency across all 4 points.

LEVEL	NO-LOAD POWER REQUIREMENT	AVERAGE EFFICIENCY REQUIREMENT
I	used if you do not meet any of the criteria	
II	no criteria was ever established	no criteria was ever established
III	≤10 Watts: ≤0.5W of No Load Power 10~250 Watts: ≤0.75W No Load Power	≤1Watt: ≥ Power x 0.49 1~49 Watts: ≥[0.09 x Ln[Power]] + 0.49 49~250 Watts: ≥84%
IV	0~250 Watts: ≤0.5W No Load Power	≤1Watt: ≥ Power x 0.50 1~51 Watts: ≥[0.09 x Ln[Power]] + 0.5 51~250 Watts: ≥85%
V	Standard Voltage Ac-Dc Models (>6Vout)	
	0~49 Watts: ≤0.3W of No Load Power	≤1 Watt: 0.48 x Power +0.140
	50~250 Watts: ≤0.5W of No Load Power	1~49 Watts: [0.0626 x Ln[Power]] + 0.622
		50~250 Watts: ≥87%
	Low Voltage Ac-Dc Models (<6Vout)	
	0~49 Watts: ≤0.3W of No Load Power	≤1 Watt: 0.497 x Power + 0.067
	50~250 Watts: ≤0.5W of No Load Power	1~49 Watts: [0.0750 x Ln[Power]] + 0.561
		50~250 Watts: ≥86%

Figure 2: The table above summarizes past performance thresholds as they were established over time. The term power means the power designated on the label of the power supply.

LEVEL VI PERFORMANCE THRESHOLDS

The Level VI standard tightens performance thresholds for adapters in active mode and no-load conditions. Along with tightened regulations for adapters governed under previous regulations, the new standard expands the range of products that fall under the standard. Regulated products will now include:

- *Multiple-voltage external power supplies*
- *Products with power levels >250 watts*

The latest performance thresholds are summarized in the tables below:

SINGLE-VOLTAGE EXTERNAL AC-DC POWER SUPPLY [1], BASIC-VOLTAGE		
Nameplate Output Power (P_{out})	Minimum Average Efficiency in Active Mode (expressed as a decimal)	Maximum Power in No-Load Mode (W)
$P_{out} \leq 1$ W	$0.5 \times P_{out} + 0.16$	0.100
1 W < $P_{out} \leq 49$ W	$0.071 \times \ln(P_{out}) - 0.0014 \times P_{out} + 0.67$	0.100
49 W < $P_{out} \leq 250$ W	0.880	0.210
P_{out} > 250 W	0.875	0.500

SINGLE-VOLTAGE EXTERNAL AC-DC POWER SUPPLY, LOW-VOLTAGE [2]		
Nameplate Output Power (P_{out})	Minimum Average Efficiency in Active Mode (expressed as a decimal)	Maximum Power in No-Load Mode (W)
$P_{out} \leq 1$ W	$0.517 \times P_{out} + 0.087$	0.100
1 W < $P_{out} \leq 49$ W	$0.0834 \times \ln(P_{out}) - 0.0014 \times P_{out} + 0.609$	0.100
49 W < $P_{out} \leq 250$ W	0.870	0.210
P_{out} > 250 W	0.875	0.500

SINGLE-VOLTAGE EXTERNAL AC-AC POWER SUPPLY[3], BASIC-VOLTAGE		
Nameplate Output Power (P_{out})	Minimum Average Efficiency in Active Mode (expressed as a decimal)	Maximum Power in No-Load Mode (W)
$P_{out} \leq 1$ W	$0.5 \times P_{out} + 0.16$	0.210
1 W < $P_{out} \leq 49$ W	$0.071 \times \ln(P_{out}) - 0.0014 \times P_{out} + 0.67$	0.210
49 W < $P_{out} \leq 250$ W	0.880	0.210
P_{out} > 250 W	0.875	0.500

SINGLE-VOLTAGE EXTERNAL AC-AC POWER SUPPLY, LOW-VOLTAGE		
Nameplate Output Power (P_{out})	Minimum Average Efficiency in Active Mode (expressed as a decimal)	Maximum Power in No-Load Mode (W)
$P_{out} \leq 1$ W	$0.517 \times P_{out} + 0.087$	0.210
1 W < $P_{out} \leq 49$ W	$0.0834 \times \ln(P_{out}) - 0.0014 \times P_{out} + 0.609$	0.210
49 W < $P_{out} \leq 250$ W	0.870	0.210
P_{out} > 250 W	0.875	0.500

MULTIPLE-VOLTAGE EXTERNAL POWER SUPPLY[4]		
Nameplate Output Power (P_{out})	Minimum Average Efficiency in Active Mode (expressed as a decimal)	Maximum Power in No-Load Mode (W)
$P_{out} \leq 1$ W	$0.497 \times P_{out} + 0.067$	0.300
1 W < $P_{out} \leq 49$ W	$0.075 \times \ln(P_{out}) + 0.561$	0.300
P_{out} > 49 W	0.860	0.300

[1] **Single-Voltage External Ac-Dc Power Supply**
An external power supply that is designed to convert line voltage ac into lower-voltage dc output and is able to convert to only one dc output voltage at a time.

[2] **Low-Voltage External Power Supply**
An external power supply with a nameplate output voltage less than 6 volts and nameplate output current greater than or equal to 550 milliamps. Basic-voltage external power supply means an external power supply that is not a low-voltage power supply.

[3] **Single-Voltage External Ac-Ac Power Supply**
An external power supply that is designed to convert line voltage ac into lower-voltage ac output and is able to convert to only one ac output voltage at a time.

