Diodes' Solutions for Set-Top Boxes

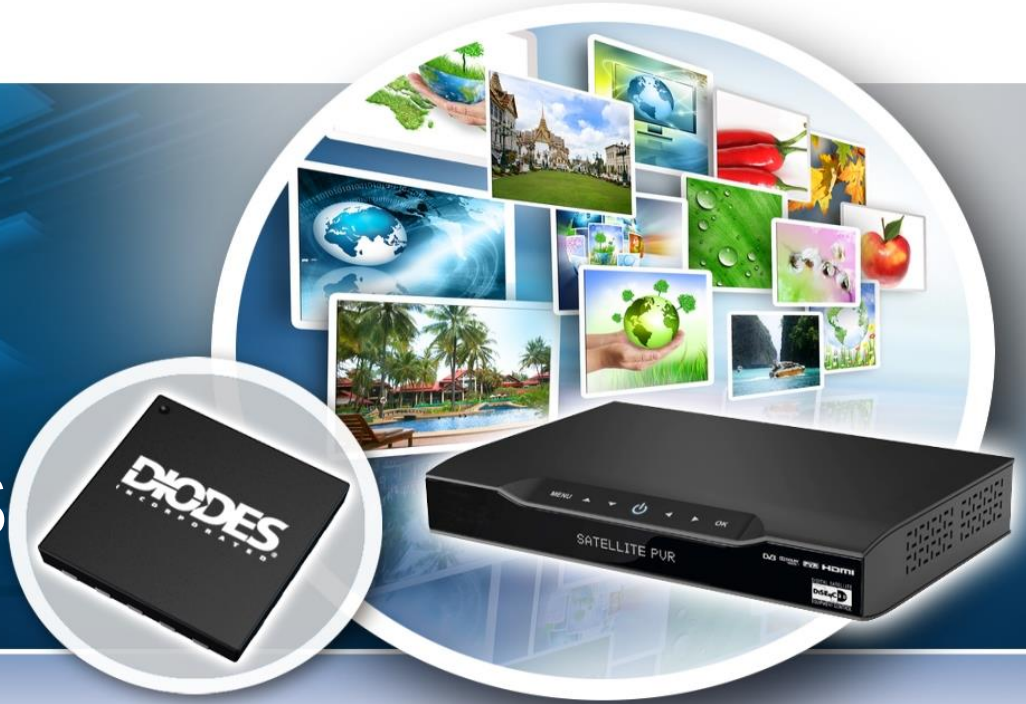


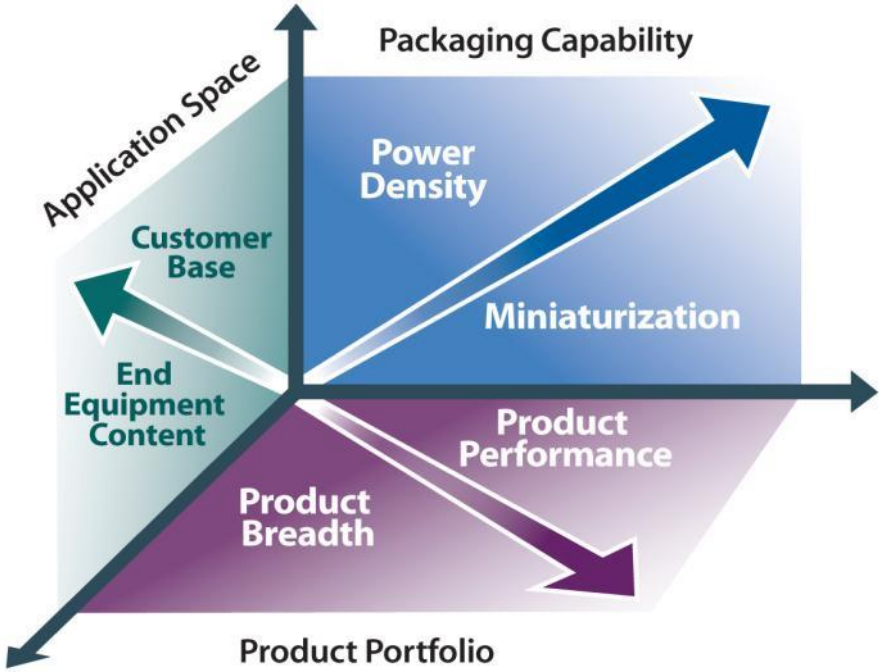
Image from Eagle Kingdom Technologies

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
- ISO9001:2008 Certified / TS16949:2009 Certified
  ISO14001 Certified
- Acquired Anachip Corporation, Taiwan, 01/2006
- Acquired Advanced Power Devices, 11/2006
- 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



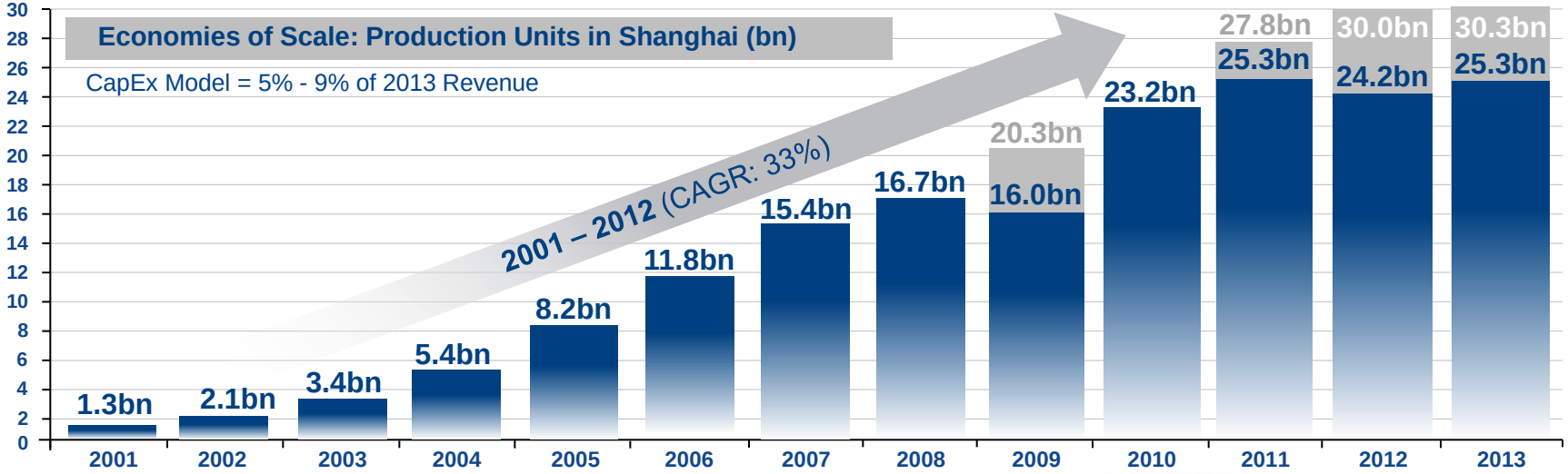
Efficient Manufacturing + Superior Processes

