



# Analog and Discrete Power Solutions

# ... Across a wide range of existing & emerging applications

### **OVERVIEW**

Diodes Incorporated (Diodes) is a leading global designer and manufacturer of analog and discrete power solutions.

We enable innovation by leveraging our broad product portfolio, company-owned operations, and leadingedge packaging technology to meet your needs.

Our broad range of application-specific solutions, coupled with a worldwide network of engineering, testing, manufacturing, and customer service sites, positions us as a premier provider for high-volume, high-growth markets.

### DISCRETE

Diodes' discrete semiconductor portfolio is where innovation meets reliability. Our products

go beyond industry standards, incorporating patented and proprietary technologies that set new benchmarks in performance. With forefront package designs, we prioritize increasing power density, enhancing power efficiency, and minimizing design space.

### **AMPLIFIERS & SENSORS**

Our amplifier portfolio includes audio amplifiers, precision op amps, high-side current monitors, and comparators. Our expanded sensor portfolio includes Hall switches, linear sensors, and contact image sensors.

### **POWER MANAGEMENT**

Our power management portfolio includes AC-DC and DC-DC Converters/LED Drivers that incorporate leading-edge topologies to meet the markets' efficiency and standby power requirements. Our LDO,



Gate Driver, and Power Switch families provide lowloss, high-power-density solutions. In addition, we have a growing USB Type-C<sup>®</sup> control and charge portfolio.

# **CONNECTIVITY & TIMING**

Diodes is a leading designer and manufacturer of essential solutions for the timing, switching, bridging, and conditioning of high-speed signals required by today's ever-increasing speed and bandwidth-demanding applications. Our serial connectivity solutions cover a broad range of



protocols and interfaces including PCIe<sup>®</sup>, SATA, SAS, HDMI<sup>™</sup>, DisplayPort<sup>™</sup>, USB, USB Type-C, Thunderbolt<sup>™</sup>, and Ethernet. Diodes provides a fulltiming portfolio including crystals and crystal oscillators, as well as clock ICs covering kHz to GHz with jitter in the low femtoseconds.

# LOGIC & VOLTAGE TRANSLATION

Our logic and voltage translation portfolio covers single- and dual-gate logic, standard logic gates, voltage translators, and interface logic (analog switches, registers, buffers, transceivers, and line drivers) offering the right operating voltages and driving capabilities for today's applications.

### MARKETS

As part of its global footprint, Diodes is focused on these high-growth, high-volume markets:

# AUTOMOTIVE

Diodes offers a wide portfolio of automotive-compliant products targeted at high-growth, high-reliability applications, such as Connected Driving (merging of ADAS, Telematics, and Infotainment); Comfort, Style, and Safety (including lighting and motor control); and Powertrain (covering conventional, hybrid, and electric vehicles).

Our automotive-compliant products are qualified to automotive standards AEC-Q100/Q101/104/200 and are manufactured in facilities that are certified to IATF 16949/VDA6.3 manufacturing routes. These products are fully supported by Production Part Approval Process (PPAP) documentation and are specific-change controlled.

# COMMUNICATIONS

Diodes offers highly effective products to enhance solutions in areas such as telecom infrastructures, enterprise networks, wireless networks, and connected devices. A broad portfolio of MOSFETs, rectifiers, protection devices, high-speed signal switches and multiplexers, ultra-low jitter XOs, clock generators, and clock buffers provides for highly efficient and cost-effective solutions to be developed.

# COMPUTING

By addressing the key requirements of the computing industry—speed, power efficiency, cost effectiveness, and reliability—Diodes' broad portfolio of products are used in all computing areas, such as notebooks, motherboards, printers, Al servers, data centers, cloud computing, storage, and adaptors. Diodes also provides leading-edge solutions for USB Type-C connectivity.



# CONSUMER

Cost-effective solutions and a high-volume logistic capability position Diodes to effectively deliver discrete, analog, mixed-signal, and logic solutions to this fast-growing market sector. Our portfolio of products are in everyday consumer applications such as IoT, wearables, home automation, and smart infrastructure.

# INDUSTRIAL

Our extensive portfolio of bipolar and MOSFET transistors, diodes, sensors, standard analog products, and power management ICs ensure reliable and effective power management in potentially harsh industrial environments. For embedded applications, Diodes offers a wide variety of products, including specialized timing products like processor-specific XOs, clocks, and PCIe and USB solutions.



