



ON Semiconductor®

Overview of Energy Efficient Solutions

Agenda

- **Update on energy efficiency regulations**
- **ON Semiconductor and energy efficiency**
- **ON Semiconductor's products and solutions for energy efficient applications**
- **Conclusion**

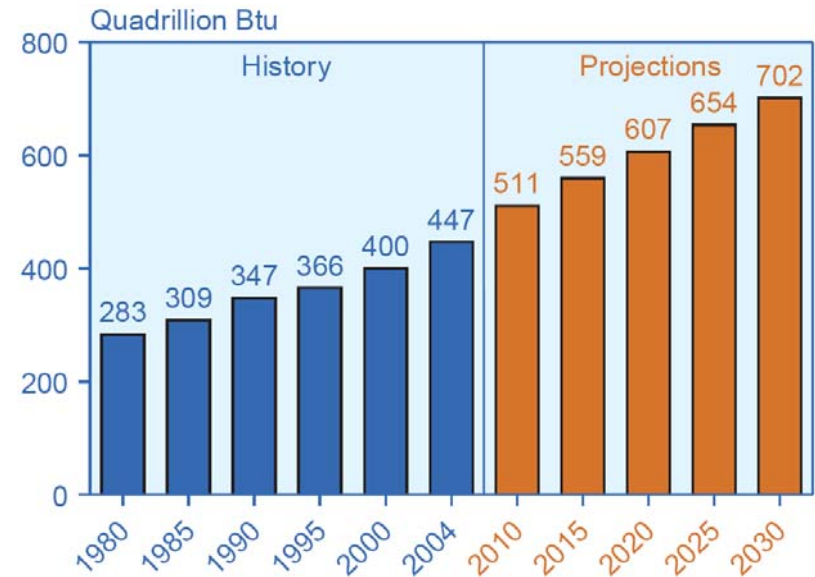


The Case for Energy Efficiency

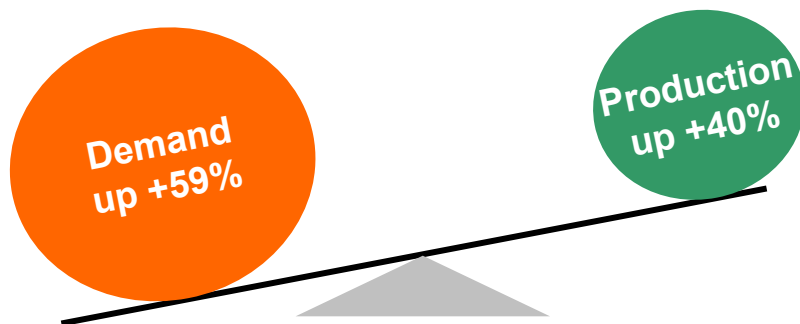
Representative Countries & Energy Consumption

Country	Population in millions (2005)	Consumption in quads (2003)
China	1304	45.5
India	1104	14.0
United States	296	98.8
Indonesia	222	4.7
Brazil	184	8.8
Pakistan	162	1.9
Russia	144	29.1
Bangladesh	144	0.6
Nigeria	132	1.0
Japan	128	22.4
Mexico	107	6.8
Germany	82	14.2
Iran	70	6.0
Thailand	65	3.1
France	61	11.2
United Kingdom	60	9.8
Italy	59	8.0
South Africa	50	4.9
South Korea	48	8.6
Canada	32	13.5
Saudi Arabia	25	5.7
Taiwan	23	4.2
Australia	20	6.1

Quad = Quadrillion Btu



Energy Statistic 1990 – 2005



OPTIONS?

More power plants and ... pollution

Conservation: Behavior change which results in the use of less energy

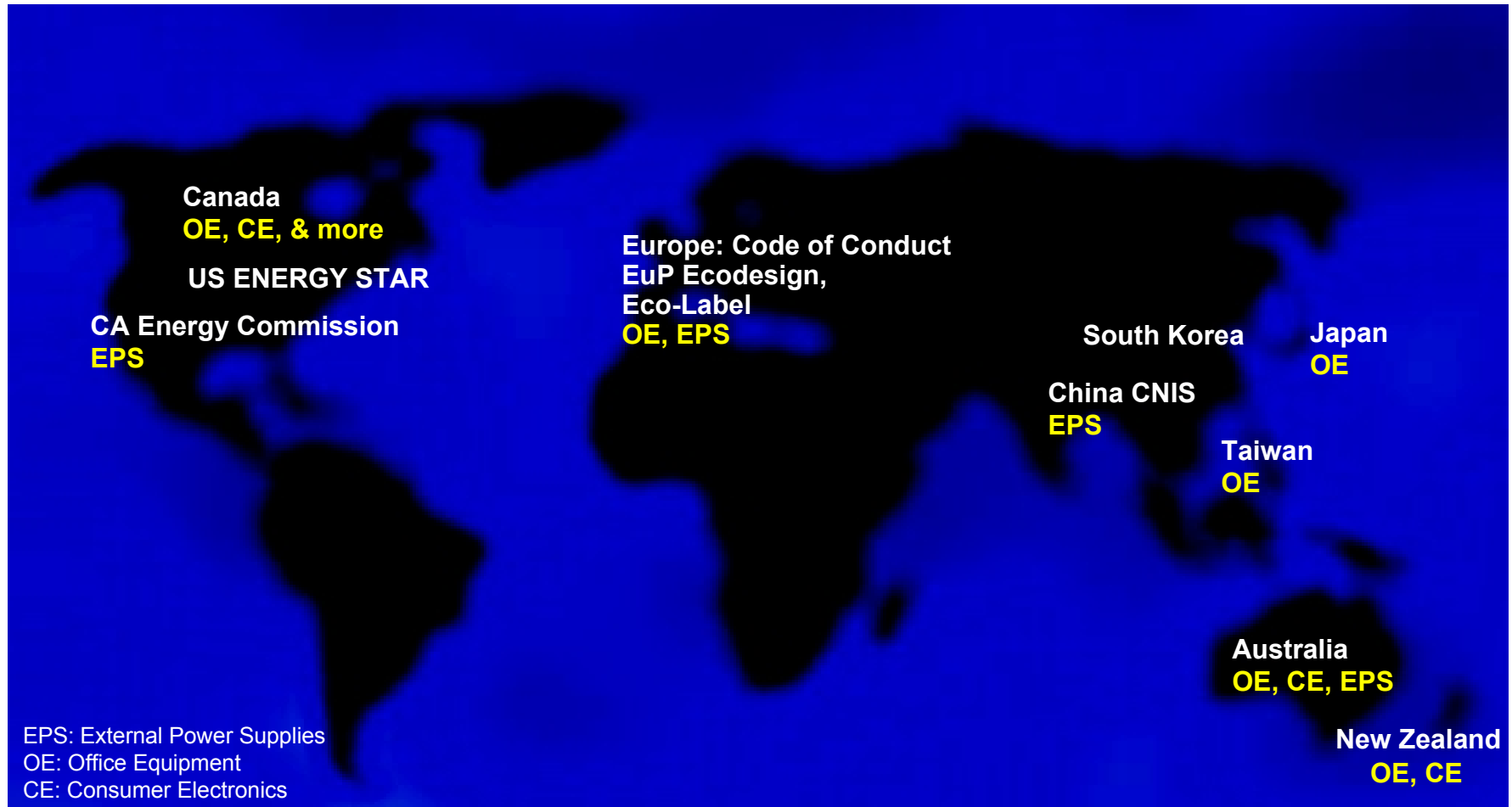
Energy Efficiency: use of technology to use less energy to perform the same task

Source: Energy Information Administration

ON Semiconductor



Worldwide Energy Efficiency Regulations



Source: Energy Star



Update on Energy Efficiency Regulations

Adapters/External Power Supplies



- [ENERGY STAR® 2.0](#) effective on Nov. 1, 2008
- [Europe Code of Conduct version 4](#) effective Apr. 27, 2009
- [Europe EuP Ecodesign Directive 2005/32/EC Regulation \(EC\) No 642/2009](#) Phase 1 effective April 2010, Phase 2 effective April 2011
- [Energy Independence and Security Act of 2007 \(EISA 2007\)](#) signed into law on Dec. 19, 2007



TV Sets

- [ENERGY STAR® 3.0](#) effective on Nov. 1, 2008
 - Standard is technology (PDP, LCD, RPTV) neutral and based only on screen size and resolution
 - Standby power: ≤ 1 W
- [ENERGY STAR® 4.0 & 5.0](#) to be effective in May 2010 & May 2012
 - Max power for 42" TV = 81 W
- [Europe EuP Ecodesign Directive 2005/32/EC Regulation \(EC\) No 642/2009](#)
 - Standard is technology (PDP, LCD, RPTV) neutral and based only on screen size and resolution



