

## TEXAS INSTRUMENTS — POWER MANAGEMENT STRATEGY

### ABSTRACT

This report delivers an in-depth and comprehensive coverage of TI's power management business, products, and technologies from a range of perspectives including:

- TI's position and performance in Power ICs
- Power IC fit and role with TI's overall business
- Areas of thrust, product development, and leverage
- Business and product portfolio segmentation
- Product portfolio analyses by product category of about 3,400 generic standard products
- Process technology and manufacturing strategy and trends

TI is the undisputed market leader and trend setter in power management. TI broadly covers all Power IC market segments. Standard Power ICs represent the highest growth part of TI's Analog Group which itself represents 51 percent of TI's semiconductor revenues, 40 percent of operating profits, and 94 percent of all standard products.

The Power IC landscape is rapidly evolving – new technologies are being developed, new competitors are entering the Power IC market, new market segments and applications are opening up -- often with unique requirements. Even well established mega-markets are changing process technologies that are used – driven, for example, by the integration of added sensor functionality.

An in-depth understanding of product lines, actions, and positioning a leading Power IC vendor helps the assessment of the Power IC market potential and development of strategies for its various growth segments such as smart grid, digital power, LED lighting, energy harvesting, wireless power transmission, and many others.

This report provides a valuable resource for business strategy and development and product marketing professionals in the power management area.

The report is structured into eight parts.

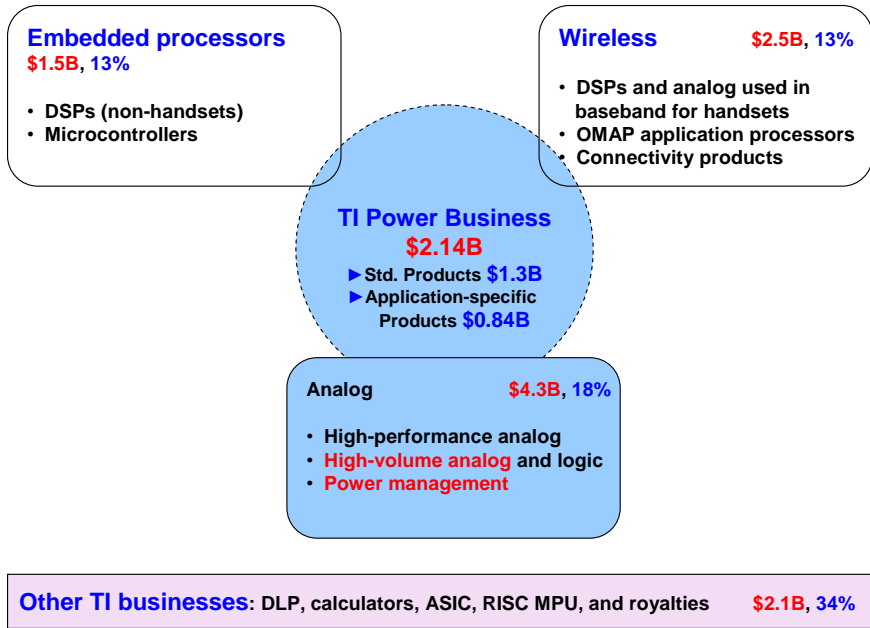
**Section 1** provides an introduction and overview of the report.

**Section 2** delivers key findings and implications that serve as an executive summary. Our latest in a series of in-depth analyses of Texas Instruments confirms that its current strategic leadership and future financial revenue and profitability performance in Power Management ICs are significantly underestimated.

