



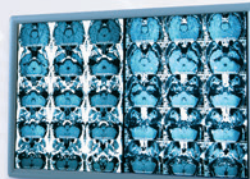
Medical Solutions



Improving lives through innovative solutions from ON Semiconductor.



www.onsemi.com



Bringing Silicon to Life

An aging population and the pressure of rising healthcare costs are driving a shift towards home healthcare. This shift along with an increased interest in health and wellness and the adoption of intelligent and connected portable devices are driving medical device innovation.

Semiconductor technology plays a significant role in that innovation. With a diverse portfolio of products and services, talented engineering staff with system expertise, a deep understanding of the quality, reliability and longevity requirements of the medical market, and global manufacturing and logistics capability, ON Semiconductor enables developers of medical technology to solve their unique design challenges with high performance silicon solutions.

Expertise and Experience

- 30+ years of custom silicon experience, including high-reliability implantable applications
- Heritage of serving the hearing aid industry since early 1970s
- Extensive system knowledge in focus applications
- Fully certified and robust custom development process
- Rich portfolio of ultra-low-power analog, digital, and memory IP
- System architects for product concept and architecture review
- Highly skilled and experienced silicon, packaging, and test engineers
- Dedicated program managers for development tracking and reporting

Quality, Reliability, and Commitment

- Process and product longevity to support extended product life-cycles
- Traceability and data retention processes that meet the special needs of medical applications
- Lot Acceptance Testing (LAT) performed on each individual lot
- World-class owned and operated fabs
- Reliability and failure analysis lab
- Quality certifications including ISO/TS 16949, ISO 9001, AS 9100, ISO 14001, MIL-PRF-38535, QML, C-TPAT and STACK
- ISO 13485 for advanced packaging facility
- FDA compliance
- REACH compliance
- Member of Hearing Industries Association



Products and Capabilities

- Bluetooth Low Energy technology System-on-Chip (SoC)
- Precision mixed-signal microcontrollers
- Preconfigured and open-programmable DSP systems
- Mixed-signal ASIC development services with flexible engagement models
- CMOS image sensors for medical imaging
- Large portfolio of power management and discrete components
- FPGA and ASIC conversions
- Custom and semi-custom ultra-low-power SRAM and EEPROM
- Foundry and value-added front- and back-end services
- Advanced packaging and product miniaturization techniques
- Customization of many portfolio products

Medical ASIC Design and Manufacturing Services

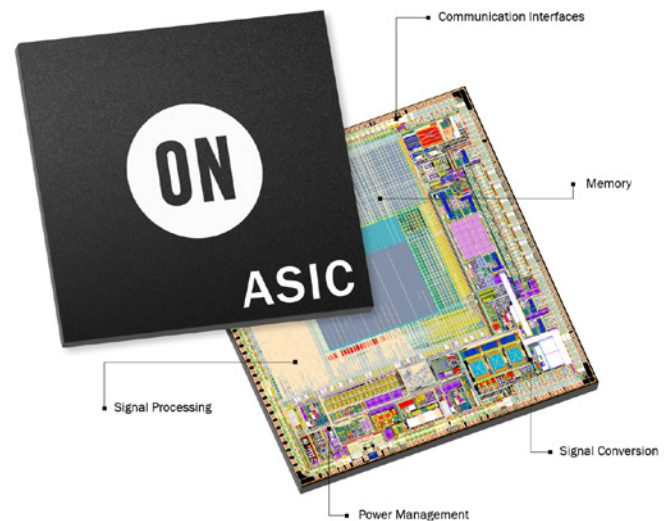
ON Semiconductor has over three decades of experience designing and manufacturing complex ASICs for medical applications, offering both mixed-signal and digital solutions.

With an increasing number of medical devices becoming portable, more intelligent, and connected, medical device manufacturers are looking for highly integrated semiconductor solutions that enable higher performance, smaller size, lower power consumption, and higher reliability.

With proven design methodologies, dedicated system architects, an extensive IP portfolio, wide selection of fab process technologies, and advanced packaging solutions, ON Semiconductor helps customers transform their concept and initial specifications into volume production of a finished device.

Intellectual Property

ON Semiconductor offers an extensive library of IP blocks for use in ASIC designs, including signal conversion, signal processing, memory, communication interfaces, and power management. System architects work with customers to identify the most appropriate technology and IP selection.



System Architects

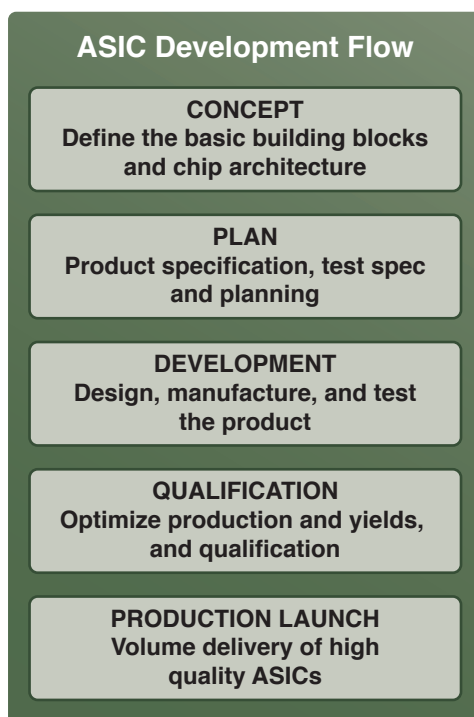
System architects help to refine design specifications to ensure feasibility and maximize functionality, while optimizing performance, power consumption, and size.

Some of the ASIC devices that ON Semiconductor system architects and engineering staff have recently developed include:

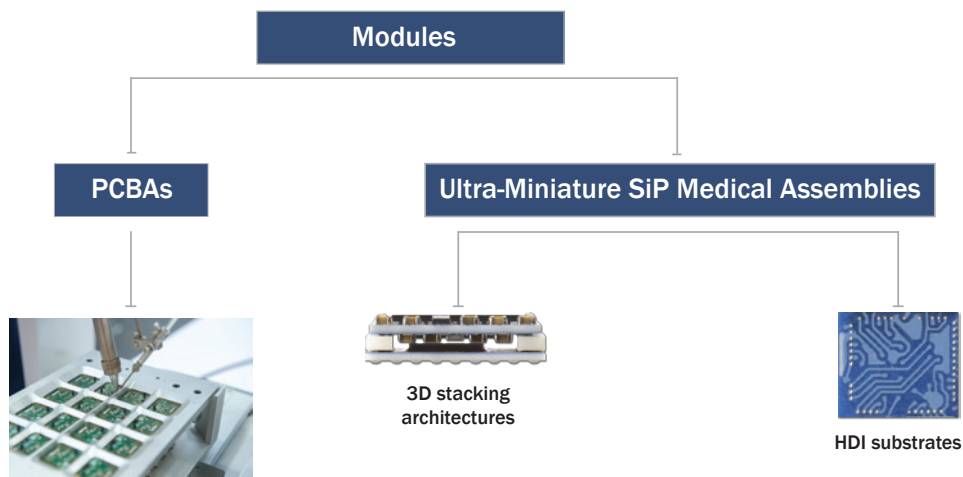
- Sensor interface for blood gas monitoring
- Vital sign patch monitor
- Data acquisition system devices for CT scanners, X-Ray, Ultrasound, and PET machines
- Precision analog front-end for ECG

Flexible Engagement

Whether the requirement is full or partial definition and design, design services after an RTL or netlist handoff, foundry services, custom advanced packaging of existing designs, or full turnkey service, ON Semiconductor tailors services to the unique requirements of medical customers.



Miniaturization Through Medical-Grade Modules



ON Semiconductor is a pioneer in the development of miniaturized packaging solutions for the medical microelectronics industry.

The company offers turnkey solutions for medical applications where size, performance, and system integration are critical. ON Semiconductor has proven leadership in miniature System-in-Package (SiP) solutions, addressing the highly space-constrained requirements of hearing aid manufacturers for over four decades. As other medical devices shrink in size, they too can benefit from the same miniaturization techniques and technologies.

Whether the need is for a custom component such as a complete tested PCBA or a fully integrated SiP, ON Semiconductor offers custom package development and manufacturing services, from design and test through volume manufacturing.

The ON Semiconductor facility located in Burlington, Ontario, offers manufacturing compliance with US Food & Drug Administration (FDA) regulations.

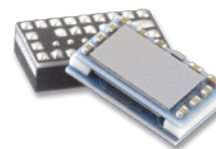
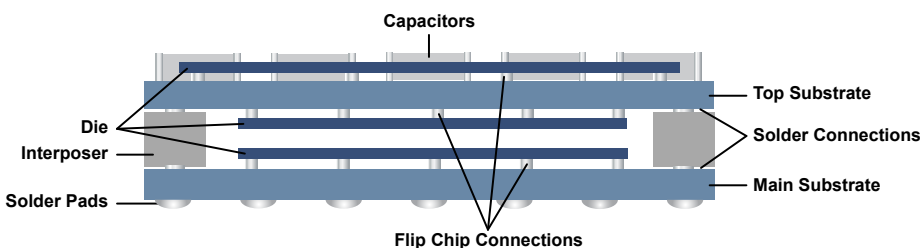
PCBA Modules

ON Semiconductor offers PCBA module design, manufacturing, assembly, and test services to standards of quality and traceability demanded by medical device manufacturers. Features like 2D barcodes screened onto every board for individual tracing is just one example of how our standard process is tailored to medical needs.

Advanced 3D Packaging

Custom 3D packaging connects different silicon die and discrete components together in the same package to dramatically save space and improve electrical performance by decreasing signal distances.