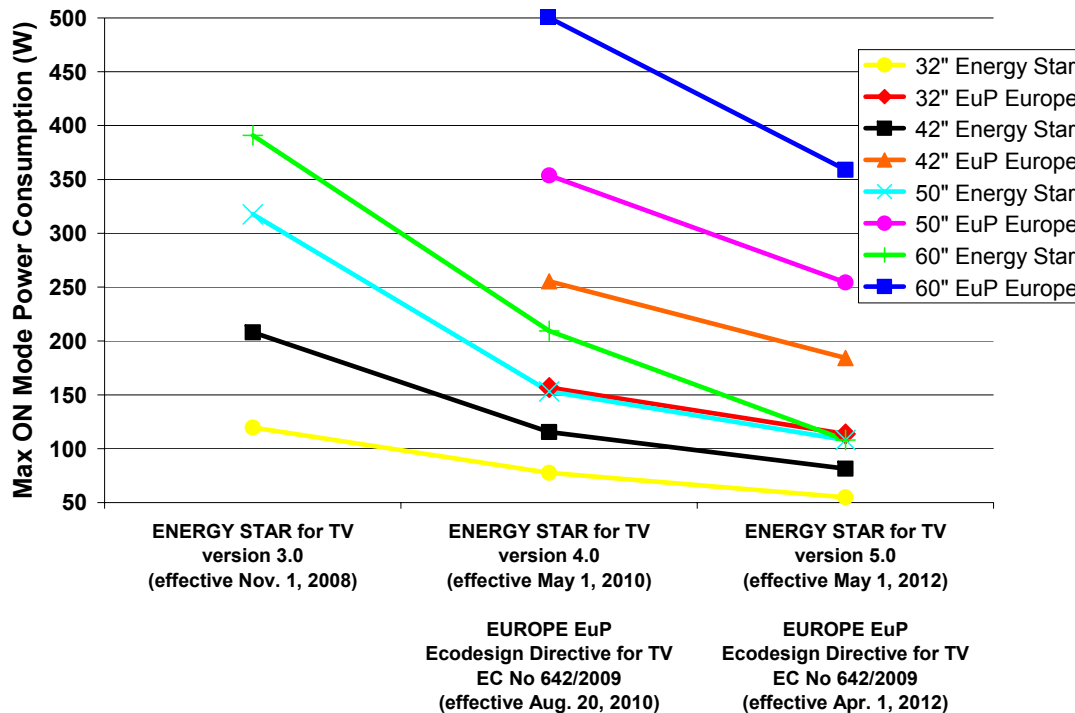
	Europe EuP Ecodesign Directive 	Energy Star 
External Power Supplies	<ul style="list-style-type: none"> • Directive 2005/32/EC REGULATION (EC) No 278/2009 • Phase 1, effective Apr. 2010 • Phase 2, effective Apr. 2011 	<ul style="list-style-type: none"> • EPS version 2.0 • Effective Nov. 1, 2008
	<ul style="list-style-type: none"> • Phase 1: <ul style="list-style-type: none"> • Efficiency: $\geq 85\%$ @ $P_{out} > 51$ W • No load power: ≤ 500 mW • Phase 2: <ul style="list-style-type: none"> • Efficiency: $\geq 87\%$ @ $P_{out} > 51$ W • No load power: ≤ 500 mW 	<ul style="list-style-type: none"> • $P_{out} > 49$ W <ul style="list-style-type: none"> • Efficiency: $\geq 87\%$ • No load power: ≤ 500 mW • $PF \geq 0.9$ @ $V_{in} = 115$ Vac & $P_{in} \geq 100$ W
Standby and off mode electric power consumption of electrical and electronic household and office equipment	<ul style="list-style-type: none"> • Directive 2005/32/EC REGULATION (EC) No 1275/2008 • Phase 1, effective Dec. 2009 Off-mode < 1 W • Phase 2, effective Dec. 2012 Off-mode < 0.5 W 	
Televisions	<ul style="list-style-type: none"> • Directive 2005/32/EC REGULATION (EC) No 642/2009 • Phase 1, effective Aug. 20, 2009 Off-mode < 1 W • Phase 2, effective Apr. 1, 2012 Off-mode < 0.5 W 	<ul style="list-style-type: none"> • EPS version 4.0 & 5.0 • Version 4, effective May 1, 2010 Sleep-mode < 1 W • Version 5, effective May 1, 2012 Sleep-mode < 1 W

For exhaustive and up-to-date information on agencies and regulations, check the PSMA energy efficiency data base at: www.psmacom



TV Active Mode Efficiency Regulatory Requirements







Power Levels Rates for Typical Screen Sizes



Maximizing LCD TV Efficiency

- Transition to LED backlighting
- CCFL Backlighting:
 - Reduction of number of lamps and consumption for the same initial light output
 - New inverter driver solution (LIPS) with only 1 conversion stage
- Reduction of standby power consumption:
 - Now ≤ 1 W
 - Future ≤ 0.3 W $\rightarrow \leq 0.1$ W

Efficiency Targets for Multi-output Desktop ATX Power Supplies




Multi-Output ATX Power Supplies			Efficiency (%)			Effective Date
	Levels	Specification	20% of rated output power	50% of rated output power	100% of rated output power	
	 CSCI Base 	<ul style="list-style-type: none"> • Multiple-Output • Non-Redundant • PFC 0.9 at 100% of rated output 	80%	80%	80%	Effective date: July 2007
	 CSCI Bronze 	<ul style="list-style-type: none"> • Multiple-Output • Non-Redundant • PFC 0.9 at 50% of rated output 	82%	85%	82%	ENERGY STAR rev. 5.0 (Effect. date: July 2009) & CSCI Bronze (Start July 2008)
	 CSCI Silver	<ul style="list-style-type: none"> • Multiple-Output • Non-Redundant • PFC 0.9 at 50% of rated output 	85%	88%	85%	Start July 2009
	 CSCI Gold	<ul style="list-style-type: none"> • Multiple-Output • Non-Redundant • PFC 0.9 at 50% of rated output 	87%	90%	87%	Start July 2010

Sources:

- 80 PLUS® : <http://www.80plus.org/>
- Climate Savers® Computing Initiative: <http://www.climatesaverscomputing.org/>
- ENERGY STAR®: http://www.energystar.gov/index.cfm?c=revisions.computer_spec



Efficiency Targets for Single-output Computing Power Supplies (Servers, Blades, All-in-1)

Single-Output	Efficiency (%)					
	Levels	Specification	20% of rated output power	50% of rated output power	100% of rated output power	Effective Date
	 CSCI Bronze	<ul style="list-style-type: none"> Single-Output Non-Redundant PFC 0.9 at 50% 	81%	85%	81%	Start June 2007
	 CSCI Silver	<ul style="list-style-type: none"> Single-Output Non-Redundant PFC 0.9 at 50% 	85%	89%	85%	Start June 2008
	 CSCI Gold	<ul style="list-style-type: none"> Single-Output Non-Redundant PFC 0.9 at 50% 	88%	92%	88%	Start June 2010
	CSCI Platinum	<ul style="list-style-type: none"> Single-Output Non-Redundant PFC 0.9 at 50% 	90%	94%	91%	Target

