INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact factor: 4.295
(Volume 5, Issue 2)
Available online at: www.ijariit.com

Some medical applications of semiconductor devices

Shiva Prasaath S. B.
shivabalamurugan@gmail.com
Vellore Institue of Technology, Vellore, Tamil Nadu

S. Usha Rani
usharanivarsha@gmail.com
Vellore Institue of Technology, Vellore, Tamil Nadu

ABSTRACT

This market categorically should be growing much faster than other commercial markets, but there are several factors that impact this segment which has curtailed investment by the service providers for new technology, including public policy and skyrocketing cost. The semiconductors mainly used in areas like "Use of semiconductors in heart surgeries, Implantable semiconductor devices and roles, Ultra low SRAM memory, Medical imaging areas, audiology focus areas, EMI filtering, and signal conditioning" and model types are briefly discussed.

Keywords—*Use of semiconductors in heart surgeries, Implantable semiconductor devices and roles, Ultra low SRAM memory, Medical imaging areas, Audiology focus areas, EMI filtering, Signal conditioning*

1. INTRODUCTION

The semiconductors applies in the medical industry continues to advance with more connectivity, smaller form factors, and higher performance. Nevertheless, the market is on track this year for growth as innovation and technology advancements help curb costs for consumers and healthcare providers alike.

The global estimate for all spending on healthcare is an enormous $6.5 trillion. Demand for services and products is advancing at a double-digit rate in underdeveloped regions and in the developed countries, additions to the insured base of consumers are climbing. Premiums are higher for the consumer due to mandated insurance coverage. Health care providers are saddled with higher costs as well.

For some time now, solutions to this issue have been proposed including consumer-sided intervention where consumers are made more aware of costs and therefore less likely to overuse services, which has been the case due to the low out of pocket expense in the past. However, since the majority of healthcare expenditure is for sicker patients, consumer demand-driven service costs have largely remained unchanged. Technology innovation is one of the ways costs can be curtailed.

The market for medical technology devices is expected to reach nearly $240 billion in 2016 and this market is growing at a compound annual growth rate of 11 per cent per year.

2. USE OF SEMICONDUCTORS DURING HEART SURGERIES

Semiconductors have the property of thermionic valves in amplifier circuits. Particularly in large installations, a drawback to the use of valves lies in the necessity to supply perhaps 2 watts of heating power per valve. There is also the need to extract this heat, which in the case of very compact or very large equipment may be troublesome. Valves are also prone to mechanical failure, particularly in situations where there is a significant amount of vibration present.

The hole exerts an attractive force on any electron liberated from a germanium atom by thermal energy, and which passes near to the hole. A new hole is now formed, and this can be filled by the capture of another free electron. The effective movement of holes throughout the germanium constitutes a flow of positive charge carriers. In this case, an impurity atom will gain an electron and is called an "acceptor". Germanium with this kind of added impurity is called p-type germanium.

As a result, a "potential barrier" builds up to prevent any further flow of charge carriers across the junction. The barrier produces the same result as a battery connected. A real battery connected in this way acts to increase the barrier and the so-called "reverse" current which can flow across the junction is small, of the order of a few micro-amperes. When its polarity is reversed, the battery can now act to reduce the barrier, and a comparatively large current can flow across the junction. The application of a "forward" voltage of 0.2 volts, may produce a current of some 5 milliamps. If an alternating voltage of about 1 volt is applied to a p-n junction, alternate half-cycles will strengthen and weaken the barrier.

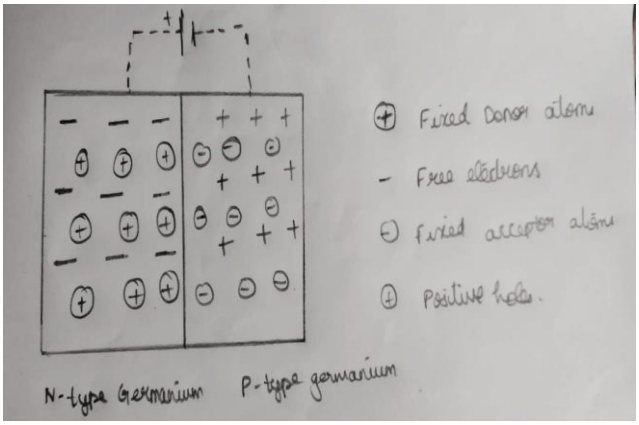

Fig. 1: Type of germanium

As a result, the junction diode acts as a rectifier, passing considerably more current in the forward than in the reverse direction. Junction diodes are widely used as rectifiers, and in spite of their small size, can rectify surprisingly large currents. Where the rectifier dissipates a considerable amount of heat, a silicon diode is used rather than a germanium one.