- Stacking with or without wirebonds
- Modular, scalable architectures with high degree of manufacturing testability
- Mature, robust technologies and structures
- RoHS-compliant and ISO-certified
- For applications with high reliability requirements



AYRE SA3291 - Wireless DSP
SiP for Hearing Aids

High-Density Ceramic Substrates

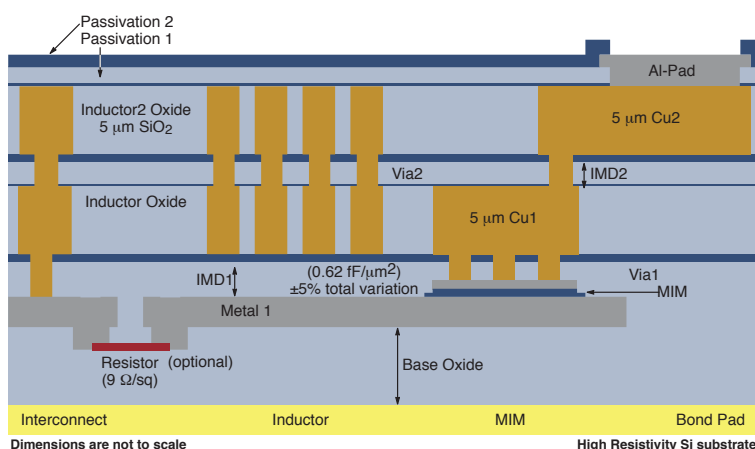
ON Semiconductor fabricates high density, high performance ceramic-based substrate circuits to optimize miniaturization.

- Proprietary multi-layer double-sided thick film ceramic substrates
- High density interconnect (1 mil line/space geometries)
- Fine-pitch through-ceramic vias for 3D interconnection
- Excellent high frequency and thermal properties
- Low \$/wiring density ratio provides excellent value proposition

High-Performance Integrated Passive Devices

Integrating passive components (resistors, capacitors, and inductors) in HighQ Copper-on-Silicon Integrated Passive Device (IPD) platform give customers a high-performance and cost-effective solution for wireless RF system-in-package applications. Key features include:

- Excellent electrical performance via high-quality integrated components (resistors, MIM capacitors, high-Q inductors)
- Reduced package size via elimination of discrete passives
- Potential for reduced total cost of ownership



Cross-section view of HighQ Copper-on-Silicon IPD Process

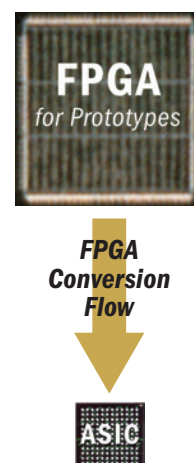
ASIC Conversion

ON Semiconductor is the industry leader in converting FPGAs to ASICs. FPGA conversions provide significant cost savings with drop-in ASIC replacements; and in most cases achieve higher performance, lower power, and better thermal performance.

To support customers facing End-of-Life device or process obsolescence from current ASIC vendors, the company also provides ASIC-to-ASIC conversions. Advanced design processes match functionality and timing across the same operating conditions and voltages of the original device to produce an ASIC with the same form, fit, and function.

Features

- Successfully converted thousands of designs over three decades
- Significant cost savings and performance enhancement
- Process longevity to support long product life cycle requirements



Semi-Customizable Solutions for Precision-Sensing Medical Devices

Struix is a semi-customizable System-in-Package (SiP) that provides medical device manufacturers with greater design flexibility than with standard products, and improved time to market compared to fully-custom solutions. Using advanced die-stacking technology, Struix integrates a 32-bit microcontroller (ULPMC10) and a custom-designed analog front-end (AFE) into a single miniature system, optimized to meet the stringent power and space requirements of portable medical devices.

Industry-Leading 32-bit Microcontroller (ULPMC10)

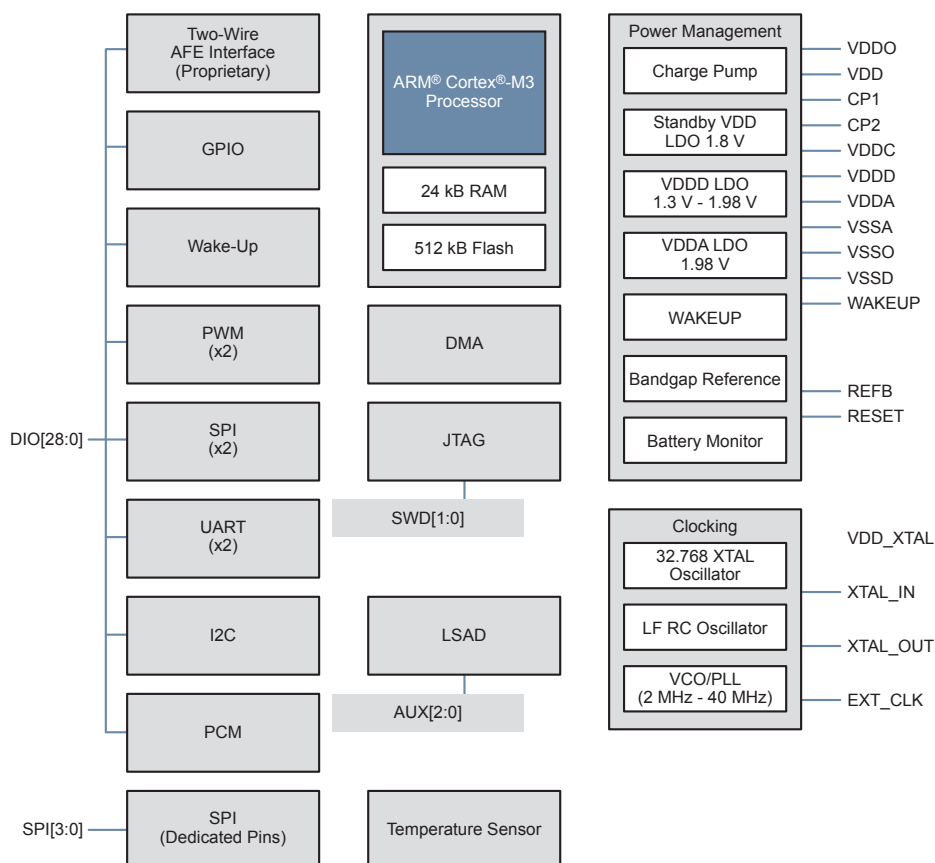
- Built around a powerful ARM® Cortex®-M3 core
- Ultra-low-power processing (less than 200 μ A/MHz operating current and less than 500 nA sleep mode current)
- Built-in power management for fail-safe operation with a wide variety of battery voltages
- Supports all standard interfaces such as UART, SPI (Master/Slave), I2C, PCM, 2-wire JTAG for debugging
- Memory
 - 512 kB on-chip Flash memory
 - 24 kB SRAM memory

Custom Analog Front-End

- “Made-to-Order” solutions using ON Semiconductor’s custom chip-engagement model
- Extensive Intellectual Property (IP) portfolio to select from for a wide variety of medical applications
- Available driver options for therapy devices (e.g., Insulin delivery, electrical stimulation, iontophoresis)

Applications

- Blood glucose meters
- Wireless electrocardiographs
- Pulse oximeters
- Telehealth/remote patient monitors
- Personal emergency response systems
- Fitness and wellness monitoring devices (e.g., activity, calorie, and sleep monitors)



Foundry Services

ON Semiconductor offers foundry services specifically tailored to the medical market. With analog, high voltage, and low power options, these world-class processes are ideally suited for applications such as cardiac rhythm management, neurostimulation, patient monitoring, and hearing aid devices.

The company provides process design kits (PDKs) and design guides for our technology. Customers are ensured direct technical communication with the foundry through a development customer service representative (DCSR). The DCSR coordinates the project through the engineering and prototype stages and responds to customer inquiries.

Value-Added Services

Other front-end and back-end services are available, such as wafer probe, custom short flow wafer processing, backgrind, backmetal, custom packaging, test, logistics, and supply chain management.

Features

- Optimized in-house process technologies tailored to medical applications
- Process longevity to support long product life cycle requirements
- World-class, high-reliability manufacturing sites certified to multiple international standards
- Access to extensive IP including configurable SRAM and EEPROM
- Multi-project wafer (MPW) prototyping support
- Extensive failure analysis capability
- Low cost shuttle service for development
- Flexible manufacturing: process modifications and lot splits

Mixed-Signal Process Technologies

ON Semiconductor offers ultra-low-power and low-leakage CMOS processes, as well as high voltage CMOS and BCD, tailor-made for the stringent demands of medical applications.

Process Name	Min Drawn Poly (μm)	No. Metal Layers	Wafer Size (in)	Max Operating Voltage (V _{gs})	NVM	Linear Cap	Trans Char	Other Devices
I4T 45V75V	0.18	4-6	8	1.8/3.3	Y	MIM	Salicide	Resistors
ONC18TG	0.18	4-6	8	1.8/5/18	Y	MIM	Salicide	Resistors
ONC18 5V30V	0.18	4-6	8	1.8/5	Y	MIM	Salicide	Resistors
ONC18G/MS	0.18	4-6	8	1.8/3.3	Y	MIM	Salicide	Resistors
ONC25	0.25	2-5	8	2.5/3.3/5	Y	MIM	Salicide	Misc
ONBCD25	0.25	2-5	8	5/12	Y	MIM	Salicide	Misc
C3/D3	0.35	3-5	8	3.3/5	Y	PIP	Salicide	Resistors
I3T25	0.35	3-5	8	3.3/12	Y	MIM	Salicide	Resistors
I3T50	0.35	3-5	6 & 8	3.3	Y	MIM	Salicide	Misc
I3T80	0.35	3-5	6 & 8	3.3	Y	MIM	Salicide	Misc
C5	0.6	2-3	8	5/12	Y	PIP	Poly	Misc
I2T30	0.7	2-3	6	5	N	PIP	Poly	Misc
I2T100	0.7	2-3	6	5	N	PIP	Poly	Misc

