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An Efficient Remote Healthcare Embedded Electronics using Medical Implantable Communication System (MICS) and Wireless Medical Telemetry System (WMTS)

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Abstract: *The added value in this work is the integration of MICS with its local and small range (2m) and high efficiency with proposed WBAN network thus achieving the highest resolution benefit from both technologies for a realizable WBAN system of low power usage & high bit rate & low range , and wide coverage. Building embedded system that provides compact, secure, low-power, wireless, plug-and-play sensor networks that ensure safety for user by considering the standard international safety guidelines. The wireless sensor networks will collect patient information remotely that leads our research into: 1-Integrating real-time patient data into patient records, 2-High assurance software to collect valid sensors measurement and interconnect sensors information network to patient records, 3- Communication between the sensors and the Central Control Unit, CCU. The outcome is an embedded system of Telemedicine which sends vital signs (as temperature, blood pressure and heart beats) of human body sensors and processing then sending via internet to professional Physician for diagnoses. The Proposed System Architecture: using wireless sensor network technology mixed with the Telemedicine service applications to provide fast response, direct patient follow up and high probability of rescue from severe symptoms of some deceases. The system is allowing doctors to give special treatment for huge network of patients in different places simply from their houses, hospitals or clinic. CMOS Cascode amplifier with gate inductive gain peaking technique is chosen to obtain ultra wide bandwidth amplifier.The simulated RF performances results of the WB Amplifier were summarized as the input return loss (S11) was revealed a minimum value of –18 dB , and the simulated result of small signal gain-peaking of (S21) is 18.6 dB within the bandwidth of (401-405) MHz. The circuits simulations were done using CADENCE Design Tools to optimize the design and get the required specifications for the proposed cascode amplifier. Also Simulation results of the proposed Bit frame format are obtained from the Proteus program.*

Index: *Telemedicine, Low-Power, Embedded system design, Embedded web connection, Embedded sensors network, WBSN, Internet of Things (IoT), RF Transceiver, Bit Frame generation, Medical Implantable Communication System (MICS), Wireless Medical Telemetry System (WMTS), inductive gain peaking technique.*

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I. Introduction

Wireless body-area network (WBAN) is a special purpose wireless-sensor network that incorporates different networks and wireless devices to enable remote monitoring for various environments. The main purpose of this technology is to reduce the load at hospitals and provide an efficient remote healthcare facility using medical implant communication system (MICS) and Wireless medical telemetry system (WMTS). One of the targeted applications of WBAN is in medical environments where conditions of a large number of patients are continuously being monitored in real-time. Wireless monitoring of physiological signals of a large number of patients is one of the current needs in order to deploy a complete wireless sensor network in healthcare system[1]. Various wireless technologies, like simple RF, Bluetooth, UWB or infrared might be used for communication between sensors. In this project, we will introduce the telemedicine-applications and issues of Bluetooth based wireless sensor networks to collect real vital signs from human body then processing and sending them by web/mobile-application to doctors and hospitals. Such an application presents some challenges in both software and hardware designs. Some of them are: reliable communication by eliminating collisions of two sensor signals and interference from other external wireless devices, low-cost, low power consumption, and providing flexibility to diagnose the patients. The main problems experienced during the implementation and applied solutions are presented. The common problem faced during the development of telemedicine system is how to integrate the existing techniques to meet requirements for telemedicine applications[2]. In addition a WBAN system has the potential to reduce the healthcare cost as well as the workload of medical professions, resulting in higher efficiency. 'Wearable' devices are miniature electronic devices worn on the body, often integrated with or designed to replace existing accessories such as a watch. This market segment is booming, enabled by Internet of Things technology. Thus the need for smaller, more intuitive devices is rapidly increasing. Some of the current trends are smart watches, smart glasses, and sports and fitness activity trackers. In addition to the consumer market, the medical industry is creating a demand for devices that monitor physical conditions and functions. The idea is not only to measure a physical quantity, but also to process this real world data locally and to send gathered information to interested entities. All of these functions are in single device called Sensor node. The main components of sensor node are microcontroller, memory, sensors, actuators, power supply, and transceiver.

