Diodes’ Solutions for Set-Top Boxes
Company Profile

- Public company (NASDAQ: DIOD, website: www.diodes.com)
- Founded in 1959
- Headquarters in Plano, TX; 21 locations globally
- North American, Asian, and European Inventory Locations
- Manufacturing in U.S., UK, Germany, China and Taiwan
- Acquired Anachip Corporation, Taiwan, 01/2006
- Acquired Zetex, 06/2008
- Acquired Power Analog Microelectronics (PAM), 10/2012
- Acquired BCD Semiconductor, 03/2013
- Over 5,500 employees worldwide
Why Diodes for STB Platform Solutions?

- **Product portfolio**
  - Product arena
  - Product line expansion
  - Performance enhancement

- **Packaging breadth**
  - Broad packaging portfolio
  - Increased power density
  - Small form factor

- **Application space**
  - Targeted end-equipment
  - Broad customer base
  - Platform Solution Coverage
Efficient Manufacturing + Superior Processes

**Packaging**
- Shanghai-based packaging with capacity approximately 30 billion units
- Flexible and optimized manufacturing process = low packaging cost
- Additional packaging facilities in Neuhaus, Germany and JV in Chengdu, China

**Wafer Fabs**
- Two discrete fabs, two analog fabs in Kansas City, Missouri (5" and 6"), Oldham, United Kingdom (6"), and Shanghai (6") respectively
- Bipolar, BiCMOS, CMOS and BCD process
- Strong engineering capabilities

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**Economies of Scale: Production Units in Shanghai (bn)**

CapEx Model = 5% - 9% of 2013 Revenue

- 2001: 1.3bn
- 2002: 2.1bn
- 2003: 3.4bn
- 2004: 5.4bn
- 2005: 8.2bn
- 2006: 11.8bn
- 2007: 15.4bn
- 2008: 16.7bn
- 2009: 16.0bn
- 2010: 20.3bn
- 2011: 23.2bn
- 2012: 25.3bn
- 2013: 30.0bn

2001 – 2012 (CAGR: 33%)
# Broad Product Offering

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<td>DBS Interface</td>
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![Diodes Logo](https://www.diodes.com)
Diodes Inc in Set Top Boxes

- Power Management
- Building Block Devices
- User-Interface Protection

Diagram:
- Satellite
  - LNA
  - Tuner
  - LNB PSU
- DDR2/3
- Memory
- LEDs Front Panel
- Processor
  - DRAM
  - FLASH
  - IR
  - GPIO
  - Audio
  - LAN
  - TS1
  - I2C
  - SmartCard
  - USB
  - Video

User Interface Protection
- Protection
- Power Management
- Devices
- Building Block
- User-Interface
Diodes Power Management in Set Top Boxes

STB/DVB-S LNB Power

- Satellite
  - LNA
  - Tuner
  - LNB PSU

- Tuner
- Network
- WiFi Module

DDR2/3 Memory

LEDs Front Panel

AC-DC Power Conversion

LDOs

Load Switches

DC-DC Converters

Processor

DRAM
FLASH
IR
GPIO
Audio
Video

SmartCard
USB

LAN
TS1
I2C
I2C

Audio
Video

www.diodes.com
Diodes in AC-DC STB Power Conversion

Primary Rectifiers
- Bridges
- Diodes

Switching Controllers
- PSR Controllers
  - AP3771/2
- PSR Switchers
  - AP3971
- PWM Controllers
  - AP3105N

Switches
- HV BJT

Special Function
- AP43xx
- '431

Secondary Rectifiers
- Schottky Diodes
- SBR®
- Sync. Rectifiers
Diodes AC-DC solutions in STB

### Standby Power (mW)
- **5W:** AP3771
- **30W:** AP43xx
- **50W:** AP3971
- **80W:** AP3105NA
- **100W:** ZXGD3105
- **15W:** DSRHD0v
- **40W:** AP1662