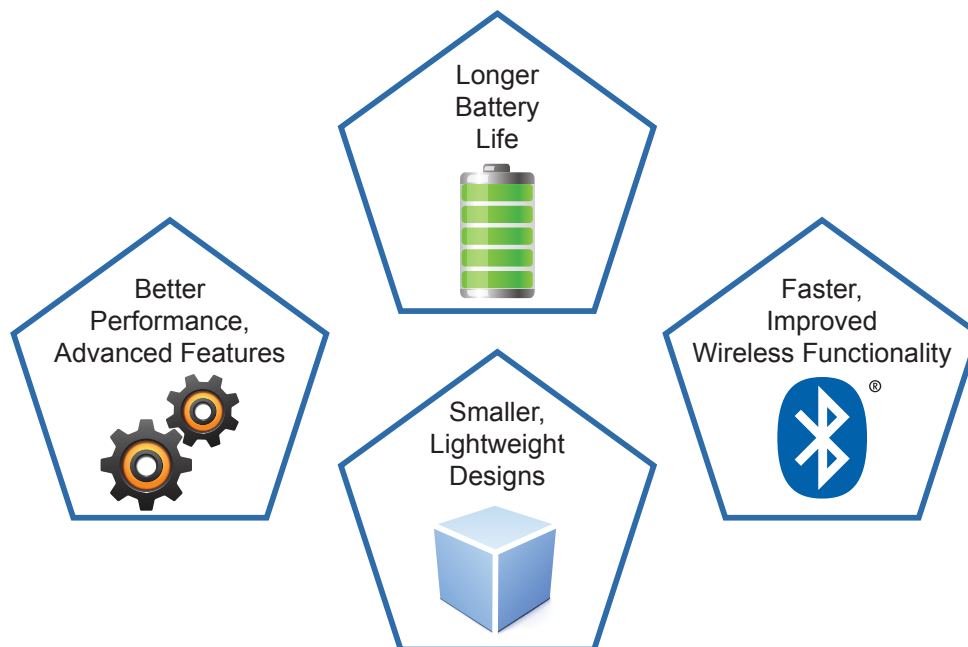
Bluetooth® Low Energy Technology Radio SoCs

The multi-protocol, Bluetooth 5 certified RSL10 radio System-on-Chip (SoCs) brings ultra-low-power wireless connectivity to IoT and “connected” health and wellness devices.

Offering the industry’s lowest power consumption, RSL10 provides devices like fitness monitors with advanced wireless features without compromising system size and battery life.

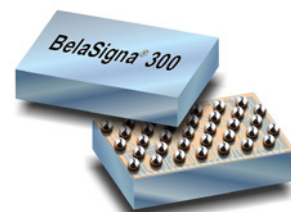


Ultra-Low-Power Wireless for IoT and “Connected” Health & Wellness



Ultra-Low-Power DSP Systems for Portable Medical Devices

BelaSigna® digital signal processors are complete, fully-programmable signal processing systems ideal for use in portable medical applications. Optimized for size, power consumption, signal integrity and computational power, BelaSigna processors deliver the flexibility of a generic DSP with the power consumption and size of a fixed-function ASIC.

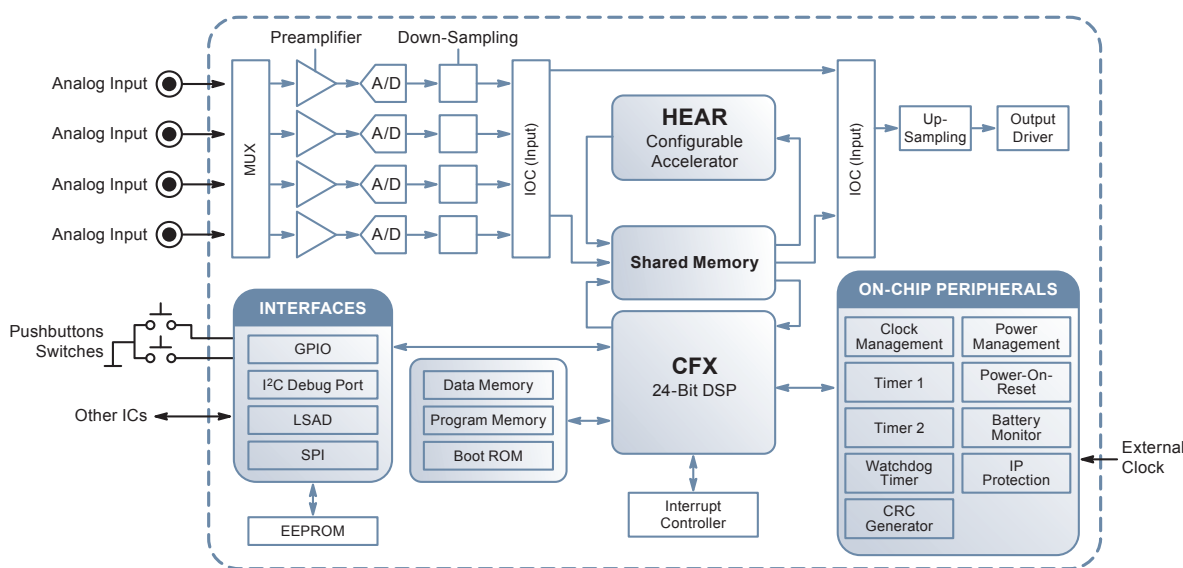


Features and Benefits

- Flexible to meet specialized requirements
- High precision analog input stage
 - ♦ 4 independent input channels
 - ♦ 88 dB dynamic range
 - ♦ A/D sampling rates from 1.27 – 60 kHz
- Ultra-low power consumption
 - ♦ Supply voltage down to 1.2 V
 - ♦ 511 μ A @ 1.8 V current consumption in a 5-lead wireless ECG
- Miniature package size
- Dual-core computing
 - ♦ Open-programmable DSP core with a highly configurable coprocessor balances processing power and optimizes power consumption and design flexibility
- Comprehensive suite of development tools

Applications

- Wireless electrocardiographs
- Pulse oximeters
- Electronic stethoscopes
- Medical devices requiring audio processing
- See AND9035/D, BelaSigna 250 and 300 for Low-Bandwidth Applications



Device	Description	MIPS Max	Dynamic Range (dB)	RAM	Interfaces	Power Consumption	Standby Current (μ A)	Analog Audio I/O	Packages
BelaSigna 300	24-Bit Audio Processor for Portable Communication Devices	240	110/88	110 kB	I2S, PCM, GPIO, I2C, SPI	1-5 mA Typical	40	4/1	WLCSP-35, DFN-44
BelaSigna 250	16-Bit Audio Processor, Full Stereo 2-In 2-Out	60	88	42 kB	I2S, PCM, GPIO, I2C, SPI, UART	5 mA @ 20 MHz	50	2/2	LFBGA-57, LFBGA-64

Open-Programmable DSP Systems for Hearing Aids

The highly customizable Ezairo® series of open-programmable DSP systems enables manufacturers to build hearing aids with high precision sound. With processing power to run several advanced software algorithms simultaneously, Ezairo DSP systems' unique and patented architecture optimally balances processing power, power consumption, and design flexibility. Ezairo systems are available in several hybrid package configurations and are ideally suited for hearing aid manufacturers wishing to develop or source their own innovative algorithms.

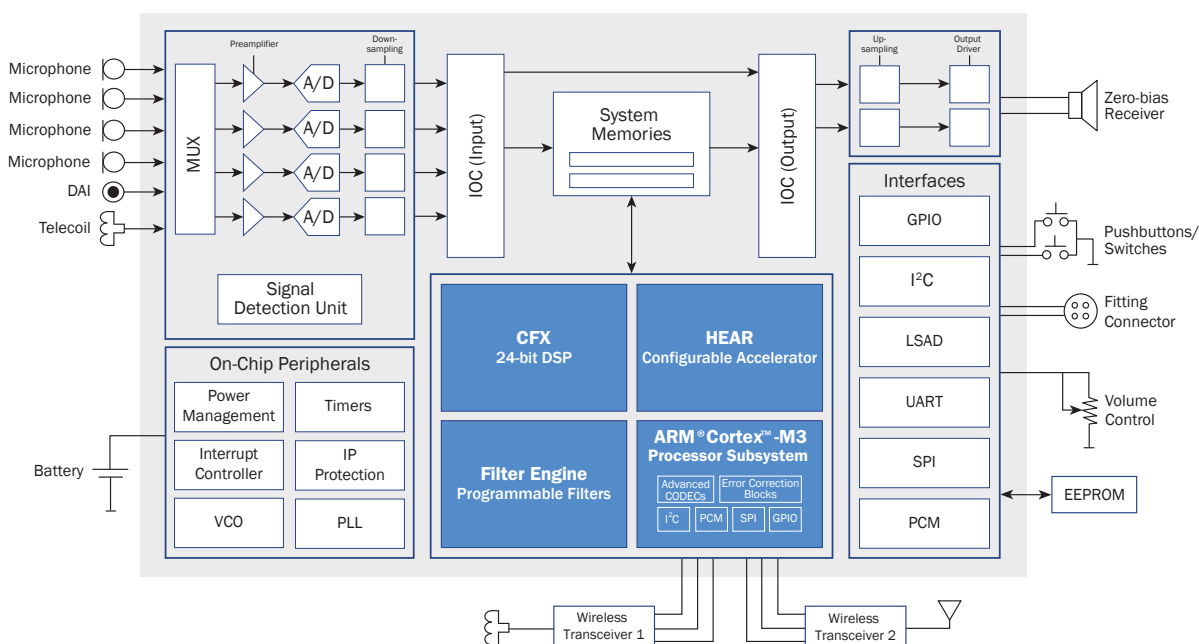
Features and Benefits

- High-precision sound with 24-bit precision computing
 - ♦ Allows development of more complex and efficient hearing aid algorithms
- Dual-core or quad-core computing
 - ♦ Balances processing power and optimizes power consumption and design flexibility

- Ultra-high audio fidelity
 - ♦ Enables substantially enhanced performance, especially for mild to moderate hearing loss profiles that demand more natural sound
- Ultra-low-power consumption
 - ♦ Extends life of small batteries
- Wireless capability
 - ♦ Seamless control of low-power radios for wireless-enabled hearing aids



	Ezairo 5920	Ezairo 7110	Ezairo 7150 SL
DSP	24 bits	24 bits	24 bits
Accelerator	HEAR	HEAR	HEAR
Wireless Control System	—	ARM Cortex-M3 Processor plus Hardwired Support	ARM Cortex M3 Processor plus Hardwired Support
Clock Speed	Max 5.12 MHz	Max 15.36 MHz	Max 15.36 MHz
Typical Power Consumption	~850 μ A @ 5.12 MHz	~700 μ A @ 10.24 MHz	~700 μ A @ 10.24 MHz
Max MIPS	45	375	375
Total Program Memory	14 kwords	40 kwords	40 kwords
Total Data Memory	20 kwords	44 kwords	44 kwords
Battery Voltage	Typ 1.25 V, Max 1.5 V	Typ 1.25 V, Max 2.0 V	Typ 1.25 V, Max 2.0 V
EEPROM	512 kbit	2048 kbit	2048 kbit EEPROM
Wireless Enabled			Yes



Open-Programmable DSP Systems for Hearing Aids

Development Tools

The Ezairo series is fully supported by an extensive suite of development tools to help manufacturers quickly and easily develop, debug and test software for hearing aid DSP systems. The development tools include:

Integrated Development Environment (IDE): A fully-integrated software development environment that enables developers to code, compile, debug, and validate hearing aid algorithms.