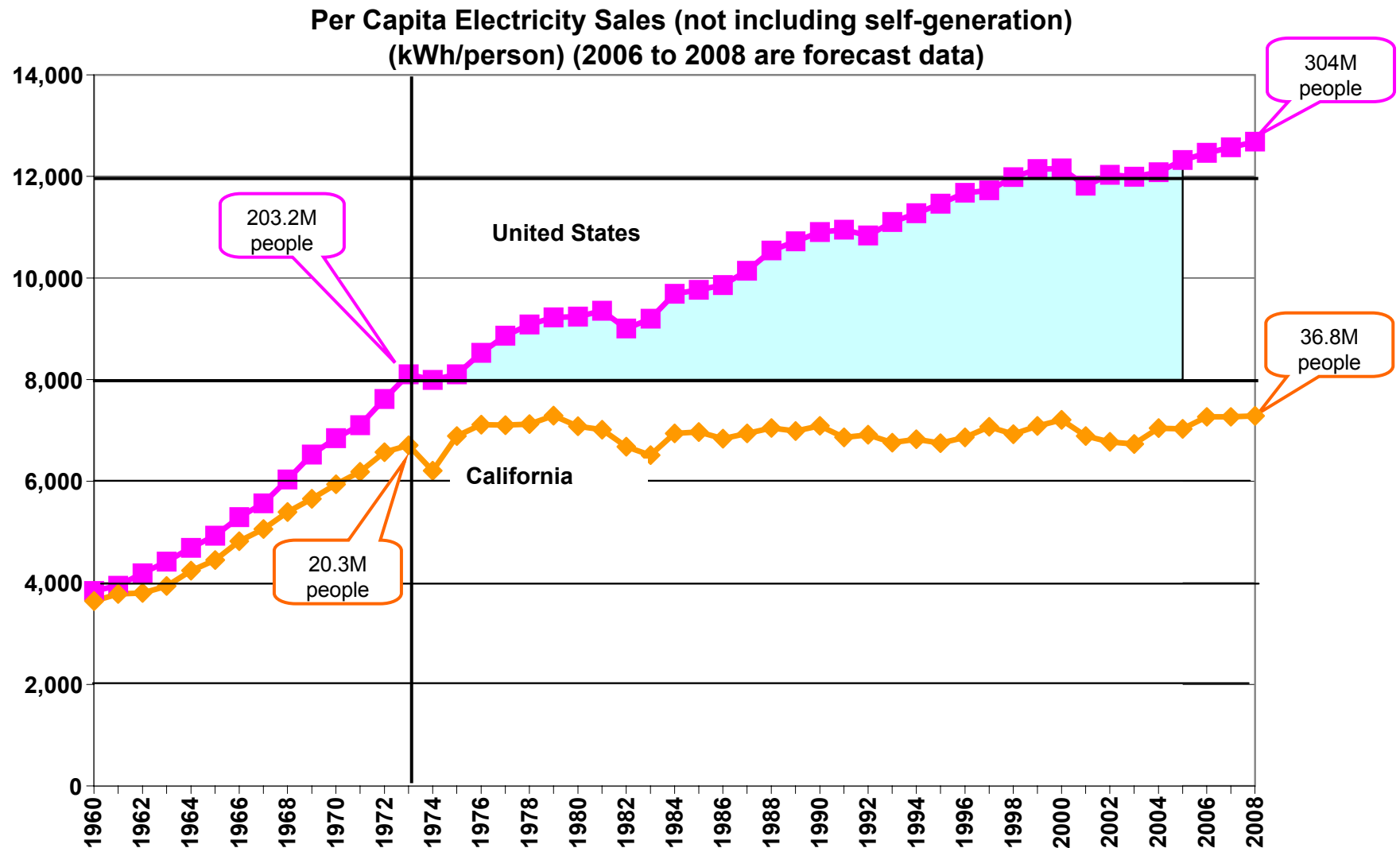
Sources:

- 80 PLUS® : <http://www.80plus.org/>
- Climate Savers® Computing Initiative: <http://www.climatesaverscomputing.org/>
- ENERGY STAR®: http://www.energystar.gov/index.cfm?c=revisions.computer_spec



All in 1 PC

Energy Efficiency Works: California Example



Sources: California Energy Commission, U.S. Census Bureau

ON Semiconductor and Energy Efficiency

ON Semiconductor's purpose is to Save Energy by providing power management & LED lighting solutions enabling our customers to meet and exceed worldwide power management regulations (efficiency, standby power, low quiescent current, PFC...) at cost parity or lower when compared to conventional solutions.

ON Semiconductor has TODAY in production the technologies and products to enable efficient power supplies & LED lighting applications.



Power Supply Focus Applications



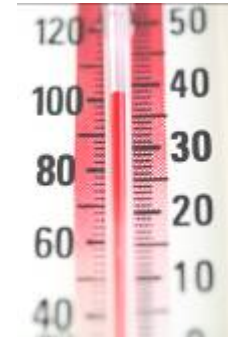
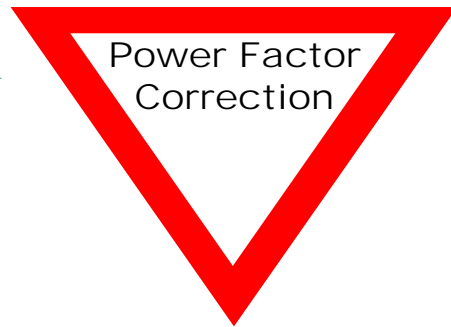
- Desktop PC
- Adapters (Notebooks, Printers, Gaming): **#1 MARKET SHARE**
- Flat TVs
- Solid State Lighting (LED)
- Smart Grid (Smart Meters)
- Digital Consumer (STB/DVD)
- White Goods



Vincent Thomas Bridge,
San Pedro (near Long Beach), CA
(each blue light is a string of 7 blue LEDs powered by NCP1216)



Challenges for Power Supplies and LED General Lighting Applications



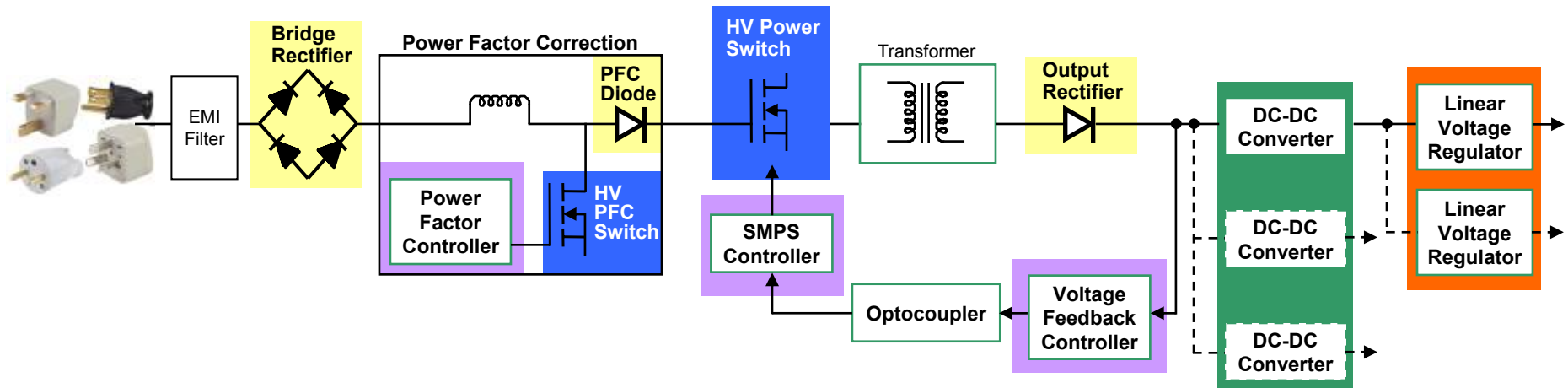
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Reliability

Same challenges faced in power supplies and in LED General Lighting applications

- Efficiency is important, even at low power due to overall efficacy requirements and thermal constraints
- In many cases power factor correction is required at relatively low power
- Space is limited, especially in bulb replacement
- Overall supply reliability is important
- Wider range of input power range including 277 Vac
- Lighting specific requirements like triac dimming
- Standards and safety rules are still evolving

Efficient Power Supply Solutions



Leadership
Products

- PFC Controllers
- AC-DC Controllers
- HV MOSFETs
- LED Drivers
- Rectifiers
- Secondary Sync. Rectification Controllers
- DC-DC Switching Regulators
- LDO voltage regulators



Leadership
Solutions

Energy Efficiency

- Computing Power Supplies
- Adapters (Printers, Game consoles, Notebooks, cell phones, etc...)
- Digital Flat TV
- Solid State Lighting (LED)



ATX high efficiency reference design

- 80+ Compliant 300 W, ATX Reference Design Documentation: [TND313/D](#)
- >85% Efficient, 255 W Power Supply Reference Design for ATX Desktop PC : [TND359/D](#)

TV power supply reference design

- 160 W CRT TV Power Supply Reference Design Documentation: [TND315/D](#)
- 220 W LCD TV 2nd Generation Power Supply Reference Design Documentation : [TND316/D](#) featuring NCP1396 and NCP1605 (should have a new 1397 version?)
- 220 W LCD TV Power Supply Reference Design : [TND321/D](#) featuring NCP1395, NCP5181 and NCP1653
- Up to 180 W High Voltage LCD TV Power and Integrated Inverter Supply (LIPS): [TND360/D](#)

Adapter (Notebook & Printer PSU)

- 90 W Notebook AC-DC Adapter Reference Design Documentation: [TND317/D](#)
- 60 W Notebook AC-DC Adapter Reference Design Documentation: [TND318/D](#)
- 40 W Printer Power Supply Reference Design Documentation: [TND320/D](#)

Others (Game console, STB, Phone charger, etc)

- 5W CCCV Cell Phone Charger: [TND329/D](#)
- 16 W xDSL Modem AC-DC Adapter: [TND330/D](#)
- 8 W, ENERGY STAR-compliant, 3-output quasi-resonant flyback converter for ASTC DTA (Digital To Analog converter): [TND332/D](#)
- 50 W Set-Top Box Power Supply Reference Design: [TND334/D](#)
- 200 W Game Console AC-DC Adapter Reference Design: [TND331/D](#)

Solid State Lighting (LED Lighting)