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



Broad Product Offering

Discrete

Diodes

Schottky Diodes
Zener Diodes
Switching Diodes
SBR® Diodes
Power Zener Diodes
Power Rectifier Diodes

Rectifiers

Schottky Rectifiers
Super Barrier Rectifiers (SBR®)
Standard Rectifiers
Fast Recovery Rectifiers
Bridge Rectifiers

MOSFETs

Small Signal MOSFETs
Power MOSFETs
Protected MOSFETs
High Voltage MOSFETS
Complementary Pairs
H-Bridges
IntelliFET

Protection Devices

Zener TVS
Thyristor Surge Protection
Data Line Protection

Bipolar Transistors

Small Signal BJT
Pre-biased BJT
Medium Power BJT
High Power BJT
Darlington Transistors
Gate-Drivers
Low Saturation BJT
H-Bridges

Function Specific Arrays

Relay Drivers
Discrete Load Switches
Discrete Voltage Regulators
MOSFET Gate-Drivers

Standard ICs

Standard Linear ICs

Linear Voltage Regulators
Standard Linear Regulators
Quasi Low Dropout Regulators
Low Dropout Regulators

Voltage References
Shunt References
Micropower References

Current Monitors
Current Output
Voltage Output

Operational Amplifiers
Comparators
Special Functions
Timer IC
Reset Generators
Current Mirror

Logic ICs

Single Gate
AHC, AHCT, LVC, LVCE, AUP
Dual Gate
LVC
Standard Logic
LVC, HC, HCT, AHC, AHCT

ASSP

Power Management ICs

DC-DC Switching Regulators
Buck
Boost
Buck/Boost/Inverter

AC/DC Solutions
Primary-Side Regulators
PWM
BJT Switches
Constant Current / Constant Voltage

Power Switches
Load Switches
USB Switches

LED Drivers
Charge Pump
Boost
Buck

Power Supply
MOSFET Controllers
Active OR-ing Controllers
Chargers

Class-D Audio Amplifiers

Sensors

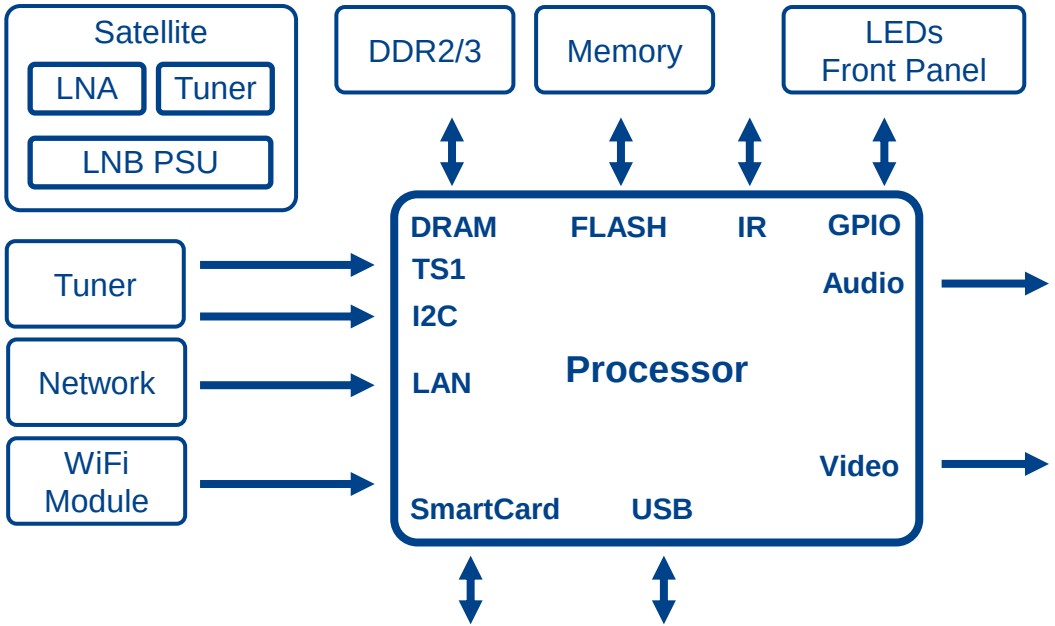
Unipolar Hall Switches
Bipolar Hall Latches
Omnipolar Hall Switches
Linear Hall
Smart Fan Drivers
Temperature Sensors
Magnetic Sensors
Low Power Motor Control
Smart Fan Drivers