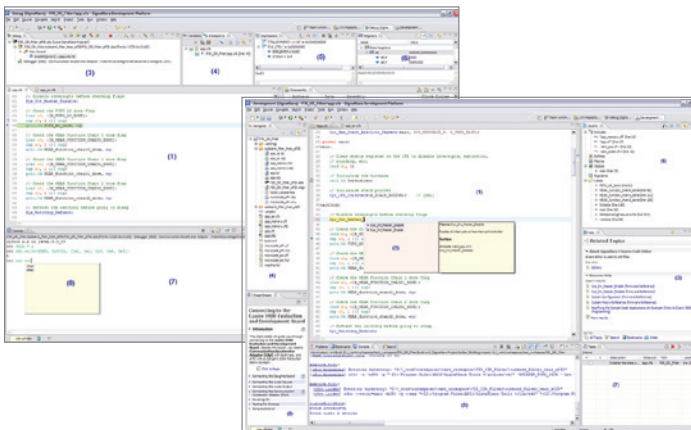
Communication Tool Kit (CTK): An easy-to-use universal software component library that facilitates communication with the DSP system for development, fitting system, manufacturing, and testing environments.

Evaluation and Development Board: Hardware for the development, demonstration, testing and debugging of hearing aid algorithms.

Hybrid Demo Board (HDB): Hardware for assessing and testing the audio performance and power consumption of hybrid modules.

Promira™ Serial Platform from TotalPhase™: Facilitates high-speed communication between host PCs and the EDB and HDB.

Online Access* to Documentation, Tools and Video Training



Integrated Development Environment (IDE)



Evaluation and Development Kit (EDK)

*A one-year subscription for online access to updates to the development tools is included in the initial cost of the Evaluation & Development Kit (EDK).

Preconfigured and Pre-Fit DSP Systems for Hearing Aids

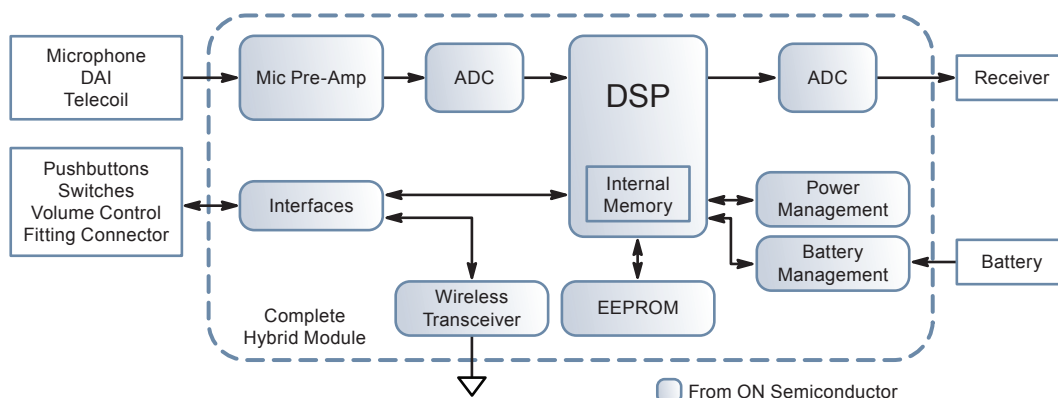
ON Semiconductor preconfigured DSP systems are available in multiple hybrid options and feature bundles, supporting all hearing aid product portfolio needs. This series is ideally suited for hearing aid manufacturers who want implementation-ready solutions that require minimal programming or configuration.

A complete software development suite is available to help select speech processing options, hardware options, and interface to fitting software.

This portfolio also includes pre-fit hybrids for manufacturers requiring an easy-to-deploy solution for entry-level markets. These devices are preprogrammed to accurately treat over 80% of the hearing-impaired population, and do not require any additional software fitting.

Advanced Algorithms

- Impulse noise reduction
- Binaural synchronization
- Binaural telecoil
- Stereo audio streaming
- Environmental classification
- Automatic adaptive directionality
- FrontWave® directional sound processing
- Adaptive noise reduction
- Adaptive feedback cancellation
- Static feedback management



Generic Hearing Aid Application Diagram

Preconfigured and Pre-Fit DSP Systems for Hearing Aids

Device	Pre-Fit	WDRC Channels	Wireless Transceiver	Advanced Algorithms	Graphic EQ Bands	Acoustic Indicators	Other Features	Program Modes
AYRE™ SA3291		up to 8	NFMI	Adaptive Feedback Cancellation; Adaptive Noise Reduction; Automatic Adaptive Directionality; Binaural Synchronization; Binaural Telecoil; Environmental Classification; FrontWave Directional Microphone; Static Feedback Management; Stereo Audio Streaming; Noise Generator for Tinnitus Masking	16	EVOKE	Datalogging; Digital Volume Control	6
RHYTHM™ R3920		up to 16	—	Adaptive Feedback Cancellation; Adaptive Noise Reduction; Automatic Adaptive Directionality; Environmental Classification; FrontWave Directional Microphone; Static Feedback Management; Impulse Noise Reduction; Noise Generator for Tinnitus Masking	16	EVOKE	Datalogging; Digital Volume Control	6
RHYTHM R3910		up to 8	—	Adaptive Feedback Cancellation; Adaptive Noise Reduction; Automatic Adaptive Directionality; Environmental Classification; FrontWave Directional Microphone; Static Feedback Management; Noise Generator for Tinnitus Masking	16	EVOKE	Datalogging; Digital Volume Control	6
RHYTHM SB3231		up to 4	—	Adaptive Feedback Cancellation; Adaptive Noise Reduction; FrontWave Directional Microphone; Noise Generator for Tinnitus Masking	8	EVOKE	Trimmer Support	4
RHYTHM SA3229/SB3229		up to 4	—	Adaptive Feedback Cancellation; Noise Generator for Tinnitus Masking	8	EVOKE	Digital Volume Control; Trimmer Support	4
RHYTHM R3110	✓	2	—	Adaptive Feedback Cancellation; Adaptive Noise Reduction; Noise Generator for Tinnitus Masking	—	—	Trimmer Support	3



Features	RHYTHM™			
	SA3229	SB3229	SB3231	R3110
Root Part Number				
Advanced Algorithm Features				
Binaural Synchronization				
Binaural Telecoil				
Stereo Audio Streaming				
Impulse Noise Reduction				
iSceneDetect™ Environmental Classification				
Automatic Adaptive Directionality				
FrontWave® Directional Microphone			•	•
Adaptive Noise Reduction			•	•
Advanced Adaptive Feedback Cancellation	•	•	•	•
Static Feedback Management				
Performance				
Adaptive AGC-O				•
Input Dynamic Range	96 dB	96 dB	96 dB	96 dB
Bandwidth	8 kHz or 16 kHz	8 kHz or 16 kHz	8 kHz or 16 kHz	8 kHz
High Power Compatibility	•	•	•	•
Audio Path Word Length	20-bit	20-bit	20-bit	20-bit
WDRG Amplification				
Number of WDRG Channels	1, 2 or 4	1, 2 or 4	1, 2 or 4	2
Adjustable Thresholds and Time Constants	•	•	•	
Adjustable Expansion Ratio	•	•	•	
In-channel Expansion	•	•	•	
Twin Average Detection	•	•	•	•
Frequency Response Shaping				
Graphic Equalization	8 band	8 band	8 band	
Additional Parametric Filters	•	•	•	
Preconfigured Filters	•	•	•	LC, HC
Generic Biquad Filters	•	•	•	
Acoustic Indicators				
EVOKE™ Advanced Acoustic Indicators	•	•	•	
Configurable Low Battery Indicator	•	•	•	
Click-free Memory Switching with Cross Faders	•	•	•	
Programmable Memory Change Indicator	•	•	•	
Trimmer Functionality				
Trimmer Support	•	•	•	•
Number of Trimmers	4 + VC	4 + VC	4 + VC	4
Other Features				
Datalogging				
Internal Noise Generation for Tinnitus Treatment	•	•	•	•
Real Ear Feedback Measurement			•	
In-Ear Stimulation with Narrow Band Noise	•	•	•	
Rocker Switch	•	•	•	
Digital Volume Control	•	•	•	
Programmable VC Range	•	•	•	
VC/MS Software Lock	•	•	•	
Programmable Power-on Delay	•	•	•	
Programmable Interface	SDA/I2C	SDA/I2C	SDA/I2C	
Program Modes	4	4	4	3
Number of Inputs	4 (2 MIC, 1 DAI, 1 TCOIL)	4 (2 MIC, 1 DAI, 1 TCOIL)	4 (2 MIC, 1 DAI, 1 TCOIL)	3 (1 MIC, 1 TCOIL)
Advanced Power Management	•	•	•	
One Time Programmable (OTP)	•			
Software Support				
ARK Support	•	•	•	
Feedback Path Modelling Tool			•	
SOUNDFIT™ Fitting Software		•	•	
Software Security	•	•	•	
Packaging				
Hybrid Size	5.72 x 3.18 x 1.14 mm 0.225 x 0.125 x 0.045 in	5.59 x 3.18 x 1.52 mm 0.220 x 0.125 x 0.060 in	5.59 x 3.18 x 1.52 mm 0.220 x 0.125 x 0.060 in	5.08 x 3.1 x 1.0 mm 0.200 x 0.122 x 0.0394 in
Suitable for Invisible-in-Canal (IIC)				
Reflowable	•	•	•	•
RoHS	•	•	•	•
Hybrid Package – Actual Size				



