EMBEDDED MEDICAL DEVICE

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DEFINITION OF A MEDICAL DEVICE

- It is a product used for medical purposes in patients in diagnosis, therapy or surgery.
- Different from Pharmaceutical Drug.
- Examples of Medical Devices
  - Medical Thermometer
  - Blood Sugar meter
  - X Ray Machine
  - Tongue Depressors

ROLE OF EMBEDDED TECHNOLOGY

- Operational requirements can be achieved easily.
- Increase compactness.
- Enable patients to respond well to treatments
- Remote Monitoring possible .
- Diagnosis of a Patient by Doctor.

WE WILL SEE

1) CRT-D Device technology
2) Digital flow sensors
3) Wireless Technology in Medical Devices
4) Graphical User Interface(GUI) Integration into
   Medical Devices

CRT-D DEVICE TECHNOLOGY

- This device is designed for patients suffering from heart failure.
- Measures the Variability.
- Two primary functions:
  - ❖ To Stimulate the Heart in coordinated fashion.
  - ❖ To Shock the Heart back into normal rhythm using the defibrillator whenever heart beat becomes irregular.

ICD(IMPLANTABLE CARDIOVERTER DEFIBRILLATORS)

- Defibrillation
- A pace maker
- Implantation of ICD and electrical leads.
- External programmer performs Diagnostics.
- Magnetic Switch.
- ICD communication with programmer at 175kHz and in 402- 405 MHz Medical Implant Communications(MICS).

X-RAY IMAGE OF ICD

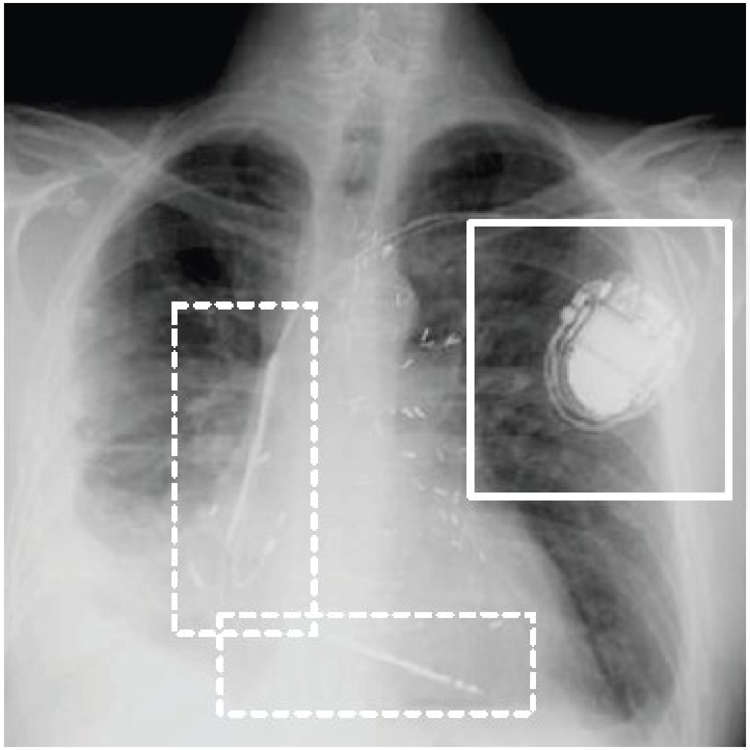
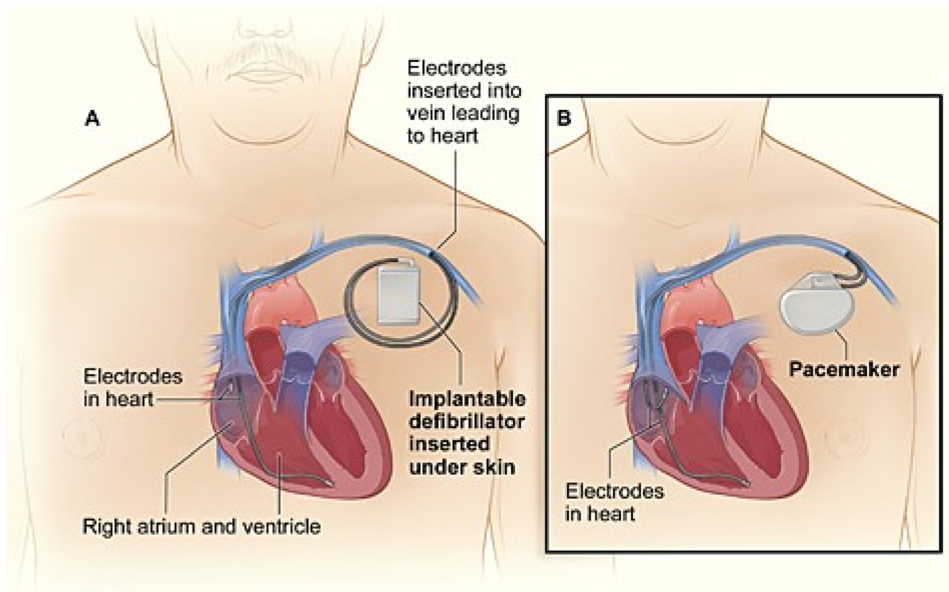