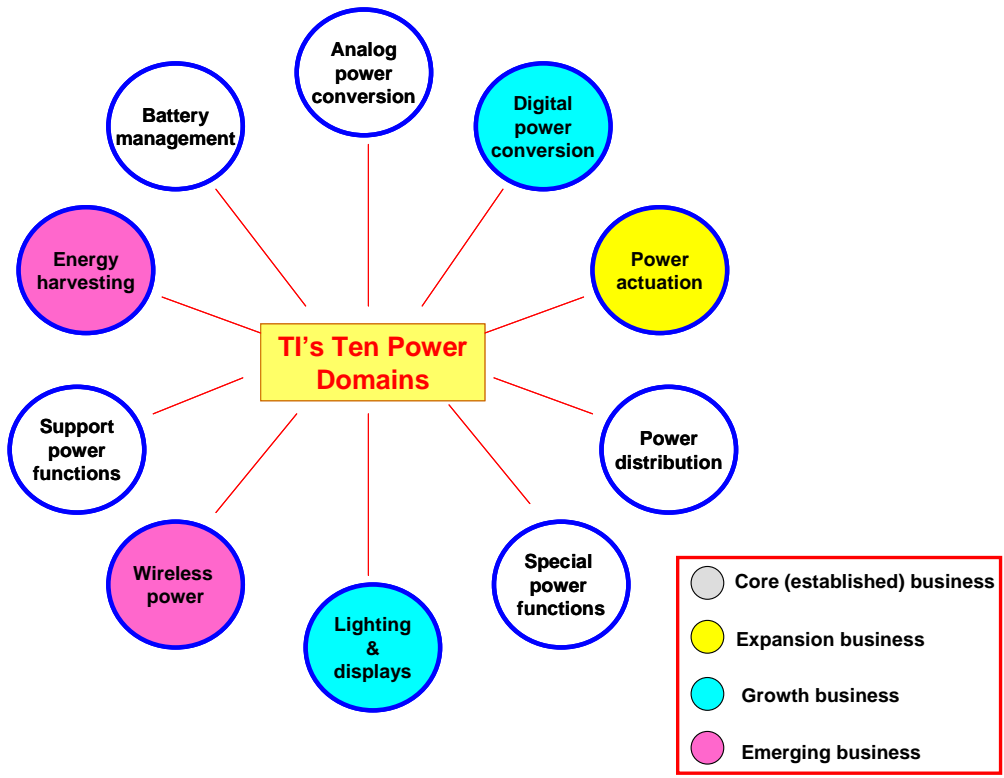
TI 2009 Power Management ICs Revenues (\$B) and MS			
	TI	Total Market	TI 2009 Market Share
<b>Total Power ICs</b>	<b>2.14</b>	<b>17</b>	<b>13%</b>
<b>General-purpose (Standard)</b>	<b>1.3</b>	<b>7</b>	<b>19%</b>
-- Digital Power	0.07	0.58	12%
<b>Application-specific</b>	<b>0.84</b>	<b>10</b>	<b>8%</b>

**Section 3** provides an overview of TI's business segments and strategy with an emphasis on power management. This section explores how TI leverages the power management business and provides insights into financial performance by business segment and product category.

Total TI 2009 revenues: **\$10.4B**  
 Operating margin: **19%**



**Section 4** introduces our segmentation of TI’s power products into ten power domains—five of which address high and emerging growth market opportunities. These include digital power, lighting and display power, energy harvesting, and wireless power. This section provides an overview of TI’s product portfolio and revenue by product category as well as integration trends.