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Mainstream CMOS Image Sensors

Device	Sensor/ SOC	Resolution (MP)	Pixel Count (H x V)	Pixel Size (µm)	Optical Format	CFA ¹	Shutter Type ²	Frame Rate ³	Output Interface	Package Size (mm)	Package ⁴
MT9V115	SOC	VGA	648 x 488	1.75 FSI	1/13"	C	ERS	30 fps	Parallel, MIPI	2.7 x 2.7	ODCSP-25
MT9V124	SOC	VGA	648 x 488	1.75 FSI	1/13"	C	ERS	30 fps	LVDS	2.7 x 2.7	ODCSP-25
ASX350	SOC	VGA	728 x 560	3.75 FSI	1/5"	C	ERS	60 fps	Parallel, NTSC/PAL	7 x 7	IBGA-63
ASX340	SOC	VGA	728 x 560	5.6 FSI	1/4"	C	ERS	60 fps	Parallel, NTSC/PAL	7.5 x 7.5	IBGA-63
MT9V111	SOC	VGA	640 x 480	5.6 FSI	1/4"	C	ERS	30 fps	Parallel	7 x 7	IBGA-52
MT9V128	SOC	VGA	680 x 512	5.6 FSI	1/3"	C	ERS	60 fps	Parallel, NTSC/PAL	9 x 9	IBGA-63
MT9V024	Sensor	WVGA	752 x 480	6.0 FSI	1/3"	C, M	GS	60 fps	Parallel, LVDS	9 x 9	IBGA-52
MT9V034	Sensor	WVGA	752 x 480	6.0 FSI	1/3"	C, M	GS	60 fps	Parallel, LVDS	11.43 x 11.43	CLCC-48
ARX550	Sensor	0.5	848 x 638	3.75 FSI	1/5"	C	ERS	66 fps	Parallel, HiSPi	9 x 9	IBGA-63
AR0140	Sensor	1.0	1280 x 800	3.0 FSI	1/4"	C	ERS, GRR	60 fps	Parallel, HiSPi	9 x 9	IBGA-63
AR0141	Sensor	1.0	1280 x 800	3.0 FSI	1/4"	C, M, RGB-IR	ERS, GRR	60 fps	Parallel, HiSPi	9 x 9	IBGA-63
AR0130	Sensor	1.2	1280 x 960	3.75 FSI	1/3"	C, M	ERS	1.2 Mp / 45 fps, 720p60	Parallel	11.43 x 11.43, 10 x 10	PLCC-48, ILCC-48
AR0132	Sensor	1.2	1280 x 960	3.75 FSI	1/3"	C, M	ERS	1.2 Mp / 45 fps, 720p60	Parallel, HiSPi	9 x 9	IBGA-63
AR0135	Sensor	1.2	1280 x 960	3.75 FSI	1/3"	C, M	GS	1.2 Mp / 54 fps, 720p60	Parallel, HiSPi	9 x 9	IBGA-63
MT9M114	SOC	1.3	1296 x 976	1.9 FSI	1/6"	C	ERS	30 fps	Parallel, MIPI	3.85 x 4.65	ODCSP-55
MT9M131	SOC	1.3	1280 x 1024	3.6 FSI	1/3"	C	ERS	15 fps	Parallel	11.43 x 11.43	CLCC-48
MT9M001	Sensor	1.3	1280 x 1024	5.2 FSI	1/2"	M	ERS	30 fps	Parallel	14.22 x 14.22	CLCC-48
MT9D131	SOC	2.0	1668 x 1248	2.8 FSI	1/3.2"	C	ERS	15 fps	Parallel	14.22 x 14.22	CLCC-48
AR0230	Sensor	2.1	1928 x 1088	3.0 FSI	1/2.7"	C	ERS, GRR	1080p60	Parallel, HiSPi	10 x 10	IBGA-80
AR0237	Sensor	2.1	1928 x 1088	3.0 FSI	1/2.7"	C, RGB-IR	ERS, GRR	1080p60	Parallel, HiSPi	10 x 10, 11.43 x 11.43	IBGA-80, PLCC-48
AR0263	Sensor	2.1	1936 x 1096	1.4 BSI	1/6"	C	ERS	1080p60	MIPI	3.88 x 4.08	ODCSP-35
AS0260	SOC	2.1	1920 x 1080	1.4 FSI	1/6"	C	ERS	1080p30	Parallel, MIPI	4.16 x 6.01	ODCSP-54
AR0231	Sensor	2.3	1928 x 1208	3.0 BSI	1/2.7"	C	ERS	60 fps	Parallel, HiSPi, MIPI	10 x 11	IBGA-121
AR0239	Sensor	2.3	1936 x 1188	3.0 BSI	1/2.7"	C	ERS, GRR	60 fps	Parallel, HiSPi, MIPI	9 x 9	IBGA-80
AR0330	Sensor	3.5	2304 x 1536	2.2 FSI	1/3"	C	ERS, GRR	1080p60	Parallel, HiSPi, MIPI	6.28 x 6.65, 11.43 x 11.43	ODCSP-64, ODCSP-61, CLCC-48, PLCC-48
AR0543	Sensor	5	2592 x 1944	1.4 FSI	1/4"	C	ERS	5 Mp/15 fps, 1080p30	Parallel, MIPI	5.07 x 5.26	ODCSP-54
MT9P006	Sensor	5	2592 x 1944	2.2 FSI	1/2.5"	C	ERS, GRR	5 Mp/15 fps, 720p60	Parallel	10 x 10	ILCC-48
MT9P031	Sensor	5	2592 x 1944	2.2 FSI	1/2.5"	C, M	ERS, GRR	14 fps	Parallel	10 x 10	ILCC-48
AR0521	Sensor	5	2592 x 1944	2.2 BSI	1/2.5"	C	ERS, GRR	60 fps	HiSPi, MIPI	12 x 12	PLCC-52, PLCC-48
AR0833	Sensor	8	3264 x 2448	1.4 BSI	1/3.2"	C	ERS, GRR	30 fps	MIPI	10 x 10	CLCC-48
AR0835HS	Sensor	8	3264 x 2448	1.4 BSI	1/3.2"	C	ERS, GRR	8 Mp / 46 fps, 1080p60	HiSPi, MIPI	10 x 10	CLCC-48
AR0842CP	Sensor	8	3264 x 2448	1.1 BSI	1/4"	Clarity+	ERS	30 fps	MIPI	—	Die
MT9J003	Sensor	10	3856 x 2764	1.67 FSI	1/2.3"	C, M	ERS, GRR	10 Mp / 15 fps, 1080p60	Parallel, HiSPi	10 x 10	ILCC-48
AR1011HS	Sensor	10	3984 x 2712	3.4 FSI	1"	C	ERS	60 fps	HiSPi	23 x 27.4	CLCC-124
AR1335	Sensor	13	4208 x 3120	1.1 BSI	1/3.2"	C	ERS	13 Mp / 30 fps, 1080p60	MIPI	5.69 x 6.29	ODCSP-63
AR1335HS	Sensor	13	4208 x 3120	1.1 BSI	1/3.2"	C	ERS	13 Mp / 30 fps, 1080p90	MIPI	10 x 10	CLCC-48
AR335 Mono	Sensor	13	4208 x 3120	1.1 BSI	1/3.2"	M	ERS	13 Mp / 30 fps, 1080p60	MIPI	—	Die
AR1337	Sensor	13	4208 x 3120	1.1 BSI Super PD	1/3.2"	C	ERS	13 Mp / 30 fps, 1080p60	MIPI	—	Die
MT9F002	Sensor	14	4608 x 3288	1.4 FSI	1/2.3"	C	ERS, GRR	14 Mp / 13 fps, 1080p60	Parallel, HiSPi	10 x 10	ILCC-48
AR1820HS	Sensor	18	4912 x 3684	1.25 BSI	1/2.3"	C	ERS, GRR	18 Mp / 24 fps, 1080p120	HiSPi, MIPI	10 x 10	IBGA-60

1. C = Color, M = Mono. 2. ERS = Electronic Rolling Shutter, GRR = Global Reset Release, GS = Global Shutter. 3. Higher frame rates can be achieved in subsampling modes. 4. Some devices are also offered without a package in bare die or wafer form.

Co-Processors for Mainstream CMOS Image Sensors

Available Features

- HDR with ALTM
- Dewarp, up to 165 degrees
- Spatial Transform Engine Software Add-on
- Overlays
- GPIOs, up to 5
- Color Pipe
 - Demosaic
 - Gamma correction
 - Auto white balance
 - Defect correction
 - Noise reduction
 - Auto exposure
 - Flicker detection

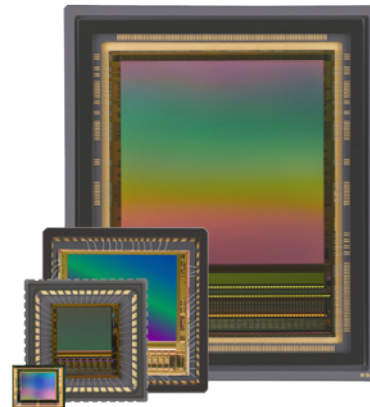
Device	Resolution (MP)	Frame Rate (fps)	Video	Output Format	Package
AP0100AT	1	45	720p/60 fps, NTSC/PAL	YUV	VFBGA-100
AP0100CS	1	45	1.2 MP/45 fps; 720p/60 fps	NTSC/PAL; YUV	VFBGA-100
AP0101AT	1	45	1.2 MP/45 fps; 720p/60 fps	SMPTE 296M; YUV	VFBGA-81
AP0101CS	1	45	1.2 MP/45 fps; 720p/60 fps	SMPTE 296M; YUV	VFBGA-81
AP0102AT	1	—	1.2 MP/45 fps; 720p/60 fps; 1080p/30 fps	RGB; YUV	VFBGA-100
AP0200AT	2	30	1.2 MP/45 fps; 720p/60 fps; 1080p/30 fps	H.264; MJPEG	VFBGA-100
AP0201AT	2	30	1.2 MP/45 fps; 720p/60 fps; 1080p/30 fps	H.264; MJPEG	VFBGA-100
AP0202AT	2	30	1.2 MP/45 fps; 720p/60 fps; 1080p/30 fps	RGB565; RGB888; YUV	VFBGA-100
AP1302	13	30	13 MP/30 fps; 1080p/120 fps	JPEG; RAW; RGB565; RGB888; YUV	VFBGA-120

PYTHON Global Shutter CMOS Image Sensors

With resolutions from VGA to 26 megapixels, the PYTHON family of image sensors addresses the needs of medical imaging applications, ranging from microscopy to cameras used for surgical theater monitoring and automation. Combining flexibility in configuration and resolution with high speed and high sensitivity, these devices capture fast moving scenes without distortion by combining low read noise and high sensitivity with frame rates up to 815 fps.