Fig. 1. Chest xray image of an implanted ICD (top right, near shoulder, solid outline) and electrical leads connected to heart chambers (center of rib cage, dotted outline).

ICD AND PACEMAKER



PACEMAKER

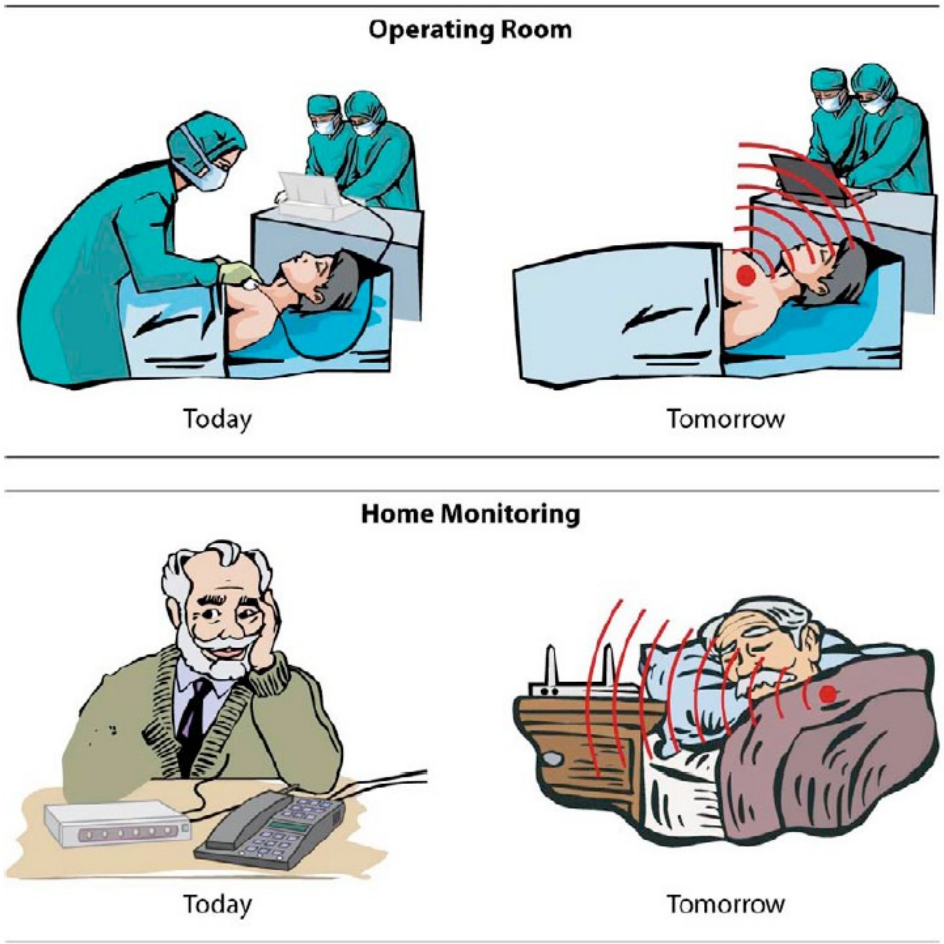
- Pacemaker must not be confused with ICD.
- They are different in terms of some functionalities.
- Pacemakers cannot be used incase of sudden cardiac arrests since they will be giving small amount of electrical impulses which are used to restore the Hearts rhythm

  during small irregularities.