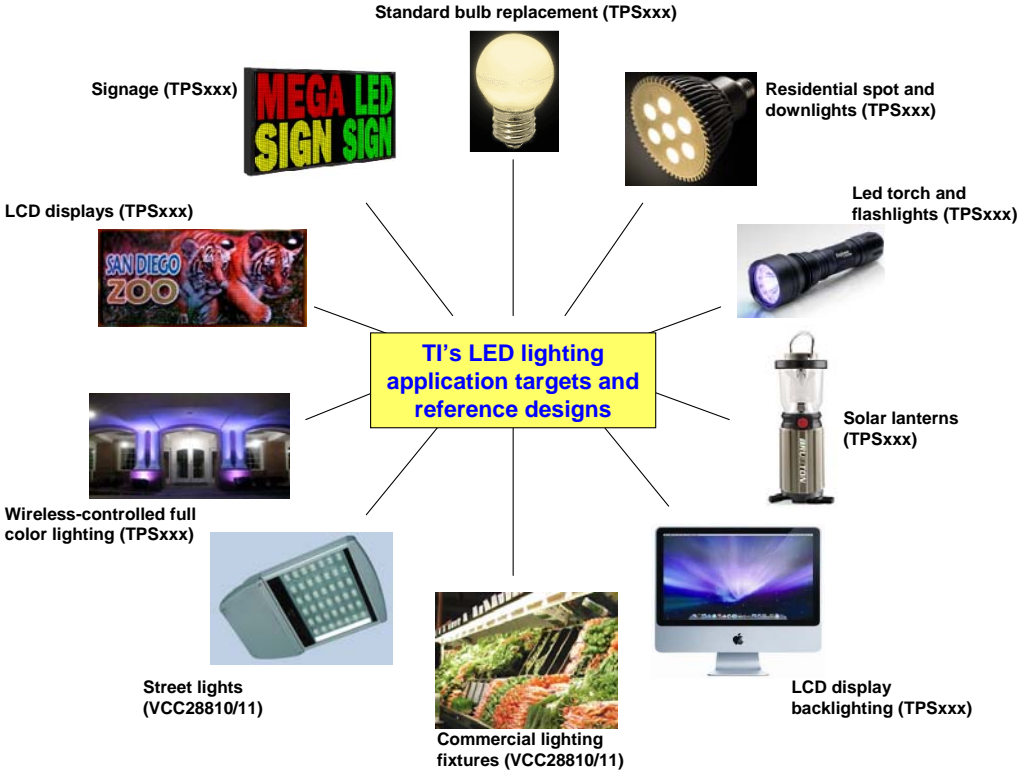


**Section 5** analyzes in depth five core power domains. Key product lines and market segmentation are analyzed, including analog power conversion, power actuation, power distribution, battery management, special power functions, and the support power functions domain.

Vendor	General purpose	Application specific	Single-function			Multi-function	Power switch			
			Inductor based	Charge pump	Linear / LDO		Internal	External	DMOS/MOS	Bipolar
<b>TI</b>	●	●	●	●	●	●	●	●	●	
National	●	●	●	●	●	●	●		●	●
Linear	●	●	●	●		●	●	●	●	●
Maxim	●	●	●	●	●	●	●	●	●	
Intersil	●	●	●	●	●		●	●	●	
Analog Devices	●	●	●	●	●	●	●	●	●	●
AnalogicTech	●	●	●		●	●	●		●	
MPS	●		●	○	●	●	●		●	
Infineon		●	●		●	●	●	●	●	
Rohm	●	●	●		●	●	●	●	●	
STMicroelectronics	●		●	●	●	●	●	●	●	

Power Domain	Number of Generic Standard Products	% of total	Standard Products Revenue (\$M)	% of total	Dominant product types
<b>Analog power conversion</b>	<b>2,154</b>	<b>62%</b>	<b>750</b>	<b>58%</b>	Non-isolated DC/DC converters
Support power conversion	407	12%	140	11%	
Power distribution	241	7%	70	5%	
Battery management	223	6%	80	6%	Battery charger ICs
Lighting displays	160	5%	70	5%	LED drivers
Power actuation	118	3%	50	4%	Power MOSFET drivers
<b>Digital power conversion</b>	<b>75</b>	<b>2%</b>	<b>70</b>	<b>5%</b>	Non-isolated DC/DC converters
Special power functions	64	2%	50	4%	Motor control
Energy harvesting	41	1%	20	2%	Solar energy products
Wireless power	1	0%	0	0	First product introduction
<b>Total</b>	<b>3,484</b>	<b>100%</b>	<b>1,300</b>	<b>100%</b>	

**Section 6** focuses on high growth power domains including digital power and lighting and the display power domain. It provides insights into the strategic significance of digital power technology for TI's future growth and profitability.