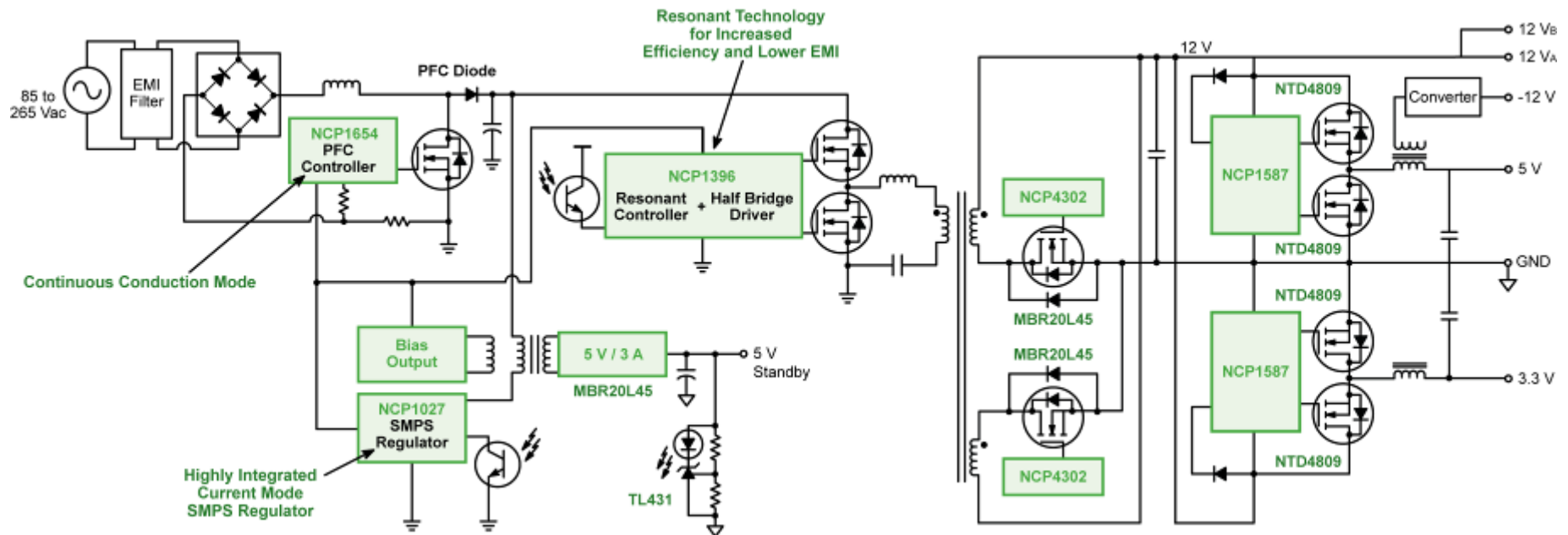
- Offline LED Driver Reference Design for ENERGY STAR® Residential LED Luminaire Applications: [TND371/D](#)
- LED Driver Reference Design for 1 to 5 W MR16 LED Bulb: [TND373/D](#)



GreenPoint® is ON Semiconductor's family of high-efficiency power supply reference designs that meet existing or emerging energy efficiency standards



>85% Efficient, 255 W Power Supply Reference Design for ATX Desktop PC



GreenPoint
From ON Semiconductor

Specification	20% load	50% load	100% load
<ul style="list-style-type: none"> Multiple-Output Non-Redundant PFC 0.9 at 50% 	85%	88%	85%

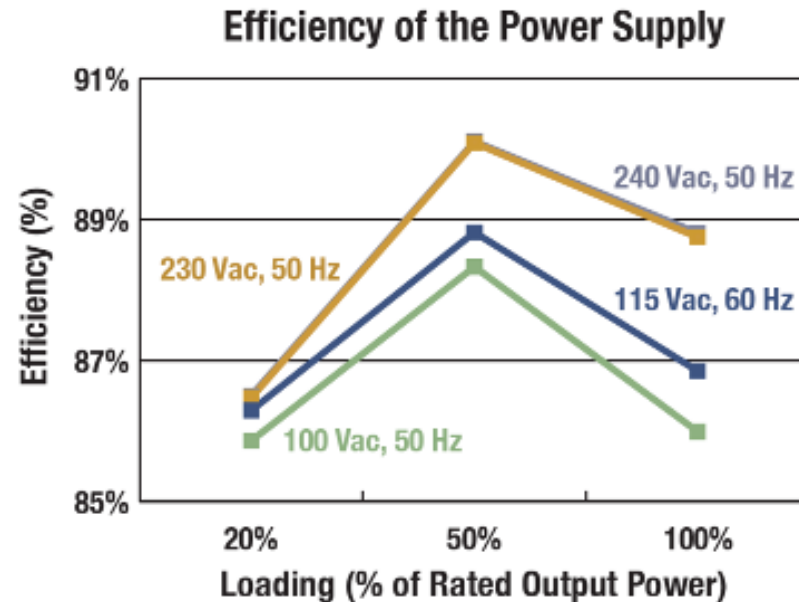


Climate Savers 3

Reference Design Documentation: [TND359/D](#)

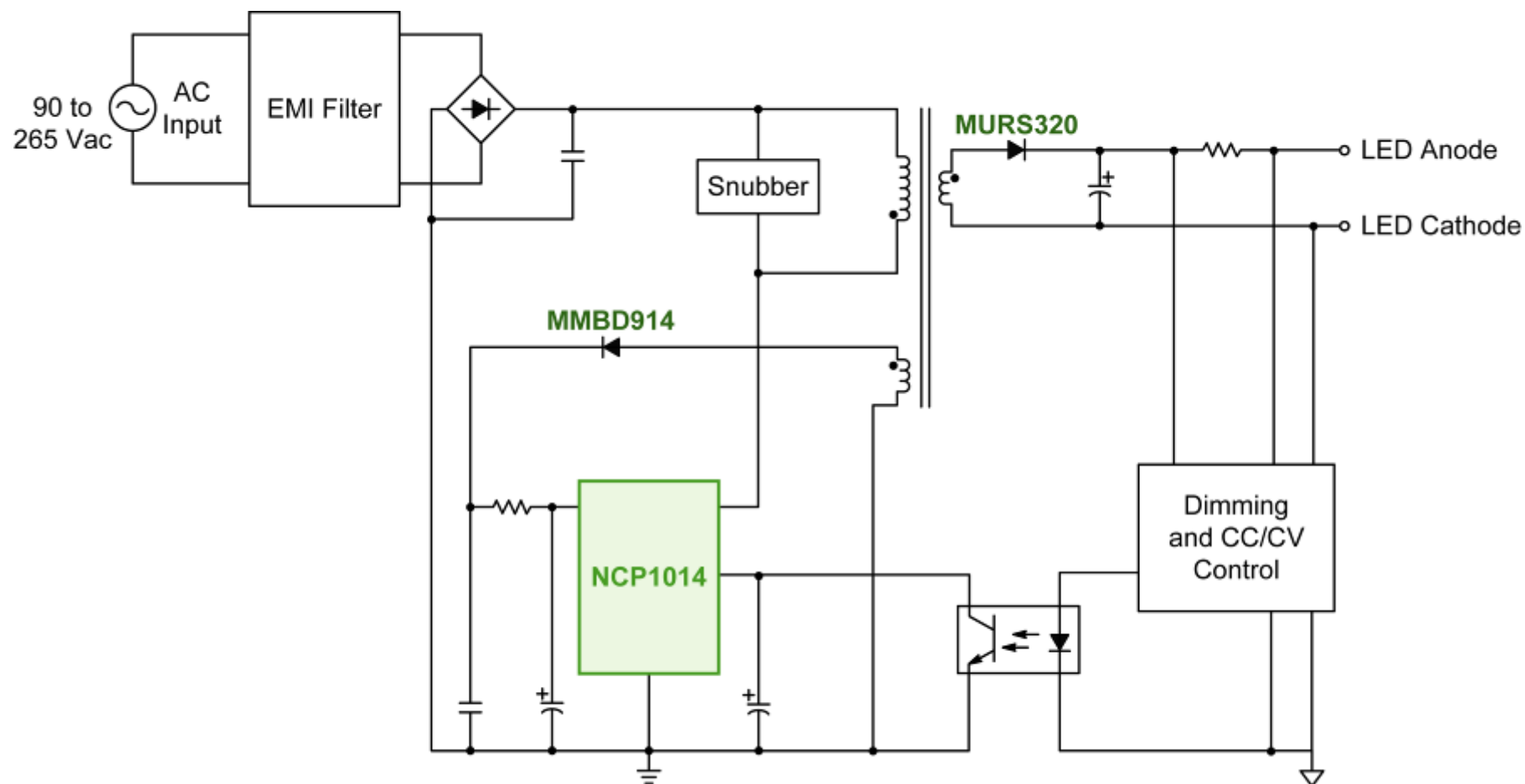


>85% Efficient, 255 W Power Supply Reference Design for ATX Desktop PC



- Compliant with ENERGY STAR® 5.0 and Climate Savers Computing Initiative Step #3
- Certified 80 PLUS Silver level
- Efficiency > 85%
 - at 100, 115, 230 and 240 Vac
 - at 25%, 50%, and 100% of rated output power
- Meets IEC61000-3-2 for Power Factor. PF > 0.95 at 100, 115, 230 and 240 Vac
- All measurements obtained at the end of a 41 cm (16 inch)-long cable
- Production ready design: fully tested, robust and cost effective.