2.1 Health care applications (block diagram)

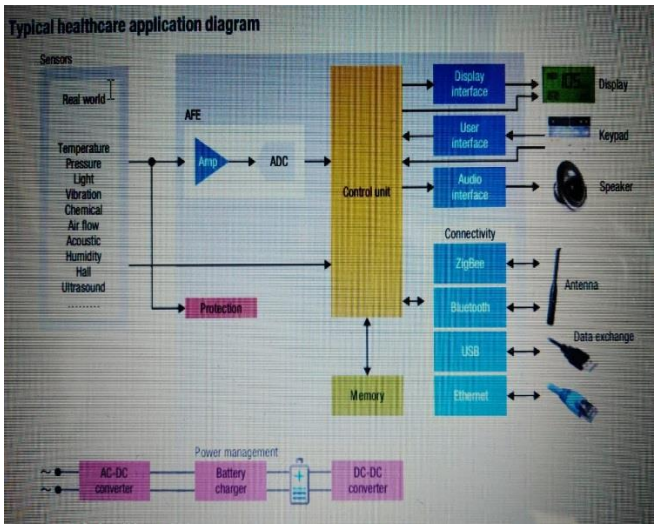

Fig. 2: Block diagram

3. IMPLANTABLE MEDICAL DEVICES

In addition to ASIC design and foundry services, we offer a variety of qualified components, including:

- Ultra-Low-Power SRAM Memory
- Multi-Channel Transient Surge Suppressors
- Medical-Grade Discrete

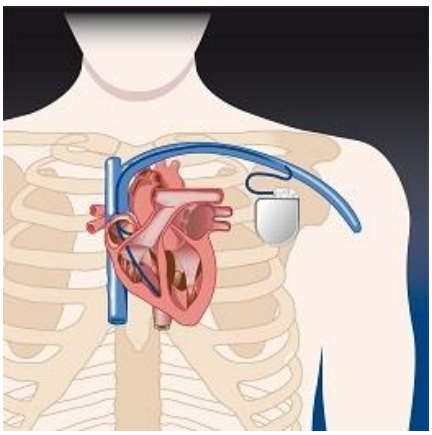

Fig. 3: Implantable medical devices

3.1 Ultra-Low-Power SRAM Memory

SRAM memory Semiconductor consumes the least power 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. The processing speed of the tracking device can be improved by well-structured algorithm. However, to control the standby power and overall system power, a

subthreshold metal oxide semiconductor (MOS) architecture/hardware is required. Considering the fact that the tracking system requires a large amount of memory to store information, a high capacity static random access memory (SRAM) cell-based cache memory is essential. However, the SRAM is known as a power-hungry device due to its high bit-line capacitances. In addition, the SRAM has a tendency to fail at subthreshold voltages and shows vulnerability at various process voltage temperature (PVT) conditions.

Thus, various subthreshold SRAM cells have been proposed in the literature to achieve less standby power with high stability

- Up to 8 Mb densities
- Optimized for ultra-low-power operation
  - Low voltage operation down to 1 V
  - Typical leakage of ~100 nA for 8 Mb SRAM
- Mature, reliable technology
  - In production for 10+ years
  - Quality-driven design and manufacturing

3.2 Multi-channel Transient Surge Suppressors (TSS)

From ON Semiconductor guard life-critical implantable devices against potentially devastating electrical fluxes resulting from external defibrillation or other emergency treatment. Offering reliable defence against electrical surge currents as high as 12 these devices protect the patient and prevent unnecessary replacement of implanted devices.