**Section 7** focuses on the emerging growth power domains including energy harvesting and the wireless power domain and how TI addresses these new market opportunities



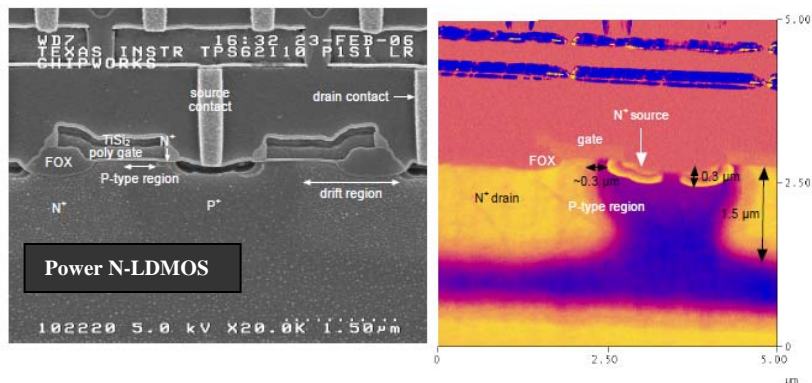
**Section 8** focuses on TI's process technologies and manufacturing strategy. The state-of-the-art modular power BiCMOS-DMOS (BCD) process technologies and consolidation of manufacturing provide TI with a distinct and decisive competitive advantage. LBC7 (250nm, 40V) is the current workhorse BCD process introduced in 2005. It generates about 40 percent of TI's total analog production and is dominated by power management ICs—both standard and application specific.

**Process Modularity**

Power domain	Major product type	CMOS	Bipolar	BiCMOS	BCD
Analog power conversion	Isolated AC/DC and DC/DC power supplies • PWM power supply controllers • Power factor correction (PFC) ICs • Power supply support	– – –	46% 34% 75%	18% – 25%	36% 66% –
	Non-isolated switching DC/DC ICs • DC/DC converters (integrated switch) • DC/DC controllers (external switch) • Charge pumps (inductorless regulators)	– – –	9% 11% –	54% 89% 100%	37% – –
	Linear regulators • LDOs • Standard	– –	13% 100%	61% –	26% –
	Integrated power management units	5%	–	–	95%
Digital power conversion	• Digital power controllers	100%	–	–	–
	• Digital power control drivers	–	–	–	100%
	• Digitally managed analog PWM controllers	–	–	–	100%
	• Digital power monitoring and sequencing	100%	–	–	–
	• Microcontrollers (Piccolo family)	100%	–	–	–
Power actuation	• Power MOSFETs • MOSFET driver ICs	– –	– –	– –	Specialty 100%
	Power distribution	–	–	–	100%
Special power functions	• Hot swap controllers and switches	–	4%	38%	58%
	• USB and PCMCIA controllers and switches	–	–	–	100%
	• Power muxes and current limited switches	–	–	–	100%
	Motion/motor control, other	53%	15%	22%	10%
Lighting and displays	LED drivers, photo-flash capacitor chargers, HID lamp controllers, CCFL backlight converters, LCD/OLED display bias ICs	–	4%	68%	28%
Wireless power	Inductor couples wireless chargers	n/a	n/a	n/a	n/a
Support power functions	• Voltage supervisors	100%	–	–	–
	• Voltage references	–	100%	–	–
Energy harvesting	• RF SOCs and low power RF ICs	–	–	100%	–
	• Microcontrollers (MSP430FSF5xx family)	100%	–	–	–
Battery management	• Charge management	–	4%	35%	61%
	• Fuel gauge, protection, authentication	89%	–	–	11%

Section 8 takes an in-depth view of the TI's workhorse modular BCD process (LBC7) used to manufacture about 40 percent of the analog products.