RF TRANCEIVER CHIP **ZL 70101**

- Now that we have implanted ICD how would communication process goes on.
- The communication process must have two criteria:
  - It should have low power ultra technology.
  - High performance transceiver chip .
- Ultra low power sniffing Technology not met by Zigbee, Bluetooth and 802.11.

FUTURE TREATMENT TO PATIENTS



RECEIVER AND BASE STATION

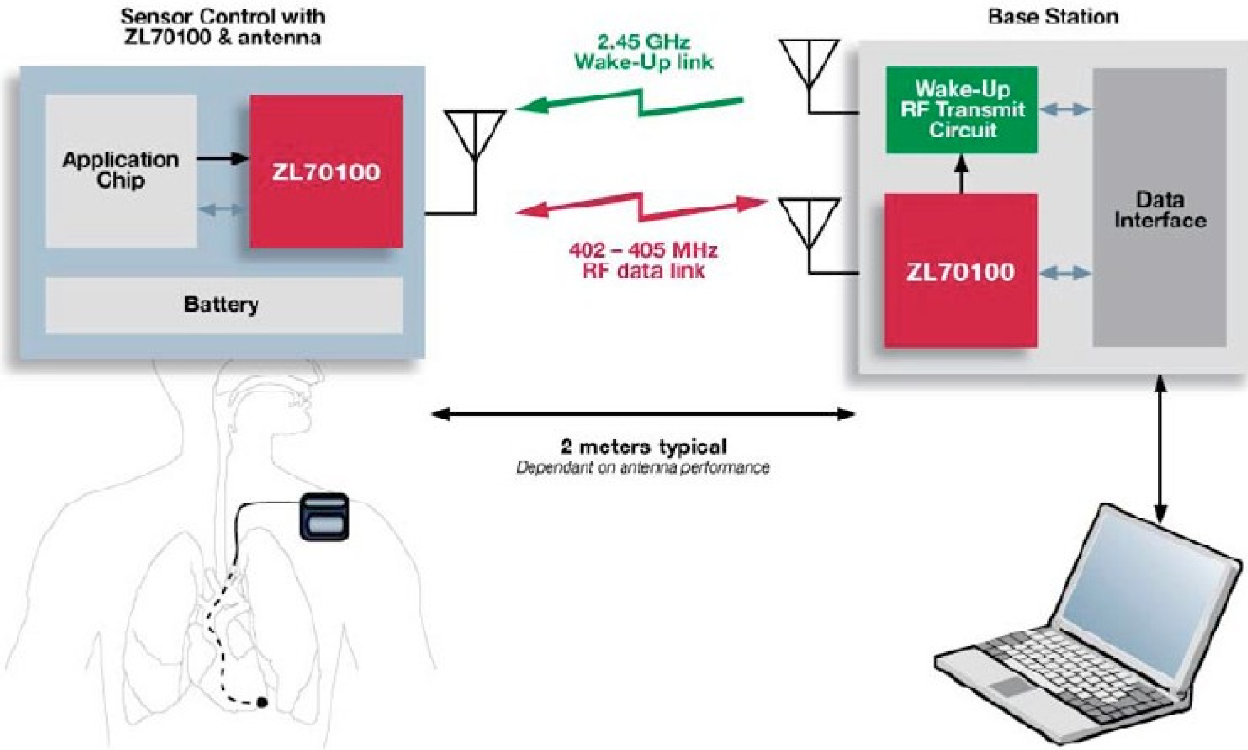
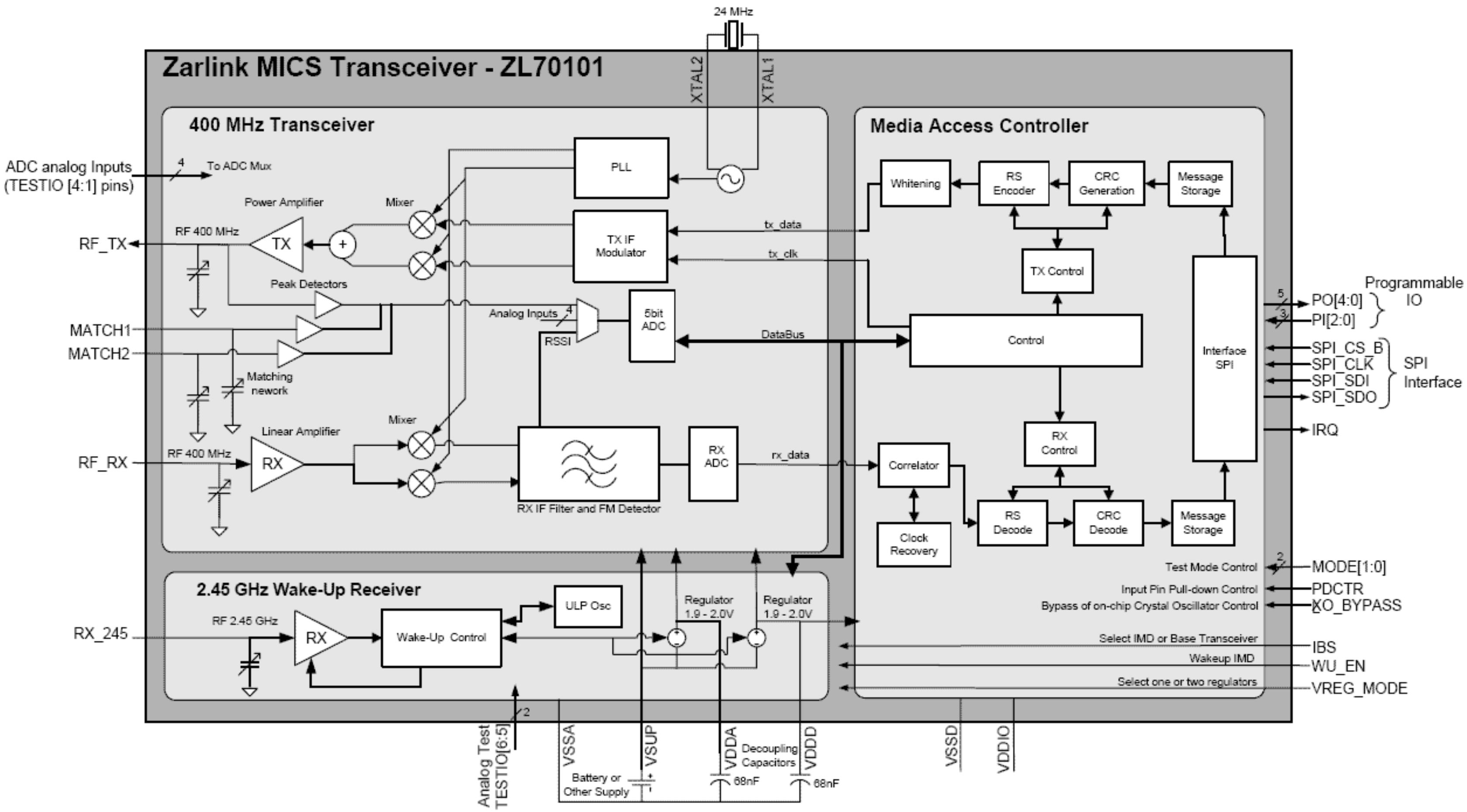


Figure 2. Overall system architecture, with the ZL70100 MICS transceiver operating in both the implanted medical device and base station.