[4] **Multiple-Voltage External Power Supply**
An external power supply that is designed to convert line voltage ac input into more than one simultaneous lower-voltage output.

DIRECT VS INDIRECT OPERATION EPSs

The Level VI standard also defines power supplies as direct operation and indirect operation products. A direct operation product is an external power supply (EPS) that functions in its end product without the assistance of a battery. An indirect operation EPS is not a battery charger but cannot operate the end product without the assistance of a battery. The new standard only applies to direct operation external power supplies. Indirect operation models will still be governed by the limits as defined by EISA2007. Figure 3 illustrates the instructions provided by the DOE to help distinguish between direct and indirect operation power supplies:

LEVEL VI EXEMPTIONS

The Level VI mandate defines exemptions for EPS products. The direct operation EPS standards do not apply if:

- *It is a device that requires Federal Food and Drug Administration listing and approval as a medical device in accordance with section 360c of title 21;*

OR

- *A direct operation, ac-dc external power supply with nameplate output voltage less than 3 volts and nameplate output current greater than or equal to 1,000 milliamps that charges the battery of a product that is fully or primarily motor operated.*

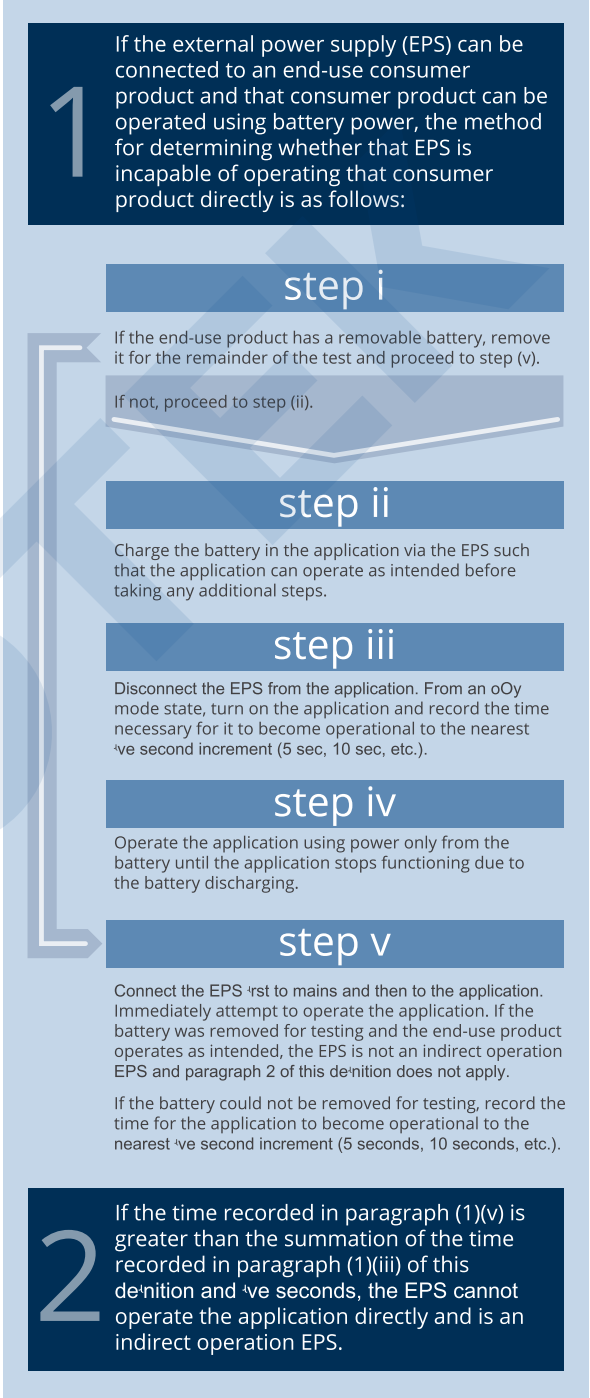


Figure 3: The above instructions have been provided by the DOE to help distinguish between direct and indirect operation power supplies.

LOOKING FORWARD

Level VI compliance in the United States became effective on February 10, 2016, two years after the rules publication in the Federal Register. It is important to note that compliance is regulated based on the date of manufacture within the United States or date of import into the United States, so legacy products can still be shipped as long as the US manufacture date or US import date is prior to February 10, 2016. Labeling requirements are covered by the same International Efficiency Marking Protocol for External Power Supplies Version 3.0 as for previous standards.

Globally, it is expected that other nations will soon follow suit with this standard. In the EU, the mandatory European Ecodesign Directive for external power supplies is currently going through revision discussions and it is expected to harmonize with most, if not all, of the US standards. It should be expected that countries with existing efficiency regulations in-line with the US, including Canada and Australia, will move to harmonize with the new standard as well.

SUMMARY

The EPA estimates that external power supply efficiency regulations implemented over the past decade have reduced energy consumption by 32 billion kilowatts, saving $2.5 billion annually and reducing CO2 emissions by more than 24 million tons per year. Moving beyond the mandated government regulations, many OEMs are now starting to demand greener power supplies as a way to differentiate their end-products, driving efficiencies continually higher and even pushing the implementation of control technologies that in some cases eliminates no-load power consumption altogether. In late 2014, Favotek began introducing Level VI compliant adapters to keep their customers one step ahea d of the coming legislation. Moving forward, Favotek continue to look for ways to implement the latest energy saving technologies into their external power supplies in order to address market demands and comply with current and future regulations.

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