Features

- CDS global shutter technology with low noise performance
- True HW scalable family concept
- High configurability and fast adaptability
- Quadratic speed increase with ROI windowing
- Multiple regions of interest
- High dynamic range
- Color, Monochrome, and Enhanced NIR configurations
- Standard and protective tape configurations
- Low power, cost efficient configurations



Device	Resolution (MPix)	Pixel Count (H x V)	Pixel (μm)	Diagonal (mm)	Lens	CFA ¹	FPS Max	Evaluation Kit
PYTHON 300	0.3	640 x 480	4.8	3.8	1/4"	C/M/NIR	815	✓
PYTHON 480	0.5	800 x 600	4.8	4.8	1/3.6"	C/M	120	✓
PYTHON 500	0.5	800 x 600	4.8	4.8	1/3.6"	C/M/NIR	545	✓
PYTHON 1300	1.3	1280 x 1024	4.8	7.9	1/2"	C/M/NIR	210	✓
PYTHON 2000	2.3	1920 x 1200	4.8	10.9	2/3"	C/M/NIR	225	✓
PYTHON 5000	5.3	2592 x 2048	4.8	15.9	1"	C/M/NIR	100	✓
PYTHON 10K	11.1	3840 x 2896	4.5	21.6	4/3	C/M/NIR	175	✓
PYTHON 12K	12.5	4096 x 3072	4.5	23.0	4/3	C/M/NIR	160	✓
PYTHON 16K	16.8	4096 x 4096	4.5	26.1	APS-H	C/M/NIR	120	✓
PYTHON 25K	26.2	5120 x 5120	4.5	32.6	APS-H	C/M/NIR	80	✓

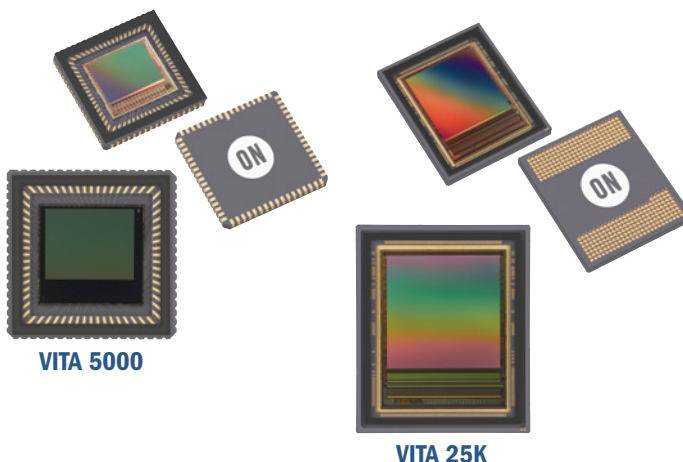
1. CFA Options - Bayer Color (C), Monochrome (M), Enhanced NIR (NIR).

Versatile CMOS Image Sensors

VITA image sensors combine flexibility in configuration and resolution with high speed and high sensitivity, addressing a wide range of customer requirements in a cost-effective family of rolling/global shutter CMOS image sensors. A flexible read-out architecture makes them well suited for medical imaging applications that demand high functionality while delivering excellent image quality.

Features

- 1.3 to 25 Megapixels
- Pipelined and triggered global shutter with dual readout
- Rolling shutter with CDS
- Quadratic speed increase with ROI windowing
- Multiple regions of interest



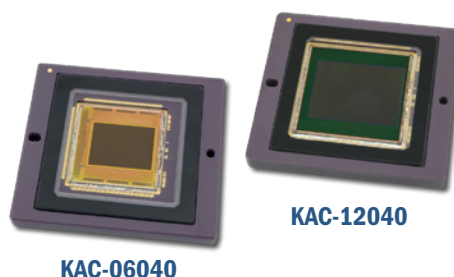
Device	Resolution (MPix)	Pixel Count (H x V)	Pixel (μm)	Diagonal (mm)	Lens	CFA ¹	FPS Max	Evaluation Kit
VITA 1300	1.3	1280 x 1024	4.8	7.9	1/2"	C/M	150	✓
VITA 2000	2.3	1920 x 1200	4.8	10.9	2/3"	C/M	90	✓
VITA 5000	5.3	2592 x 2048	4.8	15.9	1"	C/M	75	✓
VITA 12K	12.6	4096 x 3072	4.5	23.0	4/3"	C/M	160	✓
VITA 16K	16.8	4096 x 4096	4.5	26.1	APS-H	C/M	125	✓
VITA 25K	26.2	5120 x 5120	4.5	32.6	APS-H	C/M	80	✓

1. CFA Options – Bayer Color (C), Monochrome (M).

KAC image sensors provide both global shutter and low noise rolling shutter modes, combined with programmable bit depth (8 to 14 bit) with a flexible readout architecture that supports interspersed video streams. These features enable the use of multiple regions of interest that can simultaneously monitor both wide areas and local regions, making these devices ideal for medical imaging applications such as analytical microscopy.

Features

- Global shutter, low noise rolling shutter
- Programmable bit depth
- Interspersed video streams
- Multiple regions of interest
- High frame rates
- High NIR sensitivity



Device	Resolution (MPix)	Pixel Count (H x V)	Pixel (μm)	Diagonal (mm)	Lens	CFA ¹	FPS Max	Evaluation Kit
KAC-06040	6	2832 x 2128	4.7	16.7	1"	C/M	160	✓
KAC-12040	12	4000 x 3000	4.7	23.5	4/3"	C/M	70	✓

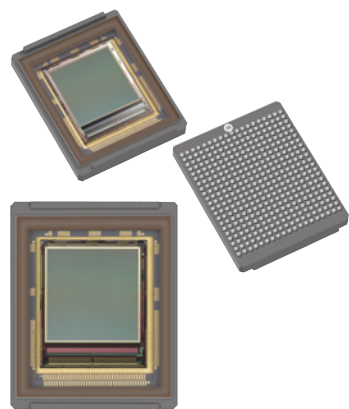
1. CFA Options – Bayer Color (C), Monochrome (M).

High Speed CMOS Image Sensors

LUPA devices offer multiple megapixel resolution with frame rates up to 500 fps. These features, combined with a power consumption as low as 150 mW with absolutely no blooming or lag, create a perfect foundation for highly reliable, high sensitivity image sensors.

Features

- Frame rates up to 500 fps at several megapixel resolutions
- Unprecedented sensitivity
- Pipelined global shutter
- Low power dissipation
- High resolution
- No blooming or image lag
- Mono and color variants



LUPA 3000

Device	Resolution (MPix)	Pixel Count (H x V)	Pixel (μm)	Diagonal (mm)	Lens	CFA ¹	FPS Max	Evaluation Kit
LUPA 300	0.3	640 x 480	9.9	7.9	1/2"	C/M	250	✓
LUPA 1300-2	1.3	1280 x 1024	14	22.9	1"	C/M	500	✓
LUPA 3000	3	1696 x 1710	8	19.3	1"	C/M	485	✓

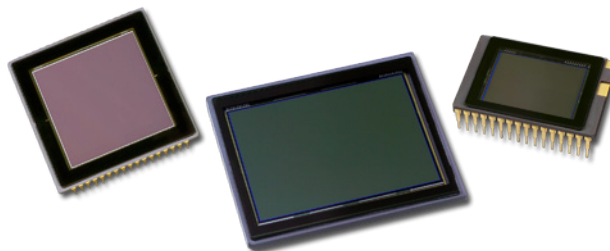
1. CFA Options – Bayer Color (C), Monochrome (M).

Full Frame CCD Image Sensors

From the intricacies of microscopy to the far reaches of astrophotography, Full Frame CCD image sensors deliver high performance results. With high quantum efficiency across the entire visible spectrum, these sensors are ideal for demanding imaging applications that require high sensitivity and high dynamic range, such as medical and dental X-ray.