Digital Broadcast by Satellite

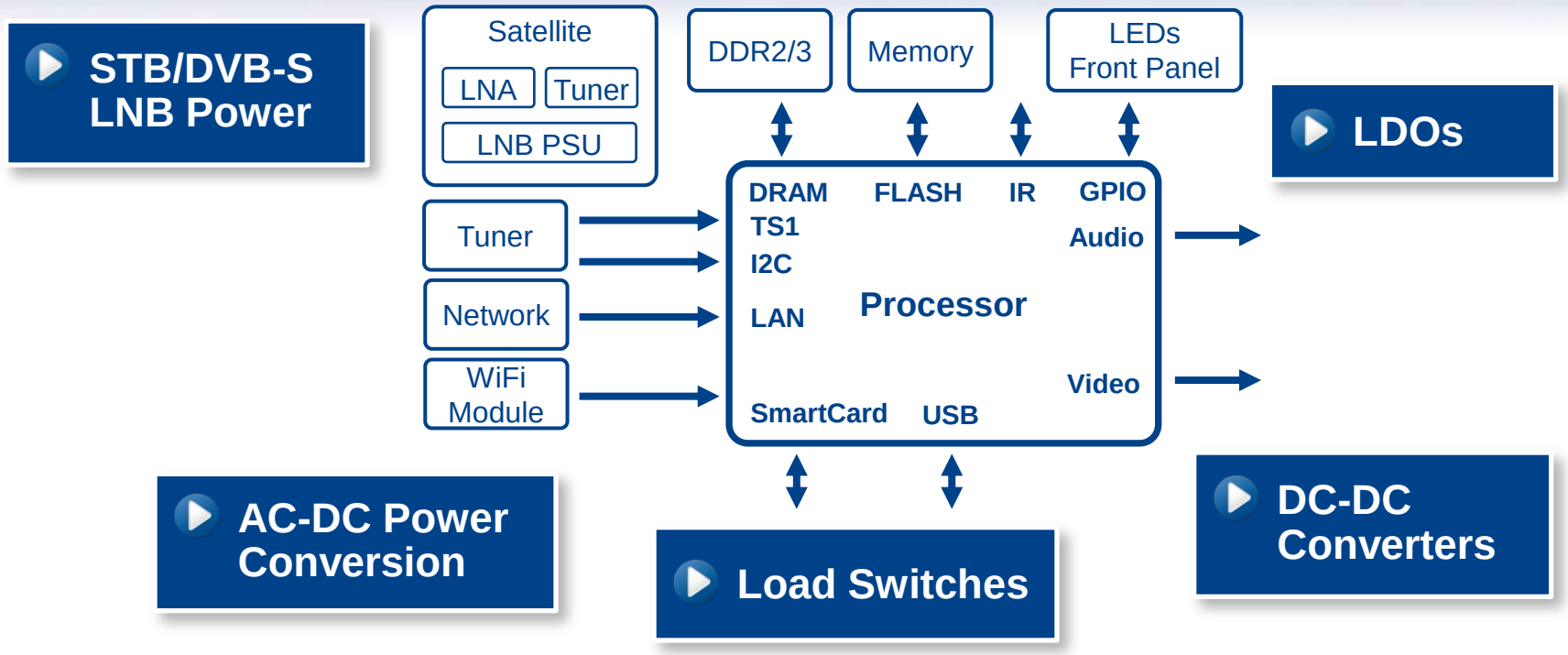
Fixed Bias Generators
Switched Bias Generators
Multiplex Controllers
Integrated Switch Matrix
DBS Interface

Diodes Inc in Set Top Boxes

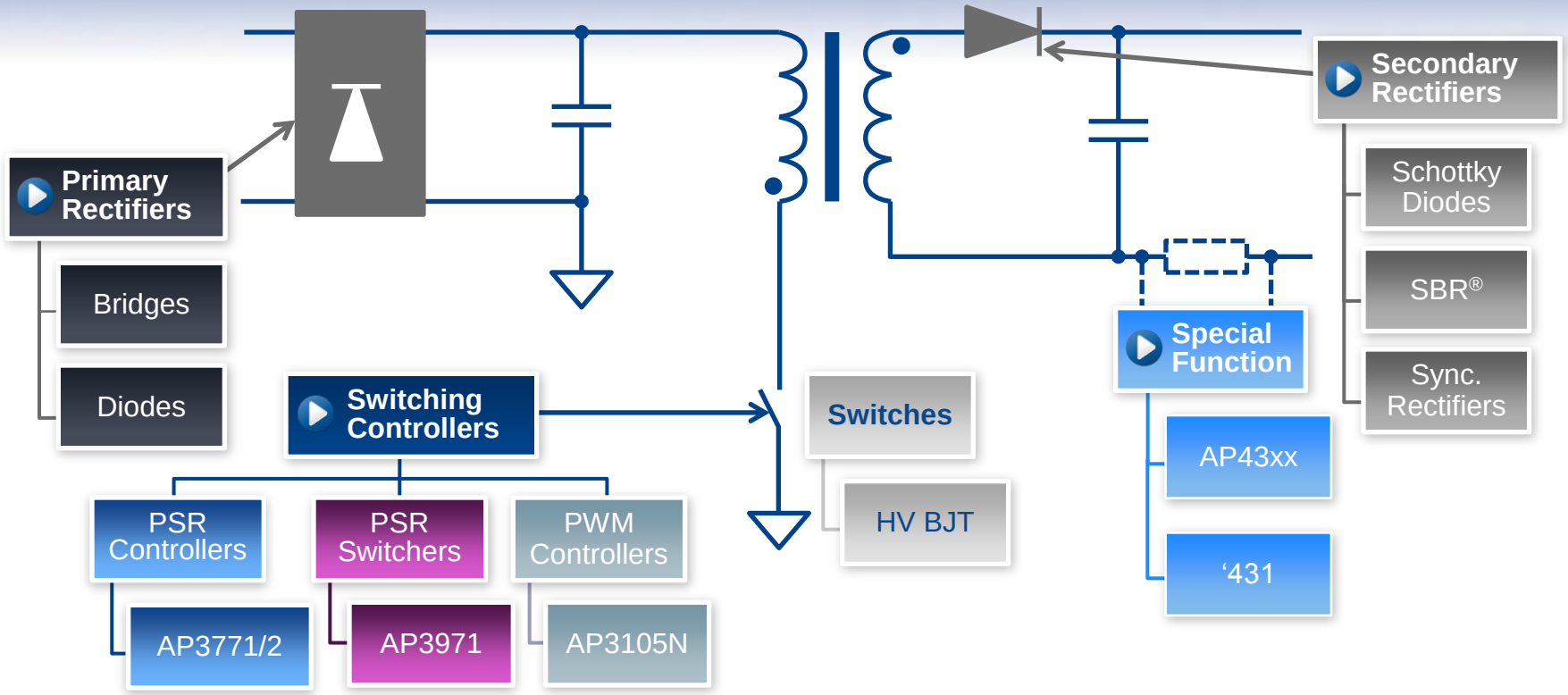
- **Power Management**
- **Building Block Devices**
- **User-Interface Protection**