ZARLINK MICS TRANCEIVER



ZARLINK CHIP

- Zarlink MICS technology .
- The system is very flexible and provides low power wake up options achieved at 2.45Ghz ISM band using wakeup receiver option.
- Media access Controller.
- Standard SPI interface can be used for easy access by application.

KEY FEATURES Of ZARLINK CHIP

- 402-405 MHz (10 MICS channels) and 433-434 MHz (2 ISM channels)
- MAC with error handling and flow control, typically < $1.5x10^{-10}$BER.
- High data rate (800/400/200 kbps raw data rate)
- Extremely low power consumption (5 mA, continuous TX / RX, 1 mA low power mode) Ultra low power wakeup circuit (250 nA) Standards compatible (MICS, FCC, IEC).

The ZL70101 RF transceiver has defined two fundamental startup modes of operation:

- IMD Mode (IMD=Implantable Medical Device)
- Base Mode

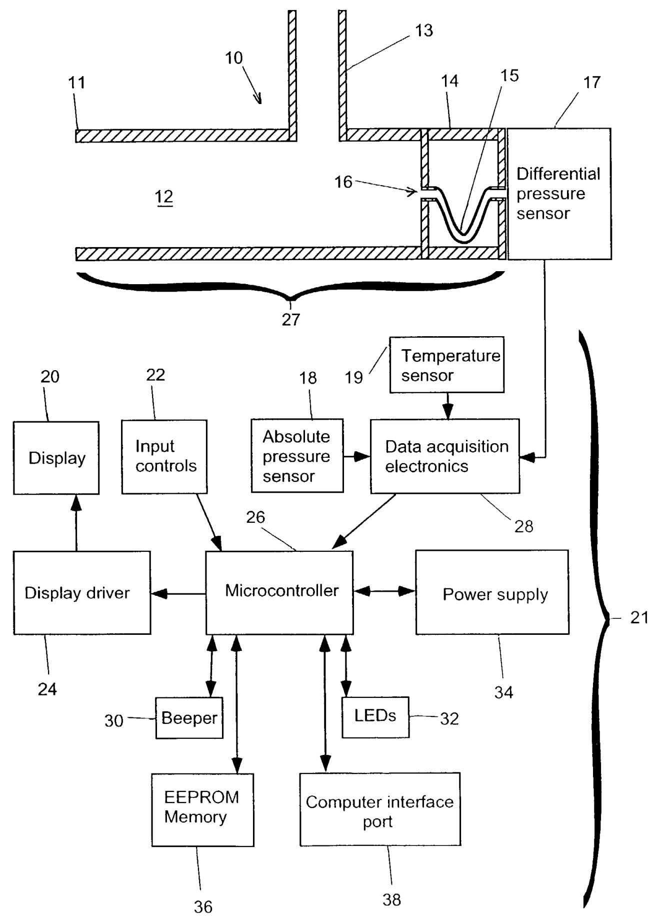
KEY FEATURES OF TRANSCEIVER

- When configured as an IMD, the transceiver is usually asleep and in a very low current state. The IMD may be woken up to initiate communications by using a 2.45 GHz link or directly by the IMD processor via the WU_EN pin. This flexibility leads to the following options for waking up an IMD transceiver for communication.
- IMD transceiver woken up by specially coded 2.45 GHz wakeup message using an ultra low power sniffing method
- IMD transceiver woken up to sniff 400 MHz link. The ZL70101 supports such a mode of operation although the 2.45 GHz wakeup system has lower power consumption
- IMD transceiver woken to send an emergency message in which case no clear channel assessment by the Base station is required
- IMD transceiver woken up by a low frequency inductive link (as typically used in pacemakers/ICDs) or some alternative mechanism

KEY FEATURES OF TRANCEIVER

- Incorporates a unique wakeup receiver
- Operation at 250 nA sleep mode
- Wakeup Signal.
- In Full operation consumes 5mA current.
- MAC implements high reliability communication.