Features

- High resolution
- Support for large sensor formats
- Simple, two-phase clocking
- Very low dark current for long exposures
- Vertical and horizontal binning



Full Frame CCD Image Sensors

Device	Resolution (MPix)	Pixel Count	Pixel (μm)	Diagonal (mm)	Lens	CFA ¹	FPS Max	Evaluation Kit
KAF-0261	VGA	512 x 512	20.0	14.5	1"	M	15.0	✓
KAF-0402	WVGA	768 x 512	9.0	8.3	1/2"	M	20.0	✓
KAF-1001	1.0	1024 x 1024	24.0	34.8	APS-H	M	3.0	✓
KAF-1603	1.6	1536 x 1024	9.0	16.6	1"	M	2.2	✓
KAF-3200	3.3	2184 x 1510	6.8	18.0	4/3"	M	2.5	✓
KAF-4320	4.3	2084 x 2084	24.0	70.7	645	M	2.0	✓
KAF-6303	6.3	3088 x 2056	9.0	33.4	APS-H	M	0.6	✓
KAF-8300	8.3	3326 x 2504	5.4	22.5	4/3"	M	2.9	✓
KAF-09001	9.1	3024 x 3024	12.0	51.3	645 1.3x	M	5.0	
KAF-09000	9.3	3056 x 3056	12.0	51.9	645 1.3x	M	0.4	
KAF-16200	16.2	4500 x 3600	6.0	34.6	APS-H	C/M	1.5	
KAF-16801	16.8	4096 x 4096	9.0	52.1	645 1.3x	M	0.4	✓
KAF-16803	16.8	4096 x 4096	9.0	52.1	645 1.3x	M	0.2	
KAF-40000	40.0	7304 x 5478	6.0	54.8	645 1.3x	C	1.3	
KAF-50100	50.1	8176 x 6132	6.0	61.3	645 1.1x	M	1.0	

1. CFA Options – Bayer Color (C), Monochrome (M).



Interline Transfer CCD Image Sensors

With an integrated electronic shutter, Interline Transfer CCD image sensors provide real time imaging in applications where a mechanical shutter or strobe illumination is either not required or desired. With progressive scan readouts, they are particularly well suited for microscopy, fluoroscopy, and other medical imaging applications that demand the highest imaging performance. Most 5.5 mm and 7.4 mm devices share common pin-out and electrical connections, allowing a single camera design to support a full family of products.

Features

- Progressive scan with electronic shutter and anti-blooming support
- High resolution
- High sensitivity
- Low image lag and smear



5.5 μ m Interline Transfer CCD Image Sensors

Device	Resolution (MPix)	Pixel Count	Pixel (μ m)	Diagonal (mm)	Lens	CFA ¹	FPS Max	Evaluation Kit
KAI-0330	VGA	648 x 484	9	7.3	1/2"	C/M	120	✓
KAI-0340	VGA	640 x 480	7.4	5.9	1/3"	C/M	210	✓
KAI-0373	WVGA	768 x 484	11.6 x 13.6	11.1	2/3"	M	30	
KAI-01150 ²	0.9	1280 x 720	5.5	8.1	1/2"	C/M/S	138	✓
KAI-1003	1	1024 x 1024	12.8	18.5	4/3"	M	30	✓
KAI-1010	1	1008 x 1018	9	12.9	1"	M	30	
KAI-1020	1	1000 x 1000	7.4	10.5	2/3"	C/M	50	✓
KAI-01050 ²	1	1024 x 1024	5.5	8	1/2"	C/M	120	✓
KAI-2020	1.9	1600 x 1200	7.4	14.8	1"	C/M	30	✓
KAI-02050 ²	1.9	1600 x 1200	5.5	11.1	2/3"	C/M	68	✓
KAI-02170 ²	2.1	1920 x 1080	7.4	16.3	1"	C/M/S	60	✓
KAI-02150 ²	2.1	1920 x 1080	5.5	12.1	2/3"	C/M/S	64	✓
KAI-04070 ²	4.2	2048 x 2048	7.4	21.4	4/3"	C/M/S	28	✓
KAI-04050 ²	4.1	2336 x 1752	5.5	16.1	1"	C/M/S	32	✓
KAI-08051 ²	8.1	3296 x 2472	5.5	22.7	4/3"	C/M/S	16	✓
KAI-08052 ²	8.1	3296 x 2472	5.5	22.7	4/3"	C/M/S	16	✓
KAI-08670	8.6	3600 x 2400	7.4	32.0	APS-H	C/M/S	12	✓
KAI-11002	10.7	4008 x 2672	9	43.4	35 mm	C/M	5	✓
KAI-16000	15.8	4872 x 3248	7.4	43.3	35 mm	C/M	3	
KAI-16050 ²	16	4896 x 3264	5.5	32.4	APS-H	C/M/S	8	✓
KAI-16070 ²	15.7	4864 x 3232	7.4	43.2	35 mm	C/M/S	8	✓
KAI-29050 ²	28.8	6576 x 4384	5.5	43.5	35 mm	C/M/S	4	✓
KAI-29052 ²	28.8	6576 x 4384	5.5	43.5	35 mm	C/M/S	4	✓
KAI-47051	46.8	8856 x 5280	5.5	56.7	645 1.1x	C/M/S	7	

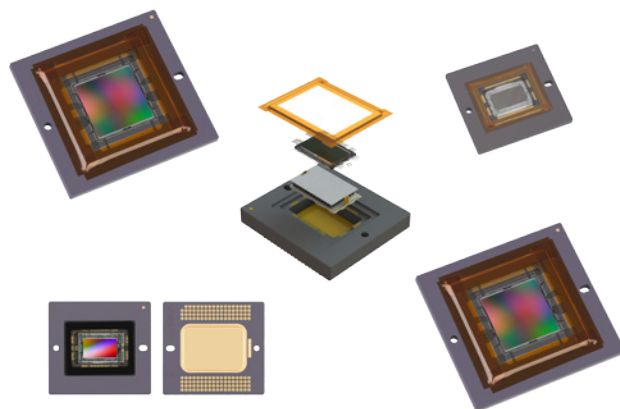
1. CFA Options - Bayer Color (C), Monochrome (M), and Sparse CFA (S). 2. Pin and Electrically Compatible.

Interline Transfer EMCCD Image Sensors

Combining the high sensitivity of an electron-multiplied output register with the pixel uniformity and resolution scalability available from Interline Transfer CCDs, KAE devices enable the capture of scenes with widely varying lighting conditions – from sunlight to starlight – in a single image and from a single camera. Multiple configurations are available in the family, including options for different resolutions and pixel sizes, light sensitivity, integrated cooling, and sealed or taped cover glass. This flexibility and performance make Interline Transfer EMCCD image sensors ideal for light starved medical imaging applications, such as fluorescence imaging (microscopy, angiography, and cardiology), ophthalmology, dermatology, and DNA sequencing.

Features

- Up to 92 dB dynamic range with sub-electron noise
- Intra-scene switchable gain
- Global shutter image capture
- Excellent image uniformity and MTF



Device	Resolution (MPix)	Pixel Count	Pixel (μm)	Diagonal (mm)	Lens	CFA	FPS Max	Evaluation Kit
KAE-02150	2.1	1920 x 1080	5.5	12.1	2/3"	C/M	30	✓
KAE-02152	2.1	1920 x 1080	5.5	12.1	2/3"	C/M	30	✓
KAE-04471	4.4	2096 x 2096	7.4	21.9	4/3"	C/M	15	✓
KAE-08151	8.2	2856 x 2856	5.5	22.2	4/3"	C/M	8	✓

Image Sensor Evaluation Support

ON Semiconductor provides supporting hardware and software to qualified engineering teams to accelerate product development. These kits contain everything necessary to build a working prototype with test functionality.



Ultra-Low-Power SRAM Memory

SRAM memory from ON Semiconductor consumes the least power consumption, and is specifically designed and qualified for implantable medical applications. In patients with pacemakers, these SRAMs remember the last day's ECG signals, which facilitates much more accurate clinical diagnoses when needed and provides the best possible patient outcomes.

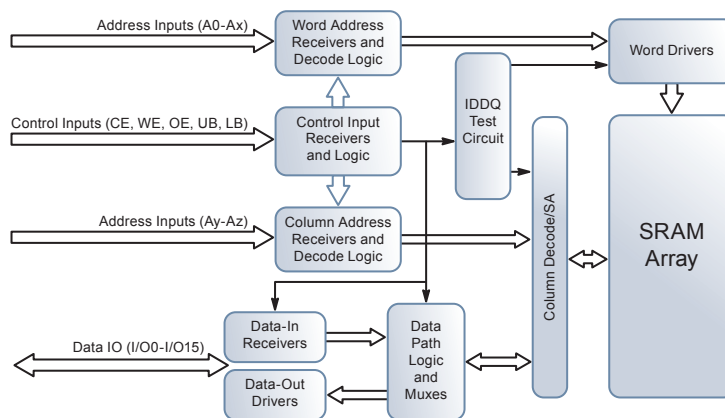
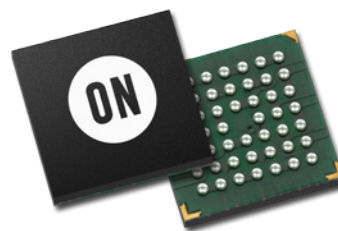
Parallel SRAM for Implantable Medical Devices

Features and Benefits

- Optimized for ultra-low-power operation
 - ♦ Low voltage operation down to 1 V
 - ♦ Typical leakage of ~100 nA for 8 Mb SRAM
- 1 Mb through 8 Mb densities
- Mature technology; in production for over 10 years
- Quality driven design and manufacturing
 - ♦ RIGID ID Traceability requirements are in place for all medical products
 - ♦ Design For Test/Quality (DFQ) incorporated into products
 - ♦ Soft Error protection expertise

Applications

- Pacemakers
- Implantable cardioverter defibrillators (ICDs)
- Neurostimulators



Typical Parallel Medical Memory Implementation

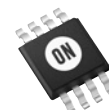
Serial SRAM for Medical Applications

Features and Benefits

- Easy-to-use 4-pin SPI interface
 - ♦ Programmable DUAL and QUAD I/O functionality
- High voltage operation
 - ♦ 5 V added capability (in addition to existing 1.8 V and 3 V power supplies)
- 20 MHz serial operation, fast write cycles (no wear-out)
- Ultra-low-power (1 μ A typical standby current)

Applications

- Patient monitors
- Pulse oximeters
- Electrocardiographs
- Cardiac monitoring devices
- Blood glucose meters