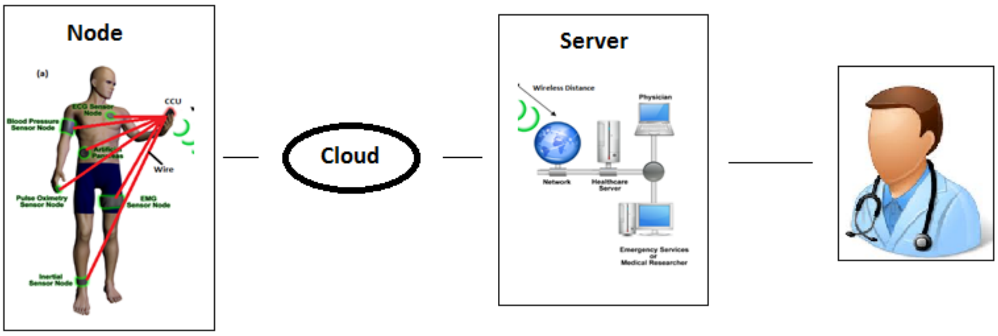

Fig.1.(a) Node to Server scenario

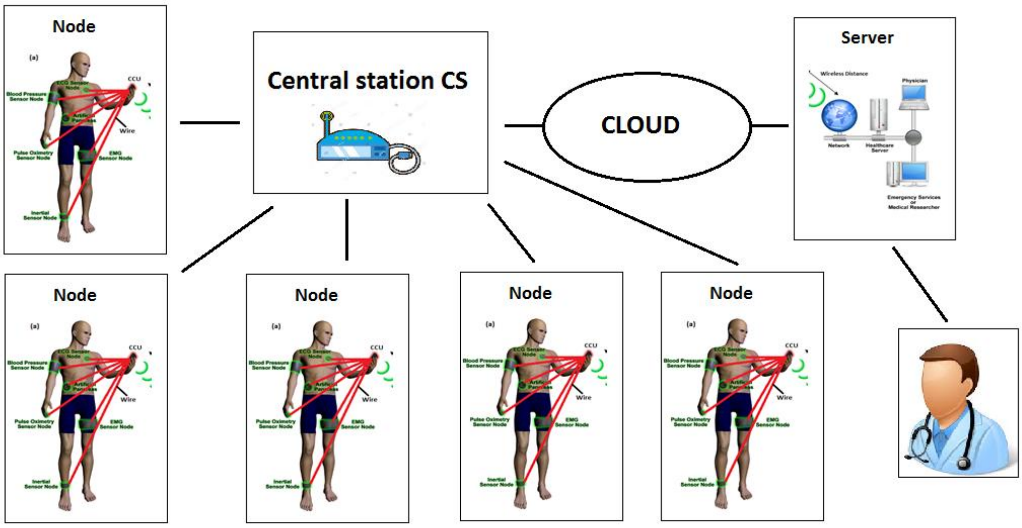

Fig.1.(b) Node to central station and central station to server scenario

In Fig.1(a) shows the current application of sensors network used in some modern medical centers. A Node collecting information from sensors through wires and transmits to the server through cloud for monitoring , this topology is used for individual patients that aren't located in the same physical location, where the node sends data directly to the server using GPRS modem. Fig.1(b) the nodes each representing a patient , sends all its data to a central station, the central station then sends all the data from all the nodes into its zone to the server through the cloud using either GPRS mode, Ethernet, WIFI , WIMAX or satellite link in case of rural areas.

II. State-of-the-Art

Telemedicine started when National American Space Agency (NASA) began to study the physiological changes of the astronauts during their space journeys. The scientists proved the possibility of monitoring the physiological functions such as blood pressure, heart beats and body temperature by doctors on the earth. The other early experiments revealed that tele-diagnose and transmitting medical data can be done[3]. The monitoring devices currently used in medical centers are not completely wearable because their electronics are bulky and wires used for connections to multiple sensors. Fig.1(a) shows the current application of sensors network used in some modern medical centers. A wireless control unit (i.e. CCU) is collecting information from sensors through wires and transmits to a remote station for monitoring. In this implementation, the control unit is cumbersome and using wires is not advised for the comfort of patients. As shown in Fig.1(b) the medical sensor network requires miniaturized and wearable sensor nodes that can communicate with the receiving device wirelessly. The system will consist of individual wireless sensor nodes that can transfer a person's physiological data via wireless link, without need of any wired connection[4].