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# Discrete

### **MOSFETs**



### SiC MOSFETs



- N- and P-channel, from small-signal to power MOSFETs
- 8V to 600V in single, dual, complementary, and H-bridge (quad) configurations
- Packages from the tiny DFN0604 to the PowerDI1012 and PowerDI8080
- (LD-MOS) technologies



- Shielded-gate trench, and lateral
- Smart load switches
- Automotive-compliant variants available

- N- channel power MOSFETs
  - 1200V rating
  - Low on-resistance R<sub>DS(ON)</sub> and Q<sub>G</sub>
  - Low RAIC, high thermal efficiency
  - TO247-4 package with Kelvin pin for optimized high-frequency performance
  - Fast and robust body diode with low reverse recovery (Opp)
  - Automotive-compliant variants available

### **Bipolar Transistors**



### IntelliFET<sup>®</sup> Self-Protected MOSFETs



DHODES

PowerDI<sup>®</sup>5



### **Diodes and Rectifiers**

BZT52

### **Bridge Rectifiers**



### **Protection Devices**



Switching diodes: single, dual,

High surge current capability

Wide bandgap, low loss

High-switching speeds

coefficient

V<sub>RRM</sub> up to 1200V and I<sub>O</sub> up to 10A

High-temperature (175°C) operation

Soft-switching behavior reduces EMI

Forward voltage positive temperature

- triple, quad Zener diodes: tolerances as tight as to ± 2.0%
- Low leakage diodes: I<sub>R</sub> < 5nA
- Schottky diodes: single, dual, and guad Standard, fast, and ultra-fast recovery rectifiers
- Automotive-compliant variants available

### SMD TT series V<sub>RRM</sub> up to 1000V,

- lo up to 10A
- Through-hole GBJ/GBU series V<sub>RRM</sub> up to 1000V, IO up to 50A
- Low forward voltage (VF) for high efficiency @Tj=150°C
- GBJS with ceramic heatsink technology Rthjc = 0.45 °C/W
- Fast filter bridge to reduce EMI noise
- High-performance Schottky
- TVS for ESD protection up to 30kV on datalines including USB, HDMI, DVI, Thunderbolt, MIPI, and Ethernet
- Low-capacitance TVS down to 0.15pF for high-speed
- General-purpose Zener TVS from 18W to 6.6kW
- Surge protection devices up to 200A Available in footprints down to 0.4 mm x 0.2 mm
- Automotive-compliant variants available

### **Schottky Rectifiers**



### FRR (Fast Recovery Rectifiers)



### Thyristors



High-side and low-side power switch options

most application requirements Automotive-compliant variants available

Technology leadership up to 900V

Very low VCE(SAT) for either higher current handling or reduced temperature operation

Excellent gain hold at high peak currents for improved driving of Si/SiC MOSFETs or IGBTs

matched, pre-bias, Darlington, and special function transistors

Wide selection of package options to cover

NPN, PNP, single, dual, complementary,

- Single and dual configurations
- Comprehensive self-protection and safeguards for the connected load
- Auto restart
- Diagnostic output
- Logic-level input
- Automotive-compliant variants available
- Industry-leading rectifier technology
- Ultra-low forward voltage (V<sub>F</sub>) for high efficiency Reduced high temperature reverse
- leakage current (IR)
- Immunity to thermal runaway
- VRRM up to 400V and IO up to 60A
- Ip of M series in nano scale
- Superior avalanche capability
- Automotive-compliant variants available
- The industry's smallest-in-class trench Schottky rectifiers offer highest current density I ow thermal resistance
- V<sub>RRM</sub> up to 200V and I<sub>O</sub> up to 60A
- Superior avalanche capability
- Environmentally friendly CSP-packaged devices are fully RoHS 3.0 compliant with no exemptions
- Broad range of packages from DFN0603 to TO220
- Automotive-compliant variants available
- Rectifiers optimized for PFC raise system
- efficiency in popular boost converter configurations Reduced losses through low  $\mathsf{V}_\mathsf{F}$  and
- fast recovery
- High forward surge current (IFSM)
- V<sub>RRM</sub> up to 1000V and IO up to 30A Soft-recovery behavior, reduced EMI
- Ultra-low leakage current
- Low thermal resistance
- Automotive-compliant variants available
- Triac, SCR, SIDAC, Thyristor surge protection devices
- IGT(ON) 5 to 50mA, I<sub>T(ON)</sub> 0.5 to 25A
- V<sub>RRM</sub> up to 800V, T<sub>j</sub> up to 150°C
- Multiple packages include TO92, SMA, and TO220
- Sensitive gate trigger
- Low thermal resistance
- High heat dissipation