Courtesy of Chipworks



# TEXAS INSTRUMENTS — POWER MANAGEMENT STRATEGY

## TABLE of CONTENTS (86 pages, 78 figures)

<b>1</b>	<b>INTRODUCTION</b> .....	<b>6</b>
<b>2</b>	<b>KEY FINDINGS and IMPLICATIONS (Findings 1 to 14)</b> .....	<b>9</b>
<b>3</b>	<b>BUSINESS OVERVIEW and STRATEGY</b> .....	<b>20</b>
3.1	Business Segments	
3.1.1	Analog segment	
3.1.2	Embedded processing segment	
3.1.3	Wireless segment (handsets)	
3.1.4	“Other” segment	
3.2	Business Leverage	
3.3	Key Financial Data by Business Segment and Product Category	
3.4	Power Management Business Relevant Acquisitions	
3.5	Two Sources of \$2.14B Total Power Management Revenues in 2009	
<b>4</b>	<b>POWER PRODUCTS SEGMENTATION</b> .....	<b>26</b>
4.1	Standard Power Management Products	
4.1.1	TI power domains and positioning for growth	
4.1.2	Strategic significance of digital Power	
4.1.3	LED lighting market focus	
4.1.4	Energy harvesting market entry	
4.1.5	Wireless power market entry	
4.2	Application-Specific Power Management Products	
4.3	Integration Trends of TI’s Power Products	
4.4	TI’s Product Portfolio Overview and Revenue by Product Category	
<b>5</b>	<b>SIX CORE POWER DOMAINS OF TI</b> .....	<b>35</b>
5.1	Two Main End-Equipment Segments	
5.1.1	Non-portable AC line/primary battery powered products	
5.1.2	Portable rechargeable battery powered end-equipment segment	
5.2	Analog Power Conversion Domain	
5.2.1	Isolated power conversion products	
5.2.2	Non-isolated power conversion products	
5.2.3	Single-function switching DC/DC conversion ICs	
5.2.4	Multifunction DC/DC conversion ICs	
5.2.5	Plug-In modules	
5.3	Power Actuation Domain	
5.3.1	Power MOSFET driver ICs	
5.3.2	Power MOSFETs	
5.4	Power Distribution Domain	
5.5	Battery Management Domain	
5.6	Support Power Functions Domain	
5.7	Special Power Functions Domain	
<b>6</b>	<b>TWO GROWTH POWER DOMAINS</b> .....	<b>57</b>
6.1	Digital Power Conversion Domain	
6.1.1	Digital power controllers (digital signal controllers)	
6.1.2	Digital power non-isolated point-of-load (POL) DC/DC controllers	
6.1.3	Digital power control drivers and power stage implementations	
6.1.4	Other digital power products	

6.2	Lighting and Displays Power Domain	
6.2.1	LED driver ICs	
6.2.2	Color LCD/OLED display ICs	
6.2.3	Other lighting products	
6.2.4	Target LED lighting applications and reference designs	
<b>7</b>	<b>TWO EMERGING POWER DOMAINS</b>	<b>72</b>
7.1	Energy Harvesting Domain	
7.1.1	TI's products for micro-scale energy harvesting	
7.2	Wireless Power Domain	
<b>8</b>	<b>TECHNOLOGY and MANUFACTURING TRENDS</b>	<b>76</b>
8.1	Process Technology	
8.1.1	TI's workhorse BCD process attributes	
8.1.2	TI's 250nm BCD (LBC7) process and device attributes	
8.1.3	TI's modular platform technology strategy	
8.2	Manufacturing	

## LIST of FIGURES

3.1	TI's Business Segments—Revenues and Operating Margins (2009)
3.2	TI's Solutions Leverage with Power Management
3.3	TI Revenue Composition and Trends by Business Segment
3.4	TI's Acquisitions Reinforcing Power Management Business
3.5	TI's Standard Power Management Revenues by Power Domain
4.1	Ten TI's Power Domains
4.2	TI's Standard Power Products Portfolio by TI's Power Domain
4.3	TI's Power Business Positioning
4.4	TI Power Domain Attributes and Product Types
4.5	Digital Power Penetration Areas
4.6	Lifecycle Positions of TI's Power Technologies
4.7	Application-Specific Power Management Products
4.8	Integration Hierarchy of TI's Power Products
4.9	Number of Generic Products and Revenue per Product by Major Product Category
5.1	Non-Portable AC Line and Primary Battery Powered Power Products Categories
5.2	Intermediate Bus Architecture (IBA) vs. Non-Portable AC Line Powered Power Products
5.3	Portable Battery Powered Power Product Categories
5.4	AC/DC Power Conversion ICs by Product Type—TI vs. Select Vendors
5.5	Overview of TI's Low-to-High Power PWM Controllers
5.6	Non-Isolated Point-of-Load DC/DC Conversion ICs—TI vs. Select vendors
5.7	Non-Isolated DC/DC Conversion ICs—Topologies and Product Attributes
5.8	Comparison of Select Power Conversion IC Vendors by Key Product Portfolio Attributes
5.9	Single-Function Switching DC/DC Conversion ICs
5.10	Internal vs. External Power Switch—TI vs. Select Vendors
5.11	Internal DMOS/MOS vs. Bipolar Switch—TI vs. Select Vendors
5.12	Overview of TI's DC/DC Converters (Integrated Switch)
5.13	DC/DC Converter ICs by Topology—TI vs. Select Vendors
5.14	DC/DC Converter ICs by Topology and Number of Channels—TI vs. Select Vendors
5.15	DC/DC Converter ICs by Topology and Load Current—TI vs. Select Vendors
5.16	DC/DC Converter ICs by Topology and Input/Output Voltage—TI vs. Select Vendors
5.17	DC/DC Controller ICs by Topology—TI vs. Select Vendors