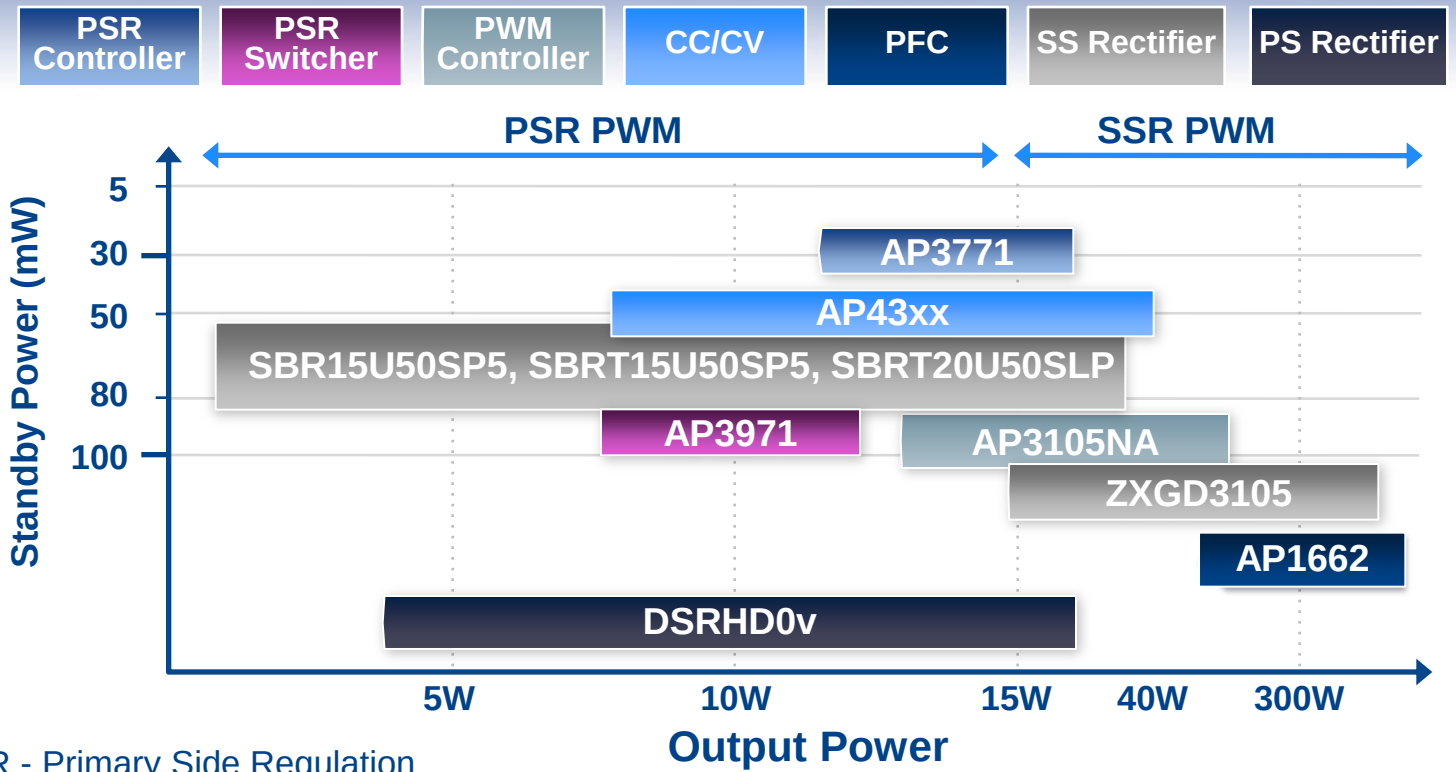
Diodes Power Management in Set Top Boxes