### Output Power
- **5W:** SBR15U50SP5, SBRT15U50SP5, SBRT20U50SLP
- **10W:**
- **15W:**
- **40W:**
- **300W:**

**PSR** - Primary Side Regulation
**SSR** – Secondary Side Regulation
## STB Box Power Solution Examples

<table>
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<tr>
<th>Power</th>
<th>5V/2A</th>
<th>12V/1A</th>
<th>12V/2A</th>
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<tr>
<td>IC Solution</td>
<td>AP3771</td>
<td>AP3971</td>
<td>AP3105NA SSR</td>
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<td>Output Voltage</td>
<td>5V±5%</td>
<td>12V±5%</td>
<td>12V±5%</td>
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<tr>
<td>Ripple</td>
<td>85mVpp</td>
<td>&lt;40mVpp</td>
<td>&lt;76mVpp</td>
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<td>Standby Power#</td>
<td>23mW</td>
<td>124mW</td>
<td>176mW</td>
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<td>Efficiency#</td>
<td>78.70%</td>
<td>77.80%</td>
<td>82.10%</td>
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<td>EMC (EN55022B)</td>
<td>&gt;6dB</td>
<td>&gt;8dB</td>
<td>&gt;8dB</td>
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<tr>
<td>Level V</td>
<td>√</td>
<td>√</td>
<td>√</td>
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<tr>
<td>Level VI</td>
<td>√</td>
<td>√</td>
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<tr>
<td>Advantages</td>
<td>Cost</td>
<td>Cost</td>
<td>Efficiency, Performance</td>
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</table>

# Measured @ 230Vac
### DC-DC Conversion in STB

#### “12V” Input
- 5A – AP655xx
- 4A – AP6540x
- 3A - AP3513E
- 3A – AP3503E
- 2A - AP3512E
- 2A - AP65200
- 1.5A – AP3211 n-sync

#### “5V” Input
- 3.5A – AP3435
- 3A – PAM2320
- 2A – PAM2310
- 2A – AP3431
- 1.5A – AP3418
- 1.2A – AP3410
- 1A - AP3417C

#### The Diodes Advantage
- **Synchronous switching**
  - Reduced external component count
  - (No external Schottky) with Improved full-load efficiency
- **Light Load High Efficiency**
  - Automatically improves system efficiency during light load situations → Meeting latest energy standards.

---

**Satellite**
- LNA
- Tuner
- LNB PSU

**DDR2/3**

**Memory**

**LEDs Front Panel**

**SmartCard**

**USB**

**LAN**

**Processor**

**DRAM**

**FLASH**

**IR**

**GPIO**

**Audio**

**Video**

**TS1**

**I2C**

**LAN**

**WiFi Module**
- 3.5A – PAM2327
- 1A – AP3417C
- 1A – AP3417M(dual)

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**WiFi Module**
- 3.5A – PAM2327
- 1A – AP3417C
- 1A – AP3417M(dual)
## DC-DC Converters in STB Snapshot

<table>
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<tr>
<th>Part</th>
<th>Type</th>
<th>I\textsubscript{OUT} (A)</th>
<th>V\textsubscript{IN} (V)</th>
<th>f\textsubscript{SW} (kHz)</th>
<th>V\textsubscript{ref} (V)</th>
<th>Short Circuit Protection</th>
<th>Light-Load High Efficiency</th>
<th>Input OVP</th>
<th>Package</th>
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LDOs in STB

The Diodes Advantage
- Large portfolio in Industry standard pin-outs, packages and currents
  Large volume supplier at cost effective prices
- Bipolar and CMOS LDOs
  Bipolar LDOs for cost effective solutions
  CMOS LDOs for improved drop-out voltages

PNP in LDO
- 2DB1182Q
- ZXT790AK
Supply Load Switches in STB

**USB**
- 0.5A – AP2141D/51D
- 1A – AP2161D/71D
- 1A/1.5A – AP2337/2821
- Prog. <2.4A – AP2552/3/A

**The Diodes Advantage**
- Large portfolio in Industry standard pin-outs, packages and currents
  Large volume supplier at cost effective prices
- AP255x - programmable over-current protection threshold up to 2.36A
  Greater than competitors