Desk Lamp Redesigned with LED Module



References:

- Design Note: [DN06051/D](#)
- White Paper: [TND358/D](#)
- GreenPoint Reference Design: [TND371/D](#)

GreenPoint[®]
From ON Semiconductor

Desk Lamp Redesigned with LED Module

Retail Store



- Halogen bulb
- No electronics, just a 60 Hz transformer (weight 1.2 kg, 2.4 lbs)

17.8 Lux/Watt



ON Semiconductor®

- LED module: Cree MC-E (4000 K color temperature)
- 8 W power supply in lamp base built around ON Semiconductor's NCP1014



72.9 Lux/Watt

Bulb Type	Input Power (W) @ 120 Vac	Illuminance (Lux)*	Power Factor
Halogen (35 W bulb)	41.7 W	744	0.961
LED module	10.9 W	795	0.857

* Measured at a distance of 0.5 meters

The LED lamp produces more light than halogen bulb for ¼ of power !!

Halogen Desk Lamp Conversion to LEDs White paper: [TND358/D](#)

Offline LED Driver for ENERGY STAR® Residential LED Luminaire Applications: [TND371/D](#)



High Voltage MOSFETs

ON Semiconductor introduces High Voltage MOSFETs in order to offer a “total system solution” to power management and continue our dedication to becoming the premier supplier of quality, cost effective, performance power management solutions.

- **Phase 1 – Introduce 600 V Product Family** **2Q09**
 - NDF10N60ZG, NDF06N60ZG, NDF04N60ZG in TO-220FP
- **Phase 2 – Expand HVFET Portfolio** **2H09**
 - Expand 600 V family and introduce additional voltage families: 500 V, 620 V
 - Add additional package: DPAK, IPK, and TO-220
- **Phase 3 – Expand HVFET Portfolio** **2010**
 - Introduce additional voltage families: 650 V, 700 V, 800 V, 900 V
 - Add additional packages: I2pak, D2PAK, TO3P
- **Phase 4 – High-performance HVFET technology** **2011**
 - Introduce internal Super-Junction technology
 - Lower Rdson performances and smaller die sizes



600 V High Voltage MOSFETs

Features

- Low on-resistance
- Low gate charge
- Fast switching
- Zener-protected gate
- Pb-free **Pb**
- Industry standard packages

Benefits

- Improved efficiency
- Faster turn-on
- Reduced dynamic power losses
- Resistance to ESD
- RoHS compliance
- Standard footprint for direct drop-in

Applications

- Adapter (notebook, printer, gaming)
- LCD panel power
- Lighting ballasts



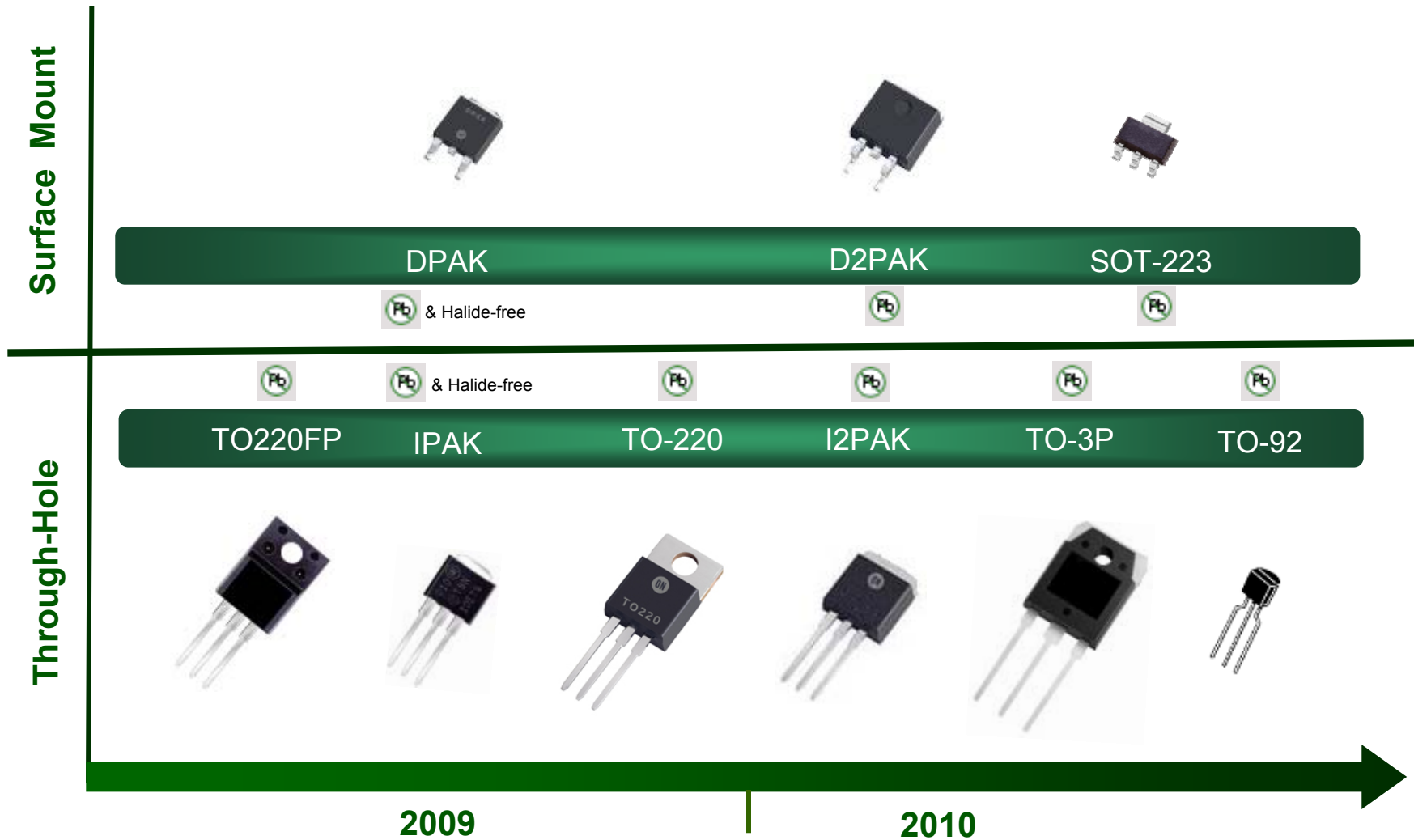
Markets

- AC-DC and DC-DC SMPS for consumer & industrial apps
 - PFC and other boost converter
 - Buck & flyback converters
 - Half bridge
 - Single and two switch forward

Part Number	V _{DSS} (V)	I _D (A)	Typical R _{DS(on)} (Ω) (25°C, @ 50% I _D)	Package	Samples Availability Date	Release to Market Date
NDF10N60ZG	600	10	0.65	TO-220FP	Now	✓ 29-Apr-2009
NDF06N60ZG	600	6	1	TO-220FP	Now	✓ 16-Jun-2009
NDF04N60ZG	600	4	1.8	TO-220FP	Now	✓ 16-Jun-2009
NDD04N60ZT4G	600	4	1.8	DPAK	Now	✓ 4-Aug-2009
NDD04N60Z-1G	600	4	1.8	IPAK	Now	✓ 4-Aug-2009



HV MOSFETs Package Offering



Rectifiers Portfolio

- *One of the broadest portfolios in the industry*
- *Investing in new technologies to become the recognized leader in high efficiency output rectifiers and PFC diodes*

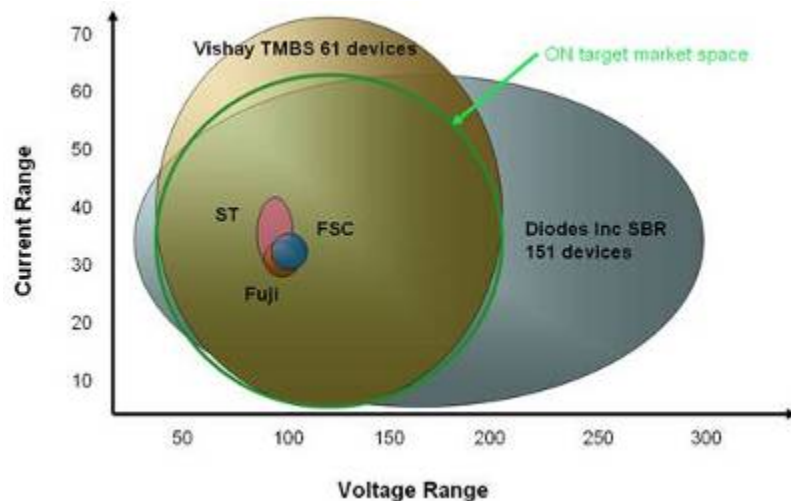
	2006 Rank	2007 Rank	2008 Rank	Company Name	Market Share
Schottky	1	1	1	Vishay Intertechnology	14.7%
Ultrafast	2	2	2	Shindengen Electric Manufacturing	10.1%
	3	3	3	STMicroelectronics	7.4%
	4	4	4	ON Semiconductor	6.2%
Ultrasoft	8	8	11	Fuji Electric Device Technology	3.3%
	6	7	7	Sanken Electric Company	4.0%
Fast Recovery	5	6	9	Nihon Inter Electronics	3.6%
	7	5	5	Semikron International	4.5%
	12	9	10	Robert Bosch	3.4%
Std Recovery	9	9	6	Toshiba	4.2%
	10	10	12	Hitachi	3.1%
	11	11	8	Lite-On Semiconductor	3.8%
Auto Surge Suppressors					