- SBR<sup>®</sup> (Super Barrier Rectifiers)

# Analog, Mixed Signal, and Logic

and AS2376/O

### AMPLIFIERS

### **Operational Amplifiers and Comparators**



### **Audio Amplifiers**



### POWER MANAGEMENT

### **DC-DC Switching Regulators**



Buck, buck-boost, and boost devices

Wide voltage input range up to 60V

Low EMI design

solutions

footprint

Low quiescent current and high efficiency at light load

High power-density and small footprint

Automotive-compliant buck converters

Easy to use with less external component count and simple PCB layout

covering whole automotive battery range

Ultra-low IQ, low-dropout, and ultra-small

### **Current Monitors**



- Simple high-side current measurement without upsetting OV reference point
- ZXCT199/21x precision bidirectional current monitors - automotive-compliant variants available
- ZXCTI08x high-side current monitors with operation up to 60V
- Simple SOT23 micropower current monitors ZXCTxxxQ automotive-compliant high-side
- current monitors qualified to AEC-Q100 Automotive-compliant variants available

Output powers from 1.5W to 30W/channel

Precision RRIO CMOS op-amps ASx333/Q

Industry-standard, general-purpose

Industry-standard, low-voltage, generalpurpose op-amps and comparators: LMV3, AZV8, and AZV3 series

Single, dual, and quad configurations

Automotive-compliant variants available

op-amps and comparators AS3xx/LM290x series

- Low-EMI filterless design, anti-saturation, and power-limit features improve audio quality with lower solution cost
- Integrated booster for dynamic/ piezo/ceramic speaker load in wireless
- speakers, IoT, and security or mobile apps High-quality headphone amplifiers for
- headsets, gaming, or TV/monitor apps Automotive-compliant variants available

### LED Lighting and IoT Power Solutions



### **Power Switches**





### Voltage References and Supervisors



- Automotive-compliant LED drivers available Innovative, reliable, low standby, and
- Small footprint, low thermal, and high
- USB Type-A/B/C/PD and HDMI port overcurrent protection
- High-side power supply load switches for 0.6 to 20V rails
- Reverse-current, overcurrent, overvoltage, overtemperature, and surge protection
- Ideal-Diode Controllers UL recognized and IEC 60950-1 CB
- scheme certified
- Automotive-compliant variants available

Wide portfolio of gate drivers rated up

Three-phase, half-bridge, high-side/low-side gate drivers for driving N-MOSFETs





- Extra-low knee current shunt references 2.5V, 1.24V TL/TLV431 equivalent shunt regulators
- Extra-low knee current AP431S Automotive-compliant variants available
- 0.6V Shunt regulators
- Microprocessor supervisors/reset generators



- High PSRR Wide input voltage families with fixed output voltages
- Tight tolerance across wide
- temperature ranges
- Automotive-compliant variants available Industry-standard '78 and '78L families

High-efficiency isolated PWM controllers

Low standby power primary-side regulation (PSR) controllers and switchers

High-voltage non-isolated buck converters

Secondary-side synchronous rectifiers

High-performance photocoupler portfolio with secondary-side CC-CV

### AC-DC Products for Offline Power Supplies

Linear and Low Dropout Voltage Regulators



### **USB** Charging



- USB-PD 3.1 standard power range SPR and EPR PPS source controllers
- Automotive-compliant dual-port USB-PD 3.1 SPR controllers available USB-PD 3.1 EPR Sink controllers
- USB-C DFP chargers

controllers

- USB-A DCP chargers with power switch

cost-effective connected lighting and IoT power solutions High-performance DC-DC and linear LED drivers for industrial and commercial LED lighting applications