**Load Switches**
- AP2280
- AP2281

**HDMI**
- 0.25A – AP2331
- 0.4A – AP2802/-01
STB/DVB-S LNB Power in STB

- **LNB Power Supply**
  - ZLPM8010 DiSEqC 2.0, 0.7A
  - ZLPM8011 DiSEqC 2.0, 0.55A
  - ZLPM8012 DiSEqC 1.x, 0.55A

- **LNB BOOST**
  - AP3031

- **The Diodes Advantage**
  - ZLPM801x generates voltage/tone and DiSEqC™ control signals for 1 LNB
  - Integration and System efficiency
    - High efficiency boost converter
    - Ultra low drop LDO and low current system design
    - 600µA Standby current
Diodes’ Building Block Devices in Set Top Boxes

**Standard Linear**
- Reset Generators
- Op Amps, Comparators

**Standard Logic**
- HC/HCT/AHC/AHCT
- LVC
- AUP

**Discretes**
- Bipolar Transistors, MOSFETs
- Diodes, Schottkies, SBR®
## Diodes’ Standard Logic Devices

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<th>AHC / AHCT Family</th>
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<td><img src="image3" alt="AUP Family" /></td>
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<td>74AHClGxx / 74AHC1Gxx SOT Package</td>
<td>74LVC1Gxx/2Gxx SOT &amp; DFN1010/1410</td>
<td>74AUP1Gxx SOT &amp; DFN1010/1410</td>
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<td>74HC/HCT/AHC/AHCT TSSOP-14 &amp; SO-14</td>
<td>74LVCxx / 74LVxx TSSOP-14 &amp; SO-14</td>
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### The Diodes Advantage

- **Wide Portfolio**
- **Diversified package**
- **Industry-standard specifications**
Diodes’ Standard Linear in Set Top Boxes

The Diodes Advantage
- Wide Industry Standard Linear Portfolio
  Large volume supplier at cost effective prices

Op Amps
- LMV321/358/324
- AZV831/832
- AZ4558/80
- AS321/358/324

Reset Gen.
- APX803/09/10
- APX811/12
- APX823/24/25A

Shunt Regs.
- 2.5V AN431, AS431, AS431i
- 1.24V AZ431L, TLV431

Comparators
- LMV331/393/APX339
- AP331/AS393/339

Audio Amps
- Headphone/Line Drivers
  PAM8908
- Class-D Amplifiers

Satellite
- LNA
- Tune
- LNB PSU

Tuner

Network

WiFi Module

DDR2/3

Memory

LEDs
- Front Panel

DRAM

FLASH

IR

GPIO

Processor

TS1

I2C

LAN

SmartCard

USB

Audio

Video

I2C

LAN

Audio

Video
Diodes’ Bipolar Transistors

- **Extensive portfolio of Bipolar Transistors**
  - Small-signal and Power, Special Functions (i.e., Pre-biased transistors)
  - Portfolio covers majority of transistor requirements.

- **Leading-edge silicon technology gives best-in-class performance and footprint to performance ratios**

- **In-house packaging provides wide selection of packaging options**

### The Diodes Advantage

- **Best in class VCE(SAT)**
  - Improves efficiency in Saturated switching applications

- **Excellent gain hold-up at high peak currents**
  - Reduces drive requirements and power dissipation

- **Small footprint low-thermal impedance packaging**
  - Reduced footprint solutions
Diodes’ MOSFETs

- Extensive MOSFET Portfolio
  - NMOS, PMOS, complementary and bridge configurations
  - $V_{DSS}$ from -450V to 650V
- Advanced Technology:
  - DIOFET → Integrates Schottky – 50% lower $V_f$
- Broad Portfolio of In-house Packaging Options
  - Industry standard package portfolio from SOT23 to T0220AB