Diodes in AC-DC STB Power Conversion



Diodes AC-DC solutions in STB



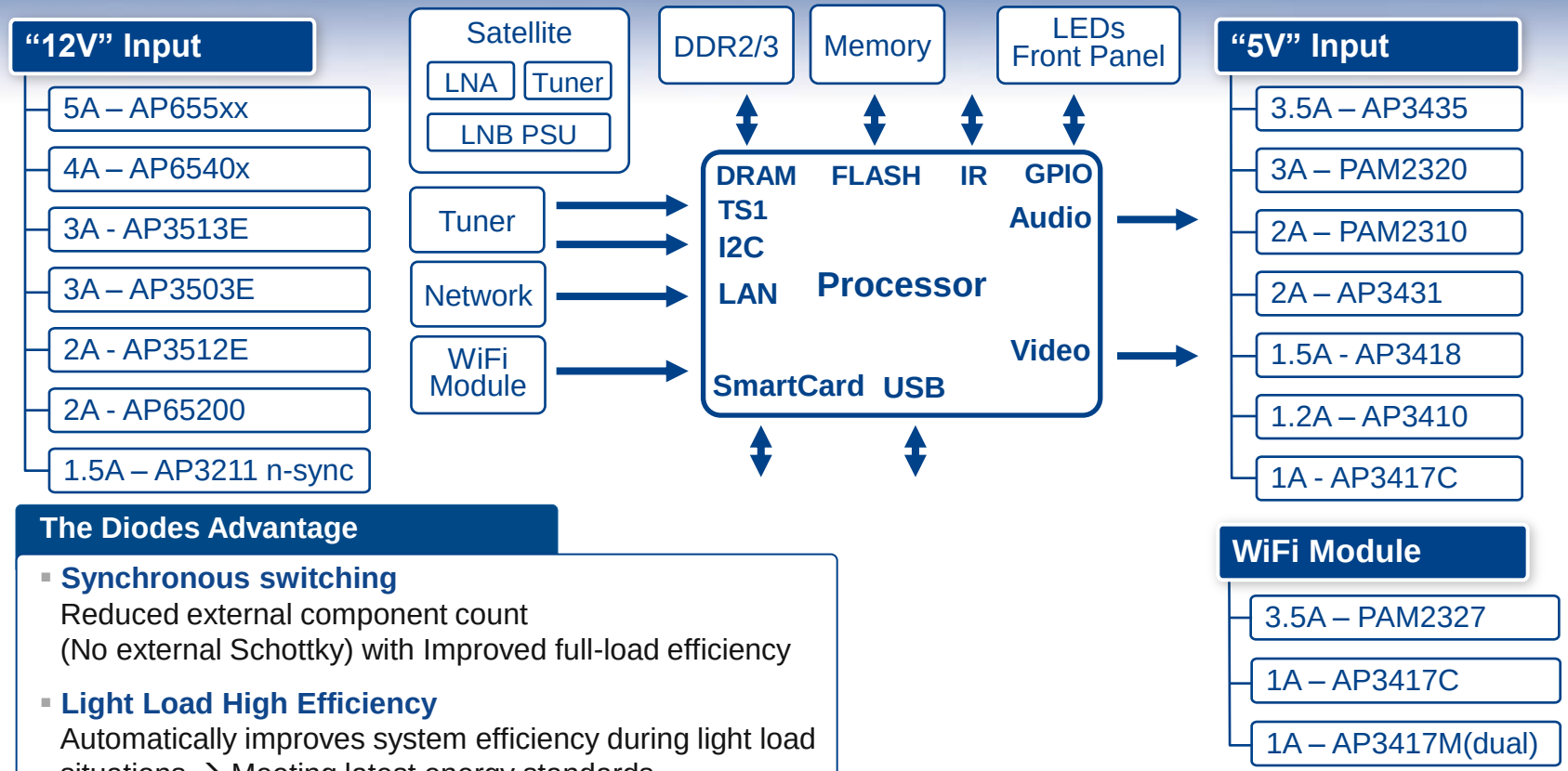
PSR - Primary Side Regulation
SSR – Secondary Side Regulation

STB Box Power Solution Examples

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

 # Measured @ 230Vac

DC-DC Conversion in STB



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.

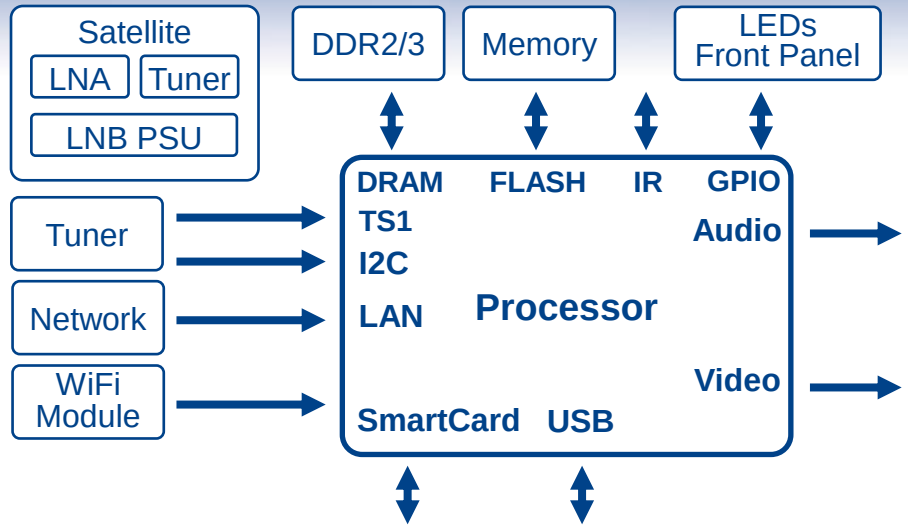
DC-DC Converters in STB Snapshot

Part	Type	I_{OUT} (A)	V_{IN} (V)	f_{SW} (kHz)	V_{ref} (V)	Short Circuit Protection	Light-Load High Efficiency	Input OVP	Package
AP3211	"12V" input POL	1.5	4.75 to 18	**1400**	**0.81**	Y	N	-	SOT26
AP65200		2	4.7 to 18	340	0.925	Fold Back	Y	-	SO-8EP, SO-8, DFN2626-10
AP3512E			4.5 to 18	500	0.925	**Hiccup**	Y	-	SO-8EP
AP3503E		3	4.5 to 18	340	0.925	**Hiccup**	Y	-	SO-8EP
AP3513E			4.5 to 18	500	0.925	**Hiccup**	Y	-	SO-8EP
AP65400		4	4.7 to 18	340	0.925	**Hiccup**	Y	-	SO-8EP
AP65500		5	4.7 to 18	340	0.925	**Hiccup**	Y	-	SO-8EP
AP3417C	"5V" input POL	1	2.5 to 5.5	1500	**0.6**	**Hiccup**	Y	**Y**	SOT25, DFN2020-6
AP3410		1.2	2.5 to 5.5	1500	**0.6**	**Hiccup**	Y	**Y**	SOT25, DFN2020-6
AP3418		1.5	2.5 to 5.5	1400	**0.6**	**Hiccup**	Y	-	SOT25
AP3431		2	2.7 to 5.5	1000	0.8	**Hiccup**	Y	-	SO-8
PAM2310			2.7 to 5.5	1500	**0.6**	**Hiccup**	Y	-	SO-8
PAM2320		3	2.5 to 5.5	1500	**0.6**	Y	Y	-	SO-8EP
AP3435		3.5	2.5 to 5.5	1000	0.8	**Hiccup**	Y	**Y**	SO-8EP
AP3427M	WIFI module	1	2.5 to 5.5	1500	**0.6**	Y	Y	**Y**	DFN3030-10
PAM2327		3.5	2.5 to 5.5	1200	0.6	**Hiccup**	Y	-	QFN2020-12