SPIRO METER



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Differential pressure sensor
27
Temperature sensor
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18
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22
Display
Input controls
Absolute pressure sensor
Data acquisition electronics
26
28
Display driver
Microcontroller
Power supply
21
24
34
30
Beeper
LEDs
32
EEPROM Memory
Computer interface port
36
38

SPIRO METER(CONTINUED)

- Diagnosis and monitoring of pulmonary diseases(asthma ,smokers cough)
- Diagnostic Spiro meter
- Monitoring Spiro meter(portable, inexpensive, easy to carry)

MONITORING SPIROMETER

- Measures " peak expiratory flow" during forced expiration
- Mechanical - Inexpensive, less accuracy
- Electronic – Uses differential pressure sensor
- Needs sterilization (else effects flow rate, gets contaminated)
- Pressure transducer is costly

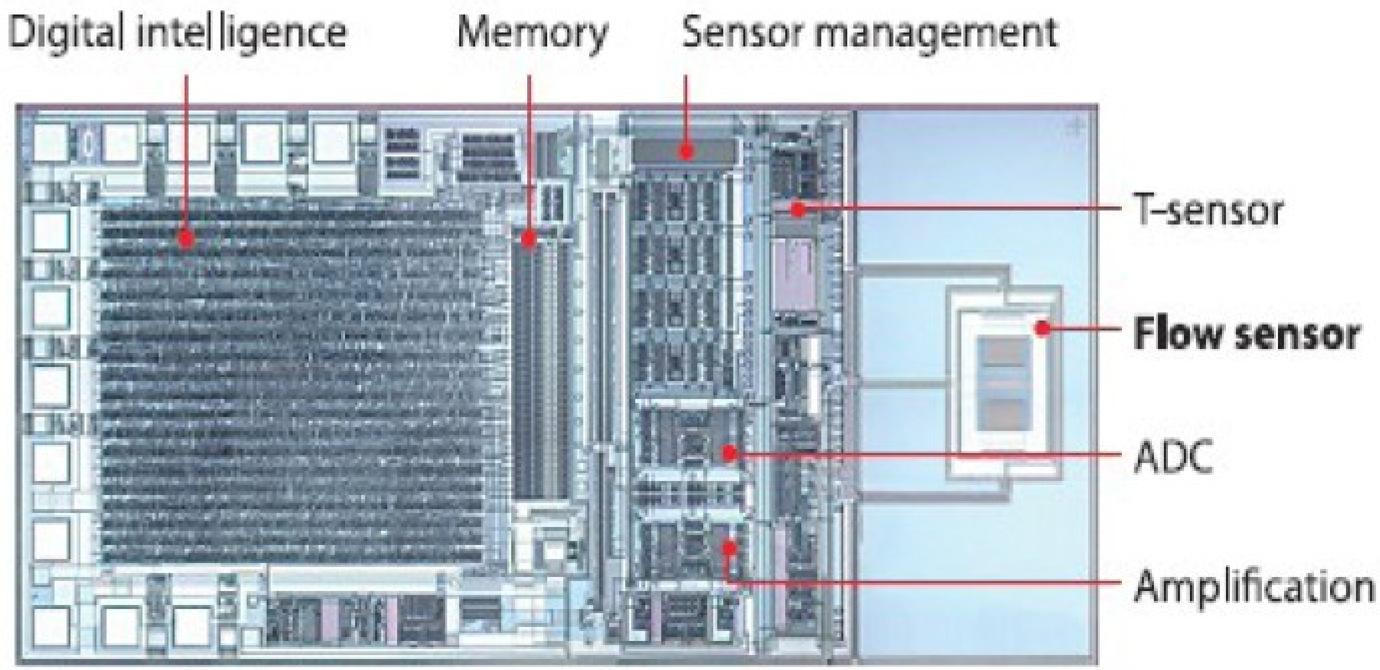
MONITORING SPIROMETER

- Processor and memory used are less speed and small
- Advanced Spiro meter provides different flow rate conditions suited for user conditions.
- Computer attachable accurate calculation of rate v/s time graph.