Source: iSuppli

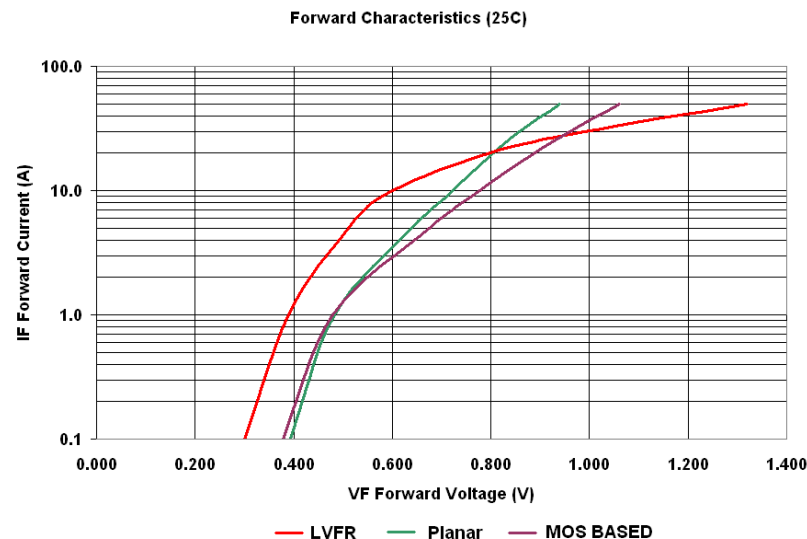


Low Voltage Rectifier Market

Battleground



Device Performance



Strategy

- Introduce new Schottky Rectifier Platform (LVFR) targeted at power supply, automotive, telecom and solar applications
 - Replace part of existing portfolio at stronger margins and expand current portfolio with wide range of voltages and currents (45-200 Volts, 10-60A)
 - Superior performance and smaller die size compared to existing planar solutions
 - Launch portfolio at APEC 2010 on demo reference designs
 - Add SMD portfolio in 2011 / 2012

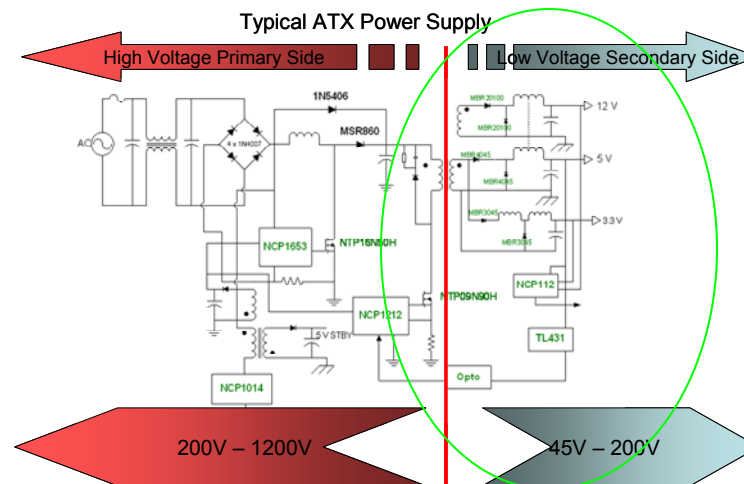
Market Driver

- Green (efficiency) requirements in AC adaptor market and expanding panel size in FPTV.

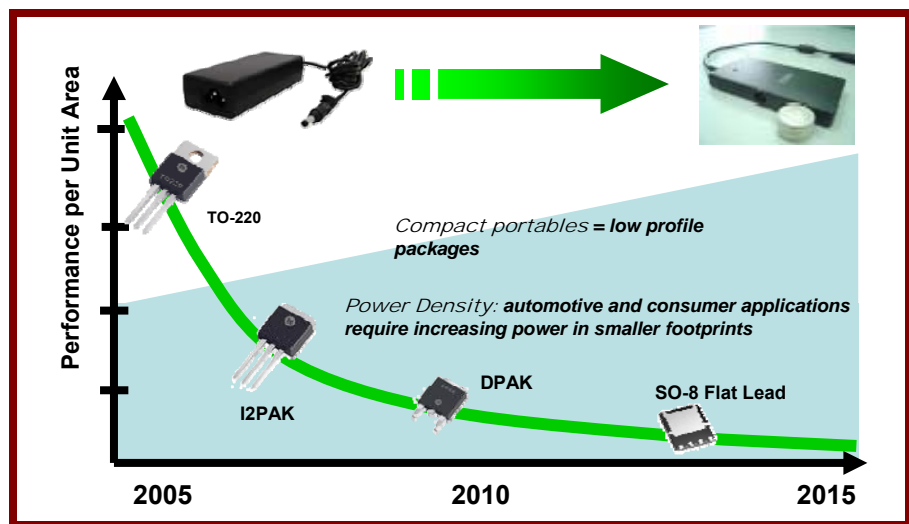
Phase

- Customer samples Oct '09, RTM 1Q10

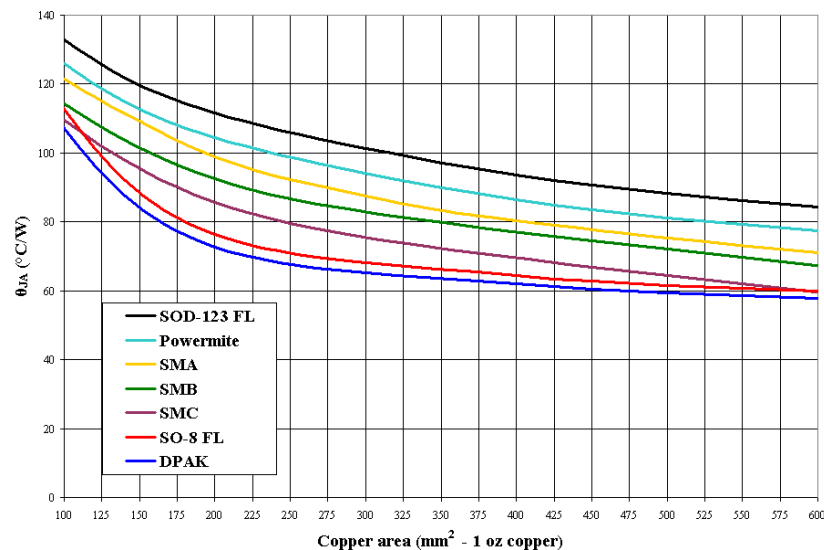
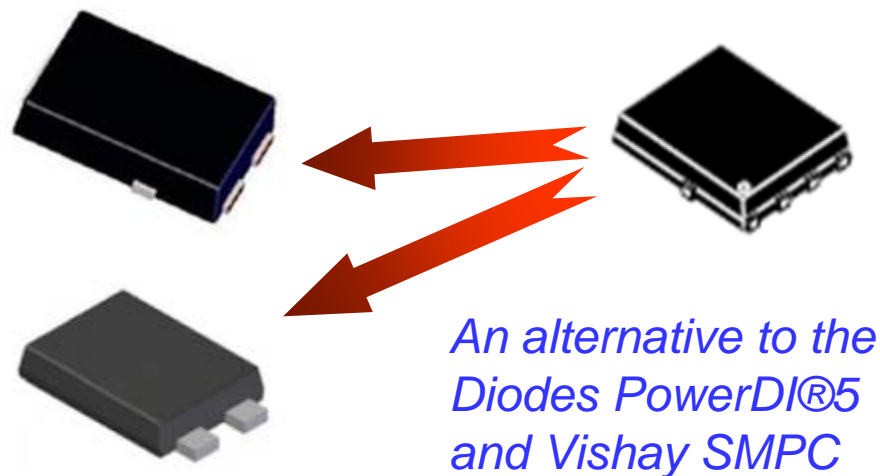
Applications – Output Rectification