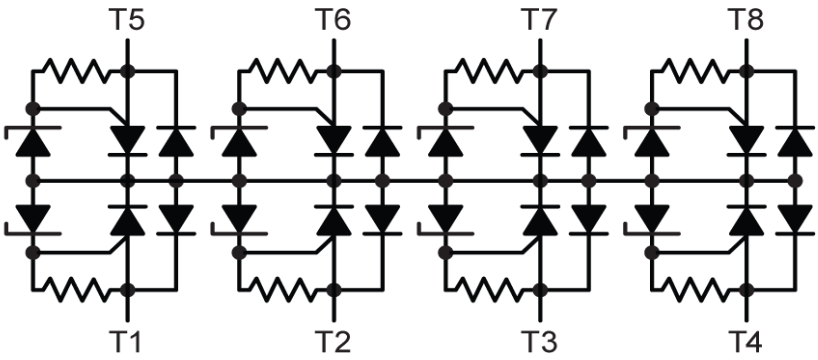

Fig. 4: Transient Surge Suppressors (TSS)

3.3 Medical Imaging Devices

Semiconductors advanced capabilities for the latest high-resolution medical imaging devices.

- I3T process with 0.35 µm CMOS digital packing density and analog speed, integrated together with drivers that can handle up to 80 V.
- I2T process with 0.7 µm CMOS digital packing density and up to 100 V output capability.
- C5 0.5 µm process provides high analog precision capability with 3.3-40 V capabilities.
- All these processes offer integration of transducer drivers, together with a sensor interface.

4. AUDIOLOGY FOCUS AREA

Hearing loss is a silent problem that often goes untreated for years. Recent studies have shown that adults with untreated hearing loss have significantly higher rates for psychosocial disorders such as depression and anxiety, are at higher risk of developing dementia, and incur higher medical bills compared to those without hearing loss.

Today's hearing solutions include removable and implantable hearing aids such as advanced digital hearing aids and cochlear implants for those with severe hearing loss, respectively. A wide range of assistive listening devices (ALDs) is also available for a variety of situations and listening environments.

Patient expectations of hearing solutions vary depending on age, hearing loss magnitude and first-time use, and hearing aid manufacturers are responding to patient demands and competitive pressures with ever-improving designs. However, challenges remain, especially in striking a balance between increased functionality and long battery life.

Semiconductors have been the leader in ultra-low power consumption solutions for hearing aid manufacturers for decades. Our ongoing R&D efforts align with your design challenges to deliver the widest selection of products in the industry from preconfigured to fully-customized solutions. You can now design hearing aids with the best performance, functionality, and secure wireless connections combined with the lowest power consumption in the industry and ultra-miniature size.

Learn more about our Ezairo products that are used by top hearing aid manufacturers around the world.

- Ezairo 5900 (dual core)
- Ezairo 7100 (quad core)
- Ezairo 7150 SL (quad core with wireless connectivity)
- Ezairo 7111
- Development Tools
  - Open-Programmable
  - Ezairo Preconfigured Suite

5. EMI FILTERING AND SIGNAL CONDITIONING

5.1 Integrated EMI filtering and ESD protection

STMicroelectronics' advanced semiconductor technology reduces the space required on PCBs. By integrating into a single package the matching filtering and protection functions usually implemented with discrete components, ST provides the flexibility to expand the number of functionalities of the end product or to create a smaller device. ST's integrated passive devices (IPDs) for RF applications, ECMF™ series for high-speed lines, and ESD suppressors housed in micro-packages provide the highest level of integration. One of the latest advanced devices joining ST's micro-package families is the world's smallest, single-line TVS, the ESDAVLC6-1BV2, in a 01005 surface-mount package to protect sensitive circuitry against voltage surges.