LDOs in STB

≥1A

- 1A – AZ1117/E
- 1A – AP7361
- 1.5A – AP7362
- 2A – AP2132
- 3A – AP7176B
- 5A – AZ1084



≤1A

- 0.15A – AP7311
- 0.2A – AP2121
- 0.3A – AP2127
- 0.3A – AP7335/2
- 0.6A – AP2111
- 0.6A – AP7365
- 0.8A – AZ1117C

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

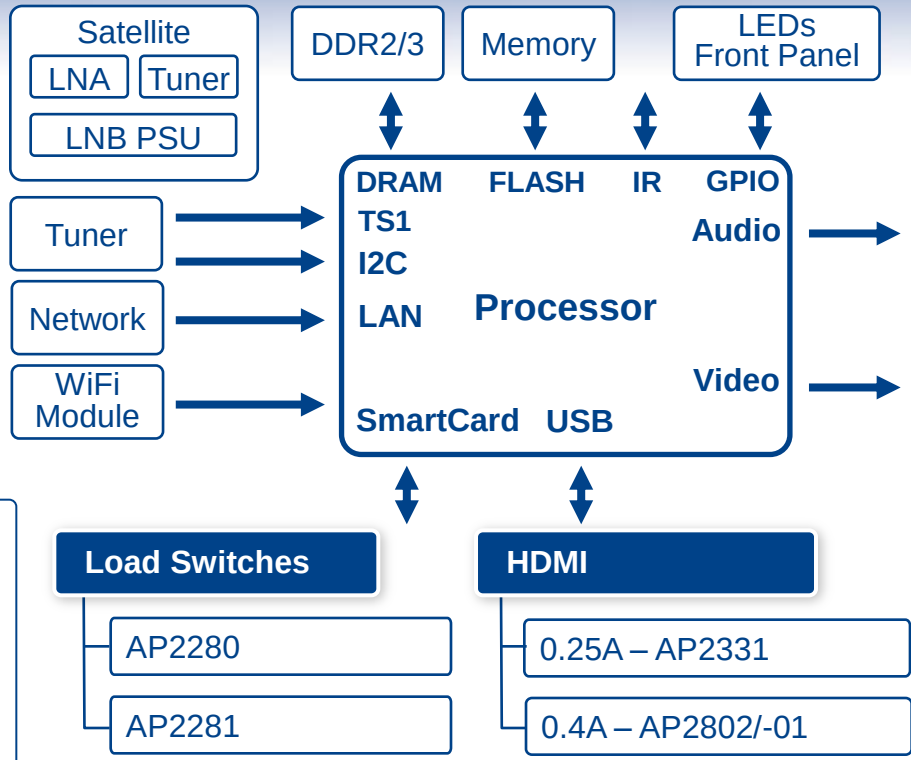
PNP in LDO

- 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

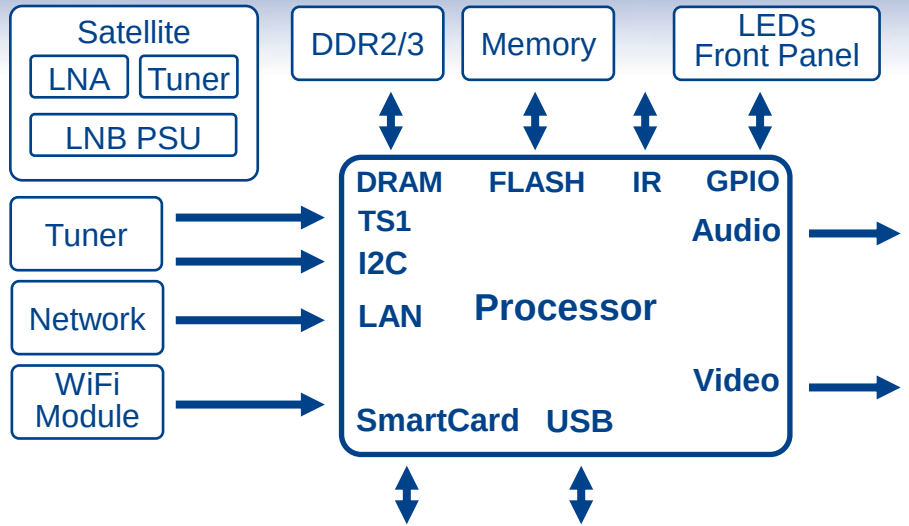
STB/DVB-S LNB Power in STB

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

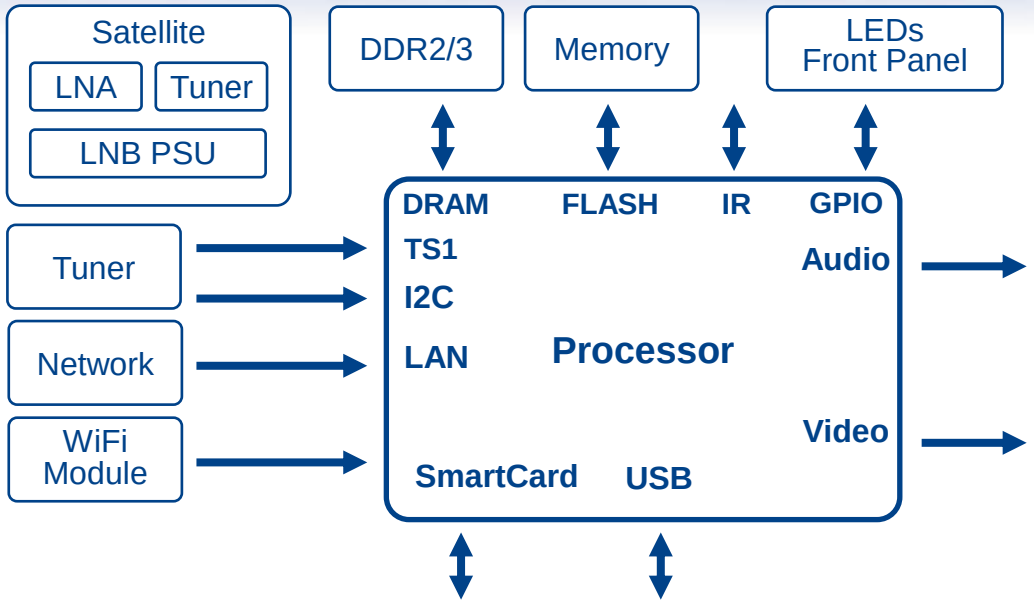
- **ZLPM801x generates voltage/tone and DiSEqC™ control signals for 1 LNB**
- **Integration and System efficiency**
  - High efficiency boost converter
  - Ultra low drop LDO and low current system design
  - 600µA Standby current