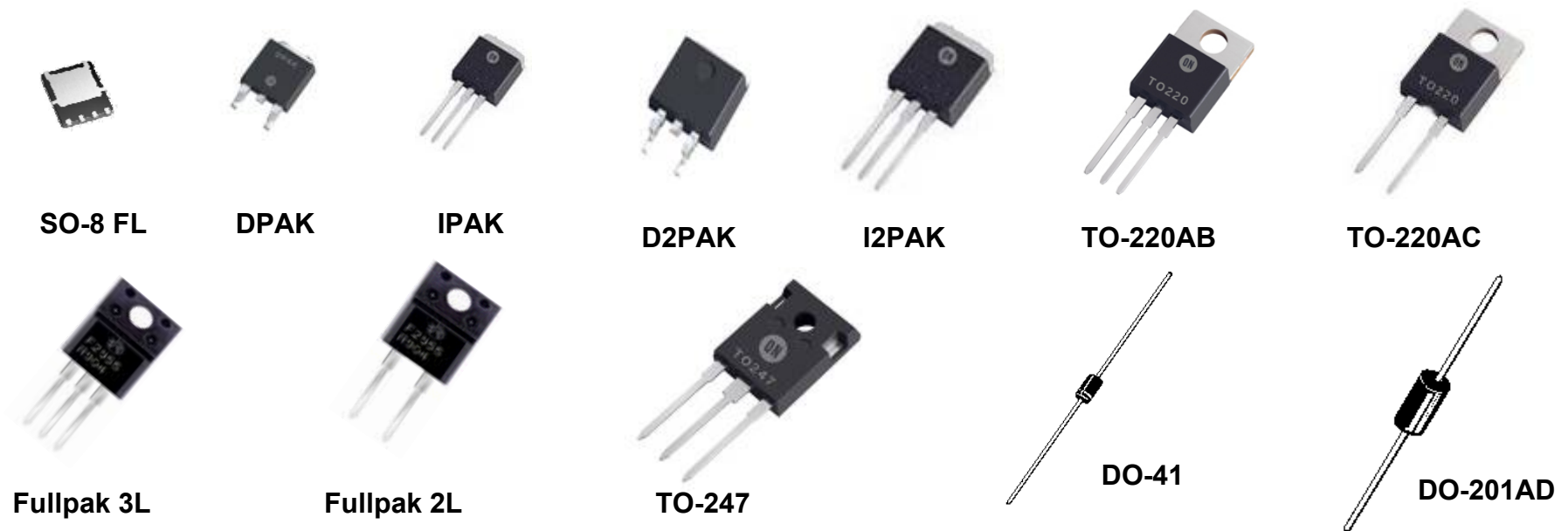
New Rectifier Package Offering: SO-8 FL



- We are now able to offer schottky rectifiers in the SO-8 flat lead package
- Thermal performance almost as good as the DPAK in a compact low profile footprint



Rectifier Package Offering



Products for Broad Range of LED Applications

• Large Display

- Architectural Lighting
- Addressable and Video Signage

• General Lighting, AC Line Powered

• General Lighting, Wide DC input

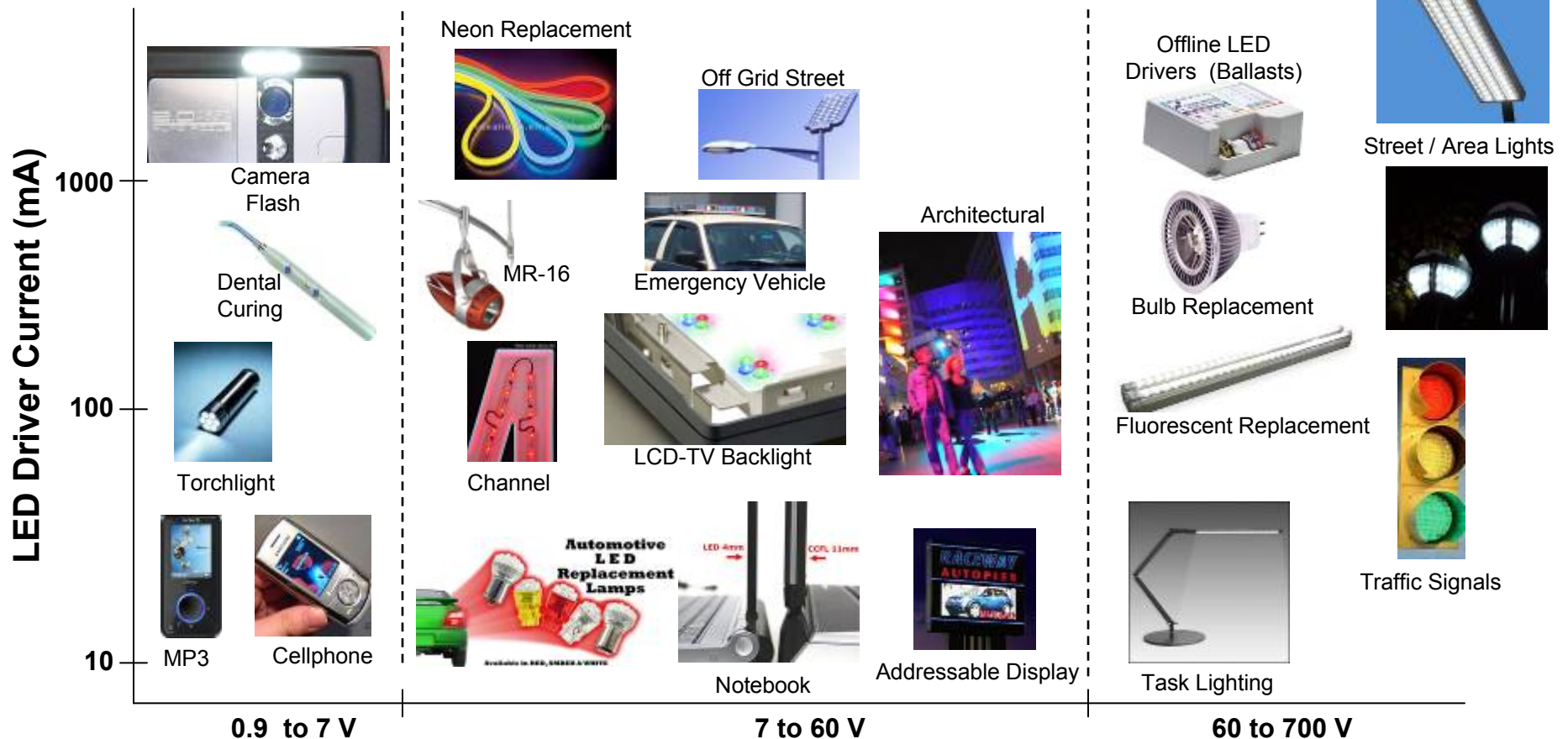
- Automotive
- Low Voltage AC (12 Vac / 24 Vac)
- DC and Solar Powered Lighting

• Portable Applications

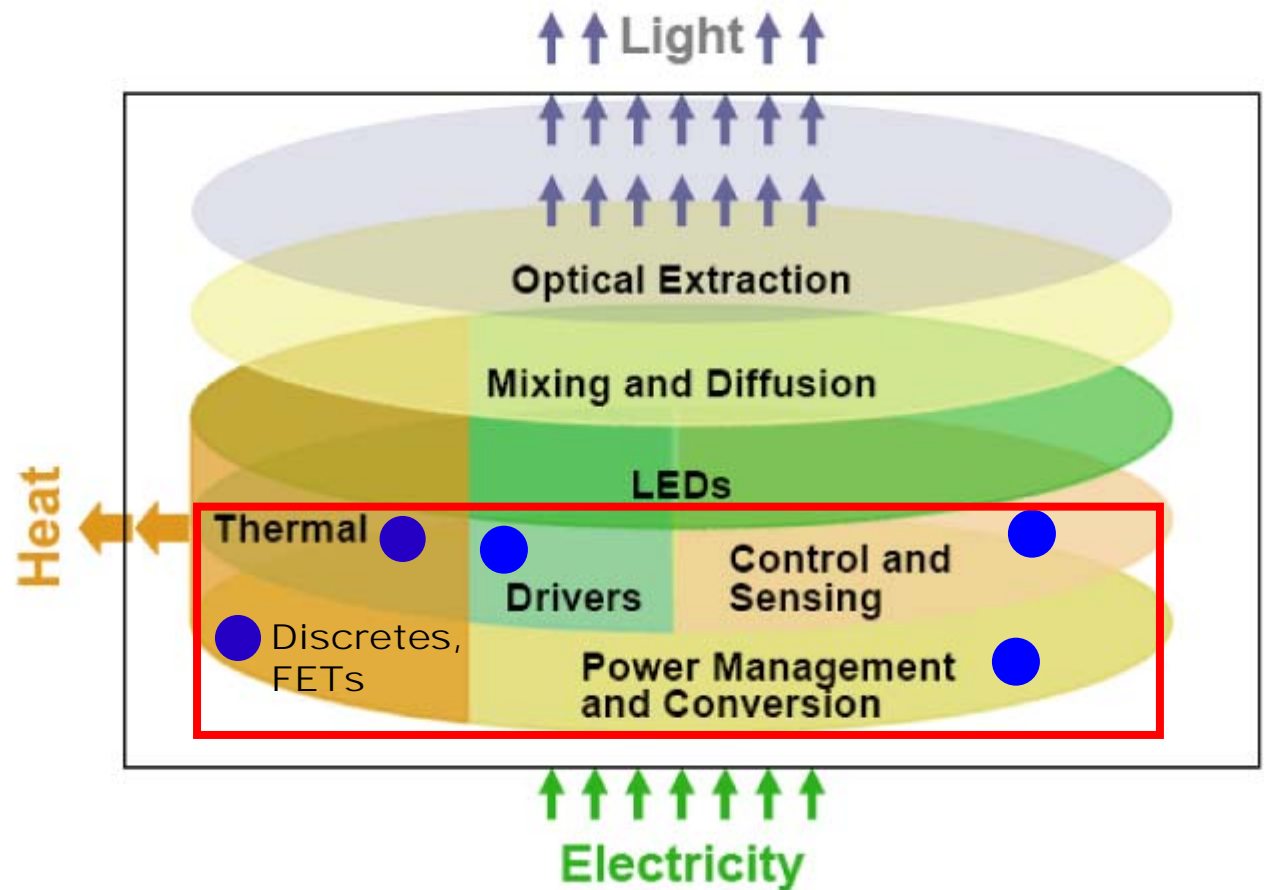
- Small LCD Backlighting (Mobile phones, Digital Cameras)
- Camera Flash
- Torch and Flashlights
- OLEDs