Low-Power Serial EEPROMs

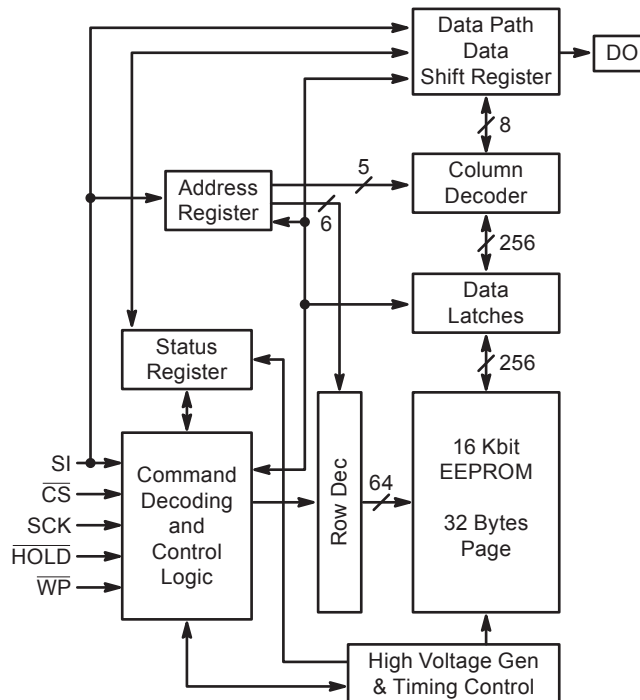
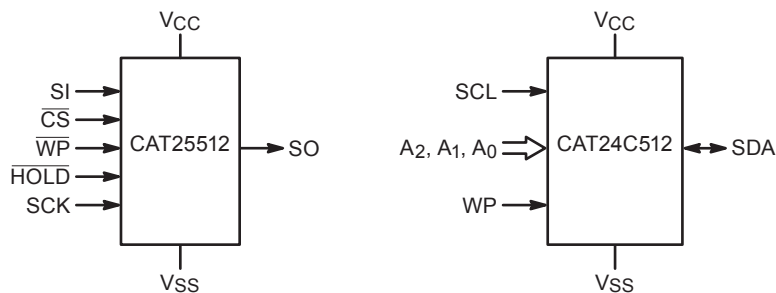
ON Semiconductor offers a range of low-power serial EEPROM products ideally suited for storing system configuration and user data in medical devices.

Features and Benefits

- Full range of densities from 1 kb to 2 Mb
- Flexible interface protocols including SPI and I2C
- Supply voltage range from 1.7 V to 5.5 V
- Optimized versions available for hearing aids where low absolute power consumption and low write current operation is essential
- Available in industry-standard and space-optimized packages (also available in die form)

Applications

- Hearing aids
- Blood glucose meters
- Patient monitors
- Test strips
- Medical patches

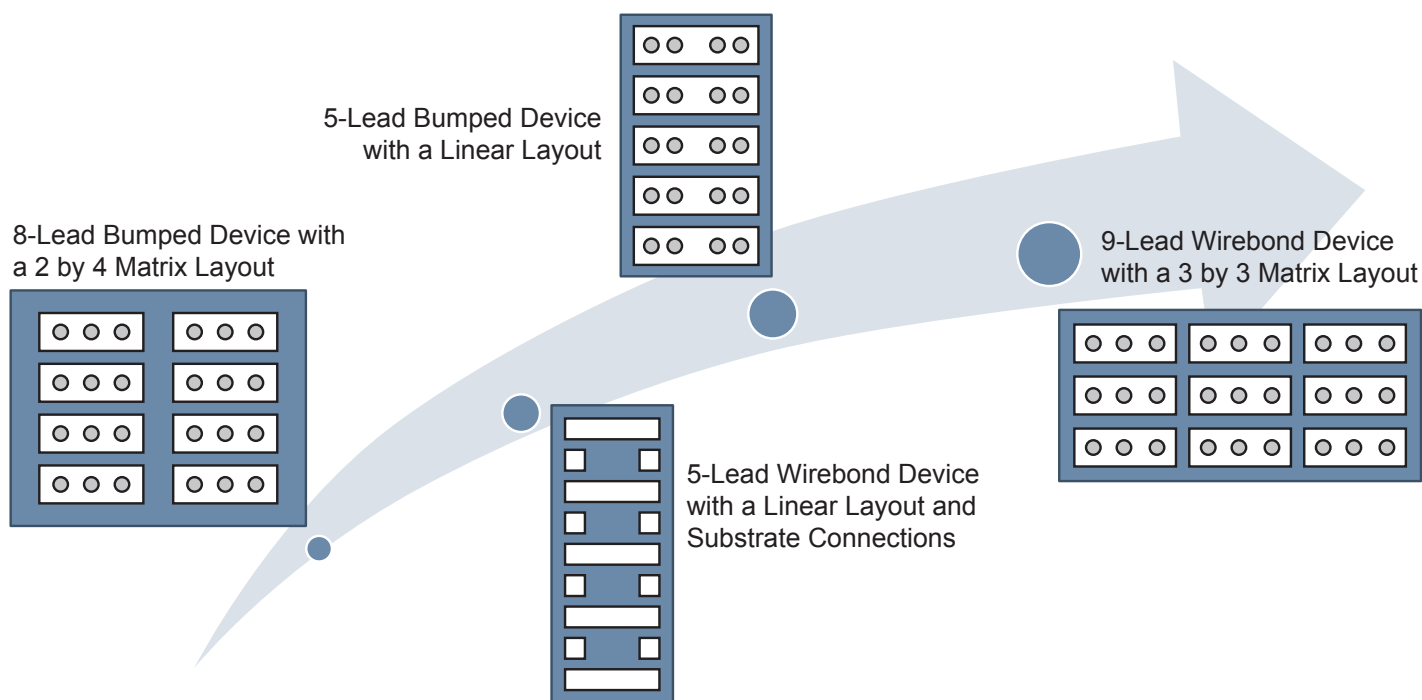
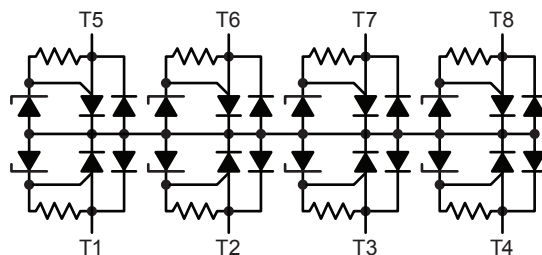


Transient Surge Suppressors

Multi-channel transient surge suppressors (TSS) from ON Semiconductor guard life-critical implantable devices against potentially devastating electrical fluxes resulting from defibrillation or other emergency treatment.

Offering reliable defense against electrical surge currents as high as 12 A, these devices protect the patient and prevent unnecessary repairs or replacement of equipment.

- Available as standard devices, or customized for unique electrical characteristics
- Extremely fast turn-on
- Maximum surge currents of greater than 12 A
- Forward breakdown voltage requirements can be tuned to application needs
- Off-state leakage currents of 100 nA
- Customizable physical footprint
- Specific to the number of terminals/leads needed
- Physical layout can be linear terminals or matrix terminals
- Device can be wire bonded or bumped for reflow
- Devices are tested, bumped (if needed) and shipped in wafer form
- Lot Acceptance Testing (LAT) performed on wafer lots



Examples of Customizable TSS Devices

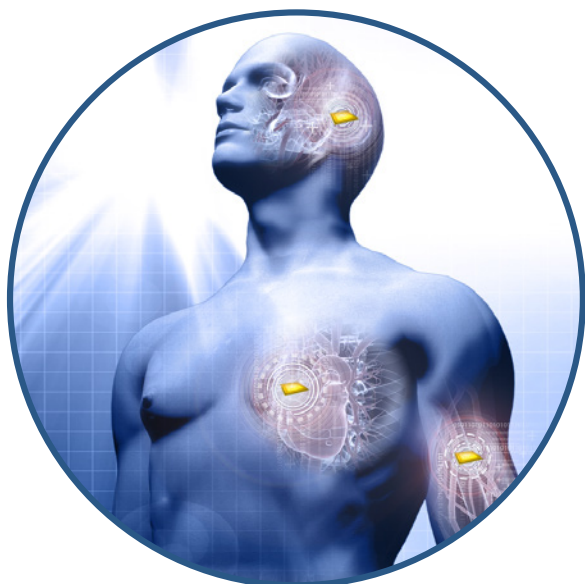
Medical Discretes

ON Semiconductor offers a broad catalogue of standard discrete components for use in medical applications, including diodes, MOSFETs, IGBTs, and power regulators. These devices are suitable for use in life critical medical applications, including FDA Class III and implanted, life-critical devices.

For medical applications, customized support for value-added services is available to address the specific needs of medical customers:

- Lot Acceptance Testing (LAT)
- Visual inspection
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Device	Description
MDNCV8170BMX180TCG	LDO Regulator
MDZ-TM3636	MOSFET, 1000 V
MD55GN01FA	RF NPN Wideband Transistor
MDSBAS40LT1G	Schottky Barrier Diode, 40 V, SOT-23
MDNSRM30CM3T5G	Schottky Barrier Diode, Dual, Common Cathode, 30 V
MDNSRM0230M2T5G	Schottky Diode, 30 V, 200 mA, SOD-723
MDNSR0230P2T5G	Schottky Diode, 30 V, 200 mA, SOD-923
MDBAT54HT1G	Schottky Diode, 30 V, SOD-323
MDBAT54XV2T1G	Schottky Diode, 30 V, SOD-523
MDSBAT54CWT1G	Schottky Diode, Dual, Common Cathode, 30 V, SOT-323
MDBAT54SWT1G	Schottky Diode, Dual, Series, 30 V, SOT-323
MDSBAS40-04LT1G	Schottky Barrier Diode, Dual, 40 V, SOT-23
MDNSD16F3T5G	Switching Diode, 75 V
MDBAV70DXV6T5G	Switching Diode, Dual, Common Cathode
MDMMQA24VT1G	TVS, 24 V, SC-74
MDSMMSZ4708FP	Zener Diode Voltage Regulator, 22 V
MDMM5Z16VMT1G	Zener Diode, 16 V
MDSZMM3Z6V8T1G	Zener Diode, 6.8 V, 200 mW, SOD-323
MDMM5Z6V8T1G	Zener Diode, 6.8 V, 200 mW, SOD-523
MDS1SMA5926BFP	Zener Voltage Regulator, 11 V, 1.5 W, SMA



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