Q EMIF1: Strong attenuation of 900 MHz and higher frequencies for different sockets including keypads and touch pads, memory cards, audio lines
Q ECMF1: High-performance common-mode noise filtering with integrated ESD protection for high-speed serial interfaces for display and camera/imaging systems with serial interfaces, High Speed USB 2.0

IPD for RF front-end: integrated passive device (IPD) solutions based on glass substrate can offer a low parasitic and high-Q solution suitable for RF applications including:

- Q Matched balun for 2.4 GHz applications such as Bluetooth or WLAN (using 50/50, 50/100 or custom matching)
- Q Diplexers for applications sharing the same antenna for 2.4 and 5 GHz WLAN Q
- Band-pass filter for 5 GHz WLAN

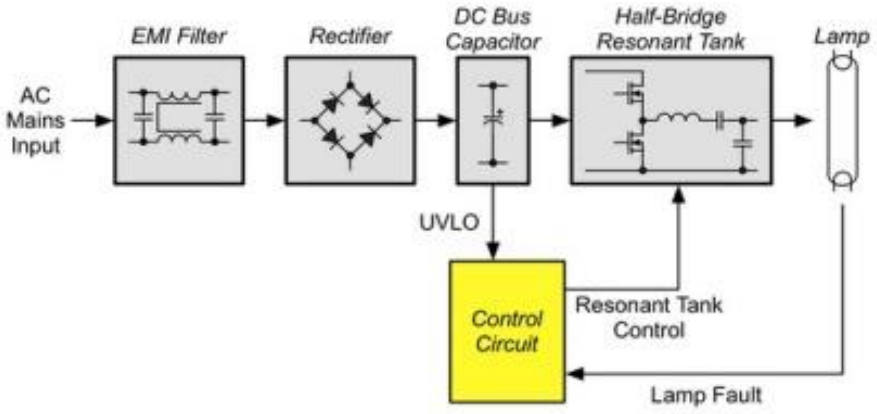

Fig. 5: EMI filtering and signal conditioning

6. CLINICAL/POINT-OF-CARE APPLICATIONS

The rise of point-of-care technologies and devices has allowed for more testing and diagnosis close to the patient, resulting in increased effectiveness and success rates. Advancements in medical testing technologies (blood glucose, oxygen saturation, rapid strep, etc.), and minimally to non-invasive genomic diagnoses such as liquid biopsies, have presented patients with improved point-of-care diagnostics and faster access to treatment options.

Over the last several decades, Semiconductors developed an extensive portfolio of intellectual property in medical applications both internally and through our partnerships with healthcare, imaging, and medical device manufacturers.

Our customers rely on our product longevity that supports their long product development and regulatory approval cycles as well as the entire product lifecycle that can span decades. We also meet the most stringent quality requirements through our world-class manufacturing facilities which offer ISO 13485 certification and FDA compliance.

Examples of relevant Semiconductor technology in PoC applications
Medical Diagnostics:

- High resolution, small pixel, monochrome image sensors for lens-less microscopy
- Rolling and global shutter image sensors for IVD/POCT readers
- Image sensors and image signal processors (ISP) for telemedicine devices
- High-resolution high-performance image sensors for applications such as ophthalmology, skin care, dental scanning, and many others
- Both CMOS and CCD solutions
- Low-Cost DNA Sequencing:
- High resolution, small pixel image sensors for maximum density
- State-of-the-art pixel to pixel isolation for excellent crosstalk performance
- Speciality packaging technologies

7. REVOLUTIONIZING THE MEDICAL INDUSTRY

With new equipment models and advances in healthcare services, semiconductor tech is helping take the medical industry to a whole new level. For example, some surgical procedures are being revolutionized through the use of robotic surgical systems. One such system allows the surgeon to sit in a “cockpit” with a 3D view of the operating field and precisely manoeuvre surgical

instruments attached to robotic arms. This procedure enables minimally invasive surgery, which means faster recovery time for patients, while the system's enhanced visualization also means less eye strain for the surgeon. Neuromorphic chip technology, which can mimic the human brain, can be used in applications such as retinal implants, helping people who have lost their sight to regain partial vision.

8. REFERENCES

[1] Calculator for the intrinsic carrier concentration in the silicon
[2] Semiconductor OneSource Hall of Fame, Glossary
[3] Principles of Semiconductor Devices by Bart Van Zeghbroeck, University of Colorado. An online textbook]
[4] US Navy Electrical Engineering Training Series
[5] NSM-Archive Physical Properties of Semiconductors]