The Diodes Advantage
- Broad MOSFET portfolio
- DFN and CSP packaging
  - Reduced footprint solutions

NMOS
- ZXMN
- DMN
- 2N7002/BS/BSS

PMOS
- ZXMP
- DMP
- BS/BSS

Pre-Biased
- DMCxxxx
- ZXMHC/DMHC

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Diodes and Rectifiers

- **Broad portfolio of Rectifiers and Schottky Diodes**
  - Fast, Super-fast, Ultra-fast rectifier portfolio
  - Schottky and Zener Diodes
  - Super Barrier Rectifier portfolio

- **Advanced Technology**
  - SBR – Super Barrier Rectifier
    - Lower forward voltage ($V_F$) than a Schottky diode
    - Lower reverse leakage ($I_R$) @ $T_J$ > Schottky diode
    - Reverse avalanche capability >5 times higher than a Schottky diode

- **Broad Portfolio of In-house Packaging Options**
  - Industry standard packages ~ SOT23 to TO220

**Rectifier/Schottky**
- BAT54
- BAV99

**SBR®**
- SBR10U45SP5
- SBR15U50SP5
- SBR15U100CTL

**Zener/TVS**
- BZT52xx/EDZxx
- T3V3xxxx/SD05

SBR is a registered trademark of Diodes Incorporated.

**The Diodes Advantage**
- **Super Barrier Rectifier Technology**
  Better and more robust than schottky diodes

- **DFN and CSP packaging**
  Reduced footprint solutions
Multi-Chip – Multiple Die in a Package (ASMCC)

ASMCC = Application Specific Multi-Chip Circuit
“An integration of various die in one package.”

Dependent on chip size, power dissipation and package capability, we can draw from our huge library of devices:

- MOSFETs, BJTs, Diodes
- Resistors and Capacitors

The Diodes Advantage

- Space-Constrained System Design
  Reduced footprint solutions
- System BOM Saving
  Component Placement, PCB Size, Component Logistics
- Customer IP Protection

“Mix ‘n Match” Elements Per Customer’s Requirements
Set-Top Box – User Interface protection

**Diodes TVS**
- D5V0LxB Family
- D5V0LxB Family
- D5V0FxU Family
- D5V0LxU Family
- D5V0LxB Family
- DT1042 Family
- DT1240 Family
- D1213A Family
- D5V0PxU Family
- DESD5V0S1Bx Family

**Connector**
- Keypad
- Smart Card
- ESATA
- SD/MMC
- USB 2.0/3.0
- Ethernet
- AC/DC Line
- Satellite LNA
- LNB PSU
- Tuner
- Network
- WiFi Module
- DDR2/3 Memory
- LED Front Panel
- Processor
- DRAM
- FLASH
- TS1 I2C
- LAN
- SmartCard
- USB Video

**Connector**
- Comp Video
- SVideo
- HDMI
- Scart (Europe)
- Audio
- DSL
- Satellite
- Antenna

**The Diodes Advantage**
- Comprehensive ESD Protection
  - High-Speed Data Line Protection
  - General ESD Protection

**Diodes TVS**
- D5V0LxB Family
- D5V0LxB Family
- DT1042 Family
- DT1140 Family
- D1213A Family
- D5V0PxU Family
- DESD1P0RFW
Diodes’ Advantage in STB

**Innovation**
- In-house Bipolar, CMOS, and DMOS processes
- Creation of improved solutions – SBR, PSR AC-DC, Gen5 BJT

**Quality**
- ISO9001 and TS16949 qualified
- Proven shipment track record
  > 26B annual components

**Cost**
- True IDM - Internal Fab and Assembly
  leverage with external supply chains

**Delivery**
- Large volume supplier of Industry Standard components
- Extensive Global Distribution Channels

**Responsiveness**
- Dedicated Regional FAEs
- Dedicated Regional QRA teams
Diodes’ Solutions for Set-Top Boxes

Thank you