DIGITAL FLOW SENSORS

- Are currently used to measure respiratory flow in patients.
- CMOS Sensor Technology
- Digital CMOS sensor chip in flow rate measurement
- Processing of signals by on-chip sensors is vital if they are to be integrated into user applications. The primary functions of these sensors in order to perform at the highest level are compensation of temperature, amplification, digitization, and linearization. A calibration process is responsible for generating sensor data for linearization and temperature compensation.
- MEMS chip.
- The future of digital flow sensor technology is to constantly increase safety and accuracy while also
- expanding the capabilities of the sensors including electronic monitoring and wireless communication.

DIGITAL FLOW SENSOR CHIP (FOURTH GENERATION)



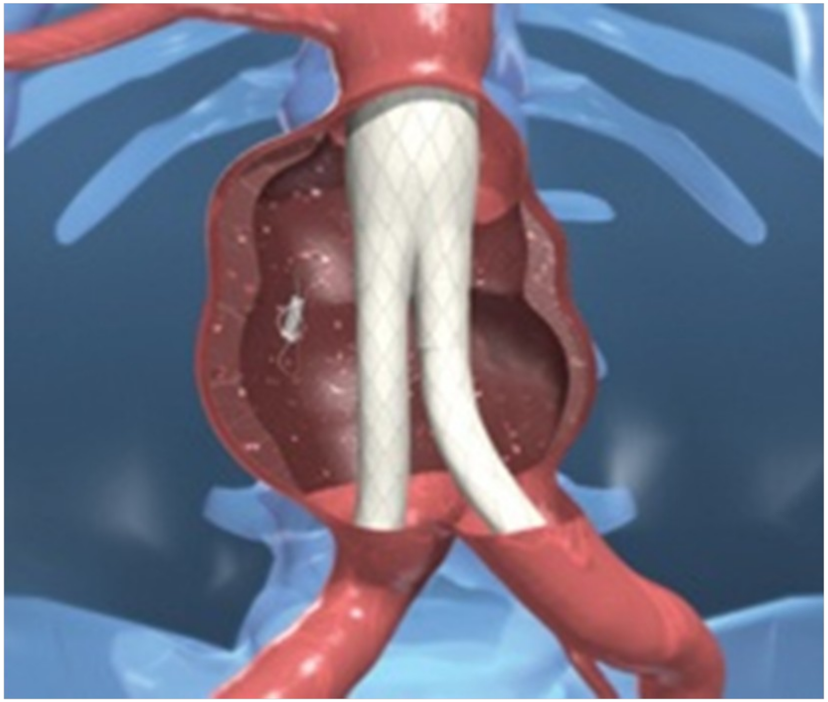
WIRELESS TECHNOLOGY IN MEDICAL DEVICES

- The link between cell phones and health monitoring is an important step in the integration of wireless technology in the medical industry, and this technology is growing rapidly. Today, patients can monitor their glucose levels and heart rhythm using a cell phone.
- integrated a monitor for blood glucose levels into a cell phone so that patients can monitor their levels, record them, and then submit them to the physician simply using their cell phone.
- Health monitoring is definitely a crucial aspect of overall health care, but there are other benefits too:
- • It gives physicians immediate access to important information in real-time
- • It can lead to lower costs of healthcare
- • It simplifies the usage of medical devices by reducing the number of wires a patient has to deal with when using the device at home

ENDOSURE WIRELESS PRESSURE MANAGEMENT SYSTEM

- Abdominal aortic aneurysm.
- Weakening of artery wall.
- Consequences.
- Miniaturized wireless implantable sensor.
- External electronic module.
- Powered by RF energy.
- MEMS technology.

ENDOVASCULAR REPAIR



GRAPHICAL USER INTEGRATION

The integrated GUI has its own embedded operating system containing HTML which is built into the hardware of the device. The embedded micro-HTML inside the integrated GUI is the key component. So, basically, “in the box” the customer receives the embedded micro-HTML, application-specific controller chip, and an LCD controller. There is no need for third-party compilers or operating systems to be tested. So, now, the more important task can be focused on, which is to enhance the application in a particular medical device. This concept seems appropriate for any GUI that can be used in an embedded system

GRAPHICAL USER INTERFACES