- 0.5% channel-to-channel matching, multiple channel LCD backlight LED drivers
- power-density package

to 600V

or IGBTs





### Inverting and non-inverting, dual, or single low-side driver Automotive-compliant variants available





### CONNECTIVITY

### Switches/Multiplexers



- Data rates up to 32Gbps
- High-speed signal multiplexer switches (USB, PCIe, USB Type-C, 10GE, HDMI, DP, MIPI, SAS, SATA, Thunderbolt)
- High-speed crossbar switches LVDS receivers/transceivers
- Audio switches, bus switches, VGA switches
- Automotive-compliant switches and multiplexers available

### Signal Integrity (ReDrivers/Repeaters/Active Switches)



- PCIe 5.0 linear ReDrivers
- IOGbos Ethernet (IOGE) linear ReDrivers
- USB4/3.2 linear ReDrivers
- SATA 3.0 ReDrivers
- SAS 3.0 linear combo ReDrivers HDMI 2.1/DisplayPort 2.1 ReDrivers
- USB Type-C and DP-ALT 4:4/6:4 10Gbps ReDrivers
- Automotive-compliant ReDrivers available

### PCIe Packet Switches/Bridges



- PCIe 3.0 packet switches
- PCIe-PCI/PCIx bridges
- PCIe, PCI, I2C/SPI, 8-bit to UART
- PCIe to USB/PCIe
- Automotive-compliant PCIe 3.0 packet switches available

### Interface



- UARTs
- IO expanders
- I<sup>2</sup>C multiplexers/switches
- Automotive-compliant IO expanders available
- LOGIC AND VOLTAGE TRANSLATION

### **General Logic and Voltage Translation**



TIMING

- Clock Generators with phase jitter as low as 40fs Clock Buffers with additive jitter as
- low as 10fs PCIe 5.0 / 6.0 clock generators and buffers
- Automotive-compliant clocks and buffers available





- Single-gate, dual-gate, and
- standard logic, and shift registers Eight technology families: LV, LVC/E, AHC/T, AUP, HC/T
- DFN0808, DFN1010, DFN1410, QFN4525, SOT25 /26/353/363/553, SO-14/-16, TSSOP-14/-16/-20
- Multi-channel, auto-direction level shifter with open-drain and push-pull interface
- Automotive-compliant single-gate logic and auto-direction level shifter/voltage translators available

# XRO

- **Crystals and Crystal Oscillators** 
  - Crystals
  - Crystal oscillators (XO, TCXO) Ultra-low jitter XOs with RMS jitter as low as 50fs
  - PCIe 5.0 / 6.0 HCSL and LP-HCSL XOs available
  - Automotive-compliant crystals, XOs, and temperature-compensated RTCs available



- Analog switches
- Shift registers and multiplexers
- Buffers, transceivers, and line drivers
- Automotive-compliant analog switches available

### SENSORS

### Contact Image Sensors (CIS)



- Used for a variety of image sensor applications such as: surface inspection systems, banknote validators, scanners, and high-speed copiers
- Scan speeds up to 50MHz
- Scan resolution up to 4800dpi
- Depth of Field (DOF) from +/-0.3 to +/-1.7mm Various optical light source configurations: RGB, IR, UV, and white LEDs

### Hall Sensors



- Omnipolar, unipolar, latch, and linear Hall sensor products
- Wide input voltage range from  $1.1 \ensuremath{\mathsf{V}_{\mathsf{IN}}}$  to  $28V_{IN}$  to cover battery-powered, industrial, and automotive applications
- Micropower, ultra-low noise, and ultra-low switch point drift
- Two-wire ISO 26262-ready AH32xxQ latches and unipolar Hall switches with self diagnostics
- ISO 26262-ready AH39xxQ dual Hall effect latches with speed and direction outputs, and built-in self-diagnostics
- Automotive-compliant variants available

- **Interface Logic**





Diodes' analog and discrete power solutions provide our customers with leading-edge solutions for next-generation systems.

Discrete products include bipolar transistors, MOSFETs (inc. smart and SiC), diodes and rectifiers (inc. SiC, SBR, Schottky, SCR, and triacs), bridge rectifiers, protection products, and functional arrays.

Analog and mixed-signal products cover these main areas: power management ICs (inc. LED drivers and photocouplers), amplifiers, sensors, signal switching, signal integrity, connectivity, and timing products.

Logic products include single-gate, dual-gate, and standard logic gates as well as voltage translators, analog switches, registers, and multiplexers.

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