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

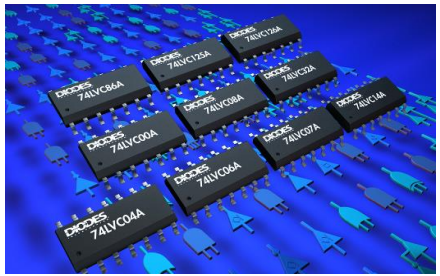
AHC / AHCT Family

74AHC1Gxx / 74AHCT1Gxx
SOT Package

74HC/HCT/AHC/AHCT
TSSOP-14 & SO-14

LV/LVC Family

74LVC1Gxx/2Gxx
SOT & DFN1010/1410



74LVCxx / 74LVxx
TSSOP-14 & SO-14

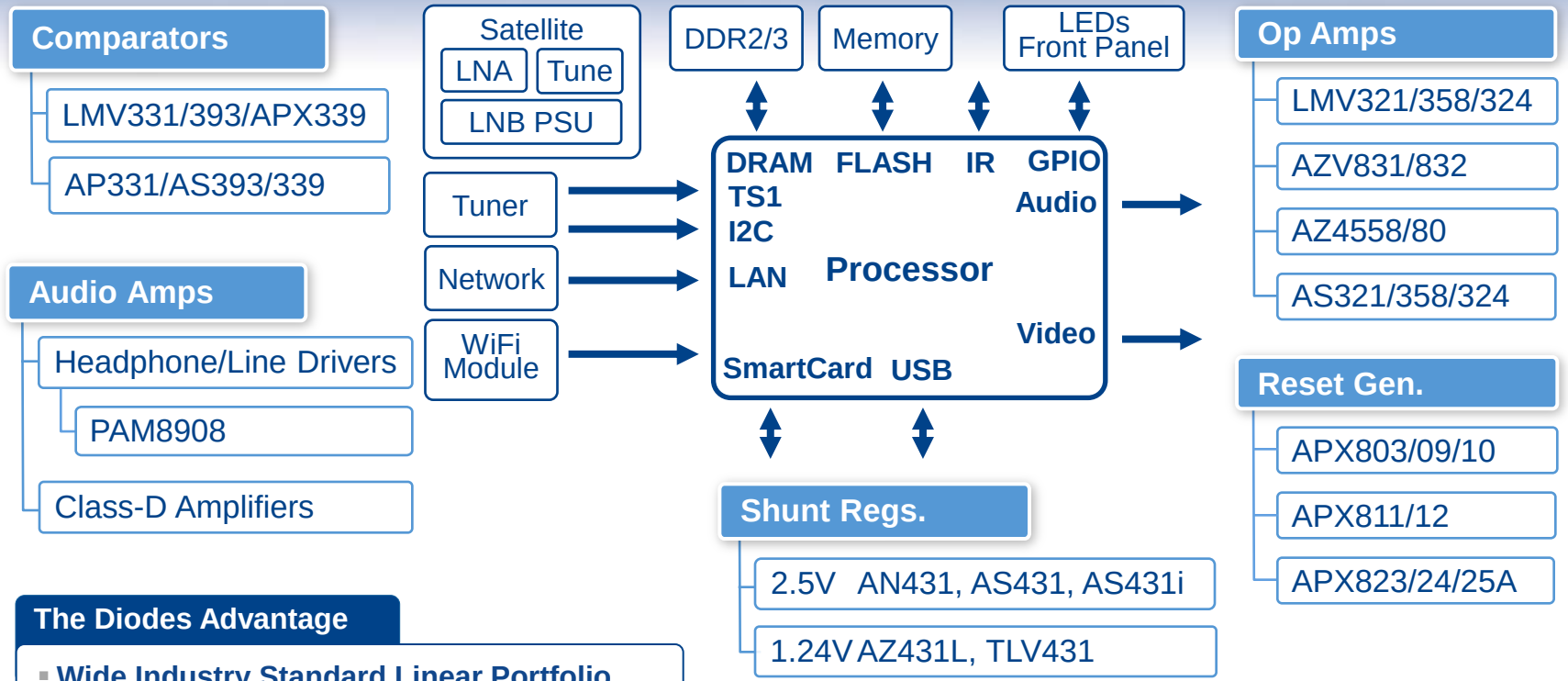
AUP Family

74AUP1Gxx
SOT & DFN1010/1410

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

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

Small Signal

- BC8xxx
- PBT DCX1xxx
- MMBTxxx

Power

- ZXT1053K
- BCX56 & BCP56
- 2DB1182

Pre-Biased

- DDTC/Axxx
- DDC/A/DCXxxx

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

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

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 = **A**pplication **S**pecific **M**ulti-**C**hip **C**ircuit

"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:

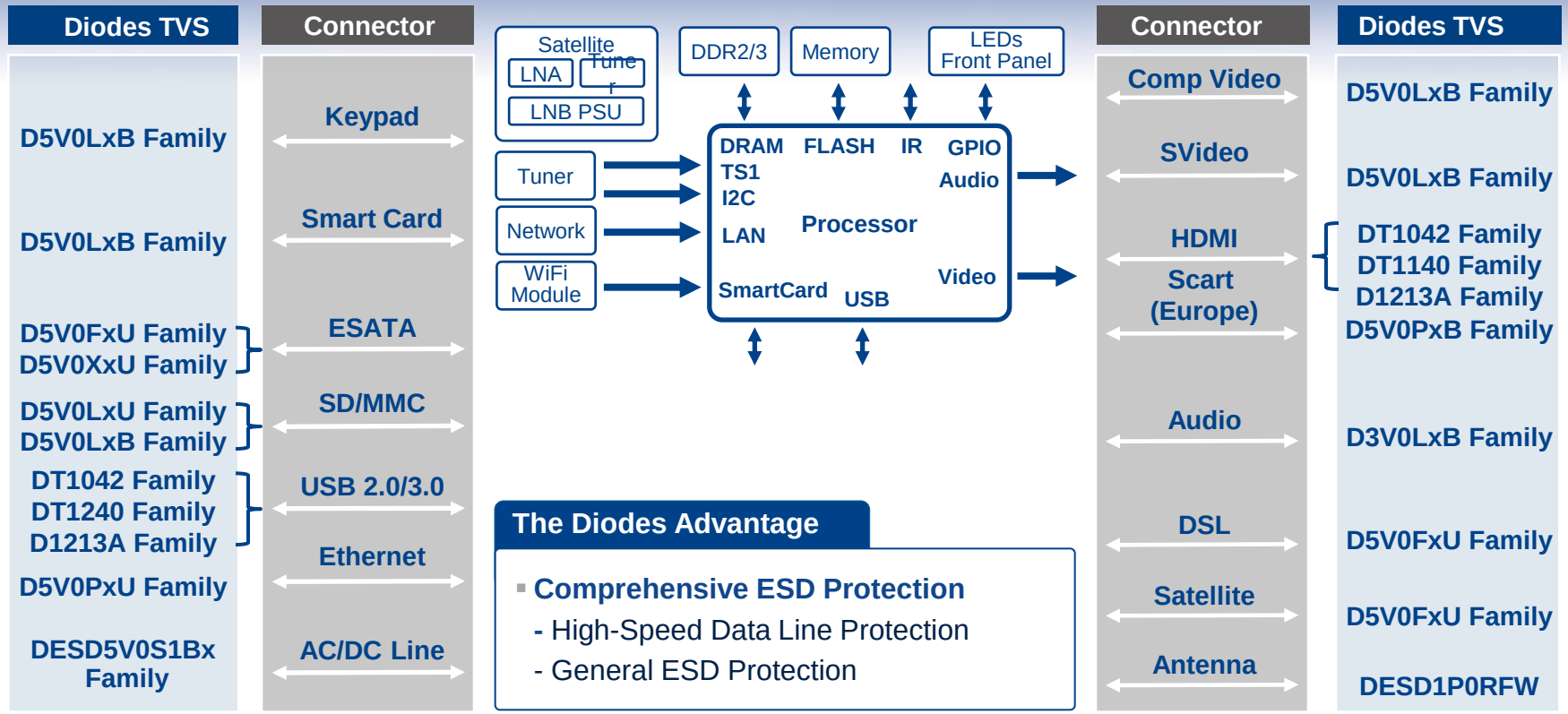
- **MOSFETs, BJTs, Diodes**
- **Resistors and Capacitors**

"Mix 'n Match" Elements Per Customer's Requirements

The Diodes Advantage

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

Set-Top Box – User Interface protection

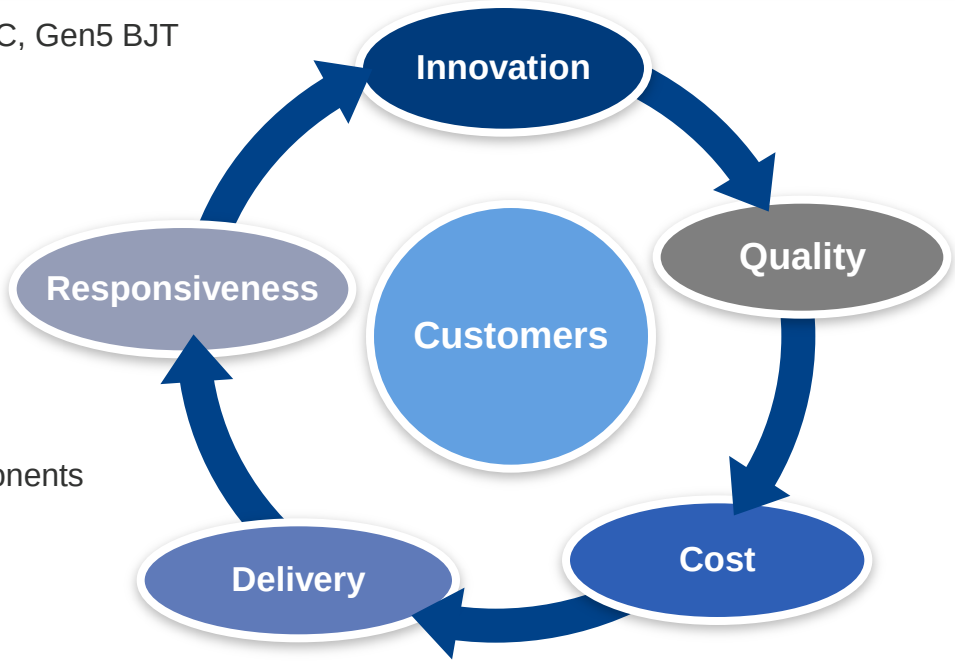


The Diodes Advantage

- **Comprehensive ESD Protection**
  - High-Speed Data Line Protection
  - General ESD Protection

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

Image from Eagle Kingdom Technologies