- 5.18 DC/DC Controller ICs by Topology and Number of channels—TI vs. Select vendors
- 5.19 DC/DC Controller ICs by Topology and Input/Output Voltage—TI vs. Select Vendors
- 5.20 Multifunction DC/DC Conversion ICs
- 5.21 Companion PMU for OMAP Application Processors
- 5.22 Multifunction DC/DC Conversion ICs by Functional Content—TI vs. Select Vendors
- 5.23 Multifunction Power Management ICs
- 5.24 Multifunction DC/DC Conversion ICs by Number of Channels—TI vs. Select Vendors
- 5.25 Overview of TI's Plug-In Module
- 5.26 Non-Isolated DC/DC Converter Module
- 5.27 Power MOSFET Driver ICs
- 5.28 NexFET Power MOSFETs
- 5.29 Power Distribution IC Applications
- 5.30 Battery Management IC Applications
- 5.31 Overview of Voltage Supervisor Products
  
- 6.1 Digital Power Conversion Domain Product Categories
- 6.2 TI's AC/DC Digital Power Products and Applications—Full Digital Control
- 6.3 Solar Power Inverter Example Using TI's Digital Power Controller
- 6.4 TI's Digitally Managed Analog PWM Controllers
- 6.5 TI's Full Digital Control PWM Controller
- 6.6 TI's Digital Power Control Driver IC (UCD7230)
- 6.7 TI's Digital Power Module (PTD8A015W PowerTrain™ Module)
- 6.8 TI's Digitally Programmable Sequencers
- 6.9 TI's Digital Power Monitor and Sequencer (UCD90120)
- 6.10 Overview of TI's Digital Power Product Portfolio
- 6.11 Lighting and Displays Power Domain Product Categories
- 6.12 White LED Driver ICs Overview (TPSxxx family)
- 6.13 LED Display Driver ICs Overview (TLCxxx family)
- 6.14 Color LCD/OLED Bias ICs
- 6.15 TI's Target LED Applications and Reference Designs
- 6.16 UCC28810 LED Driver with PFC
- 6.17 TLCxxx LED Driver for LED Display and Signage Applications
- 6.18 TPSxxx LED Driver for General Lighting and Backlighting Applications
  
- 7.1 Harvested Energy vs. Energy Source
- 7.2 CC340 RF SoC Technology Platform for Micro-Scale Energy Harvesting
- 7.3 AdaptivEnergy's Energy Harvester Module Using TI's Technology
- 7.4 Perpetuums' Energy Harvester for Powering TI's MSP340 MCU
- 7.5 Cymbet's EnerChip Thin-Film Battery Module for TI's Solar Energy Harvesting Kit
- 7.6 TI's bqTesla Wireless Charging Evaluation Kit
  
- 8.1 TI Standard Power Products vs. Process Technology
- 8.2 250nm LBC7 BCD Process Features
- 8.3 LBC7 Process Device Attributes—Power N-LDMOS Transistor
- 8.4 Power N-LDMOS Device Process Details (250nm LBC7 BCD process)
- 8.5 LBC7 Process Device Attributes—Power P-DMOS Transistor
- 8.6 Power P-DMOS Device Process Details (250nm LBC7 BCD process)
- 8.7 LBC7 Process device Attributes—Bipolar Vertical NPN Transistor
- 8.8 Vertical NPN Device Process Details (250nm LBC7 BCD process)
- 8.9 Overview of TI's Analog Fabs