• Medium Size LCD Backlighting

• Drivers for Indicator LEDs



Typical Lighting System



Visit ON Semiconductor's LED Website

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Power Solutions for the Semiconductor Industry

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Computing and Peripherals
Consumer and Portable
Industrial and Medical
Networking and Telecommunications
LED Lighting
Power Supply

High Brightness LEDs (HB-LED) and High Power White LEDs are poised to enable a market transition to energy efficient Solid State Lighting (SSL). ON Semiconductor provides inductive and charge pump LED drivers; switching regulators, linear regulators, and constant current sources; MOSFETs and rectifiers; power factor correction (PFC) ICs, and high voltage switch mode power supply solutions to enable customers to build high efficiency LED driver solutions - whether powered from the AC main or a low voltage DC power source.

LED Lighting Interactive Block Diagrams

Build a customized list of products to complete your design, by using these interactive application diagrams.

- Automotive Interior, CHMSL, Tail Light
- Cell Phone Camera Flash
- Garden Lighting
- LCD Backlighting
- Low Voltage Interior Lighting
- Off-Line Exterior Lighting
- Off-Line Interior Lighting
- Portable Flashlight (Torch)
- Signage/LED Ballast

Technical Information

Design Notes (6)	Collateral Brochures (1)
Tutorials (1)	

LED Lighting Solutions

Solution Sets

A variety of solutions are required, depending on the power source (portable battery, offline, automotive, or powered from a low voltage AC or DC supply) and the LED configuration (series, parallel, combination), requiring different constant current drivers - linear, buck (step-down) or boost (step-up), or even a flyback or buck-boost.

- LED Driver Design and Selector Guide
- Backlighting LED Driver, Charge Pump
- Backlighting LED Driver, Inductive
- Interior Automotive Lighting

Industry Information

Visit these sites for more information on standards and commercial information.

- ENERGY STAR® SSL Initiative
- National Equipment Manufacturers Association Solid State Lighting Section
- Lighting Research Center at Rensselaer Polytechnic Institute
- Solid State Lighting and Display Center at the University of California, Santa Barbara
- Cree XLamp® LEDs

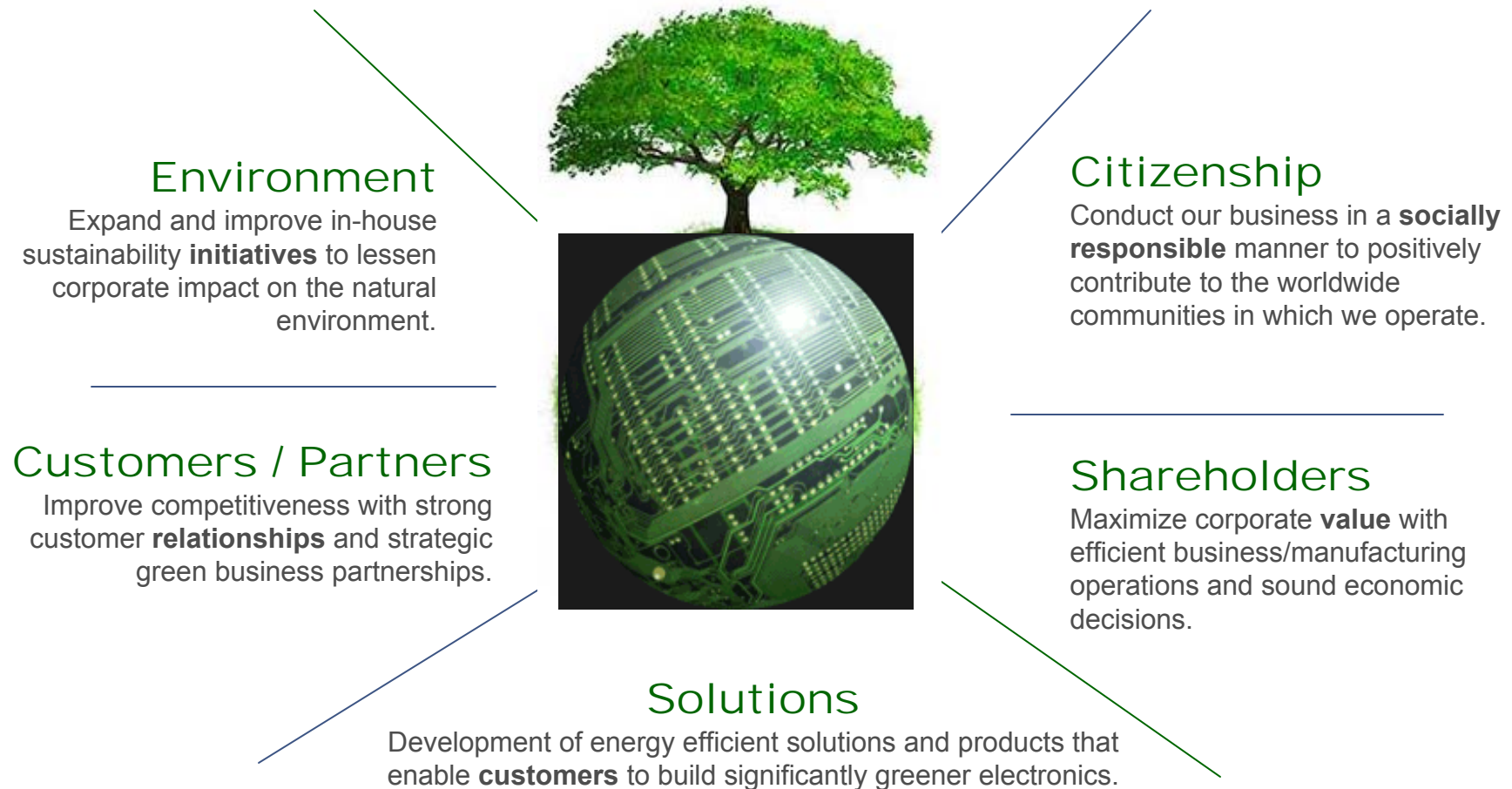
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Sustainability @ ON Semiconductor

Lean Operations, Efficient Solutions and Strategic Partnerships

ON Semiconductor is committed to supporting a greener world by reducing our carbon footprint, actively conserving resources, and effectively partnering with like-minded customers and industry organizations. With an in-house team dedicated to sustainability excellence, ON Semiconductor has achieved marked successes within our many conservation programs



Conclusion

- Significant product portfolio enhanced by recent acquisitions of AMI and Catalyst: leading suppliers of Power Analog and Power Discrete components
- ON Semiconductor has TODAY in production the technologies and products to build efficient power supplies & LED lighting applications.
- ON Semiconductor is a **complete solution provider**, offering differentiated reference designs at **high performance and lower overall system costs**
- ON Semiconductor's holistic approach
 - ↑ Active mode efficiency
 - ↓ Standby power
 - Power Factor Correction
- Our  reference designs meet regulatory requirements around the world (ENERGY STAR®, Europe Code of Conduct, Europe EuP Ecodesign, Europe Eco-Label, California Energy Commission, China CNIS, and other international agencies such as Australia Greenhouse Office, Korea e-Standby program, Japan Top Runner program and Eco Mark program)



For More Information

- View the extensive portfolio of power management products from ON Semiconductor at www.onsemi.com
- View reference designs, design notes, and other material supporting the design of highly efficient power supplies at www.onsemi.com/powersupplies