III. System structure and outlines :

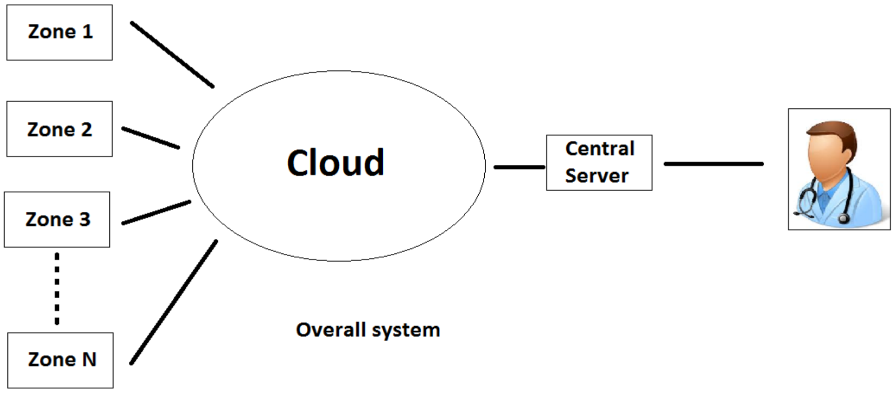

Fig.2 Overall system overview

A. Overall system overview:

A.1 WBAN zones :

Consists of a number of nodes located into one physical geographical location, all the nodes send its data to a central station (central node) this central station sends all the data of the zone to the server through the cloud using any of GPRS modem, Ethernet, WIFI, WIMAX, satellite link according to the network available in the location

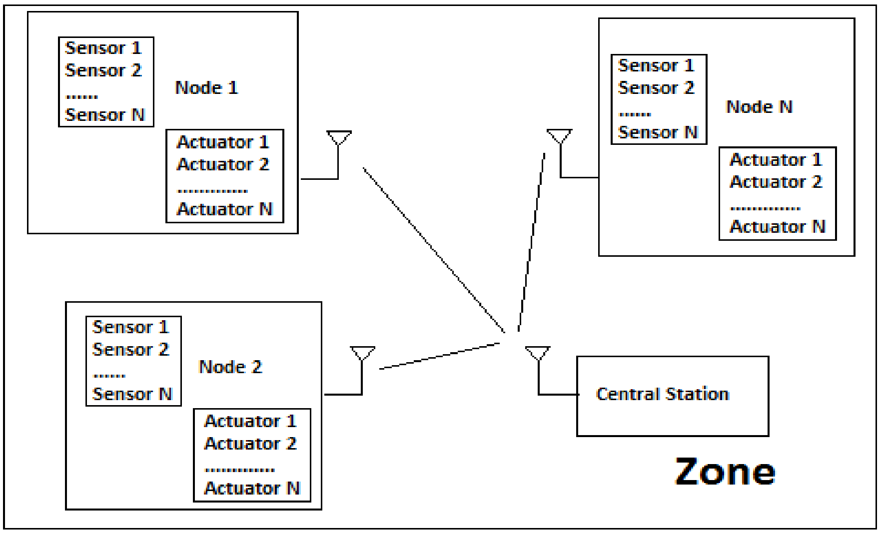

Fig.3 WBAN zones

A.2 WBAN Generic Central station:

It is Base station or data processing center. It is responsible for collecting data from different nodes in the same physical location (hospital or building) through wireless LORA modules and process them to extract useful information. It must always be active since the arrival of information is random. This is why his energy should be unlimited. In a large sensor network where the charge is a little higher, we can find two or more Sink to lighten the load [5,6].

A.3 WBAN nodes:

Include medical sensor that are integrated into a Wearable WBAN. Each sensor node can sense, sample, and process physiological signals. All of these sensors are connected to the node unit. The node will be responsible for:

- Data frame creation for a specific patient.
- Detection of malfunctions of any node and any sensor in the node.
- Data transmission and error reporting to the server.
- Receive set points from the cloud or the central station to run actuators attached to it.

For example, electrocardiogram sensor ECG can be used for monitoring heart activity, blood pressure sensor for monitoring blood pressure, temperature sensor for body temperature.

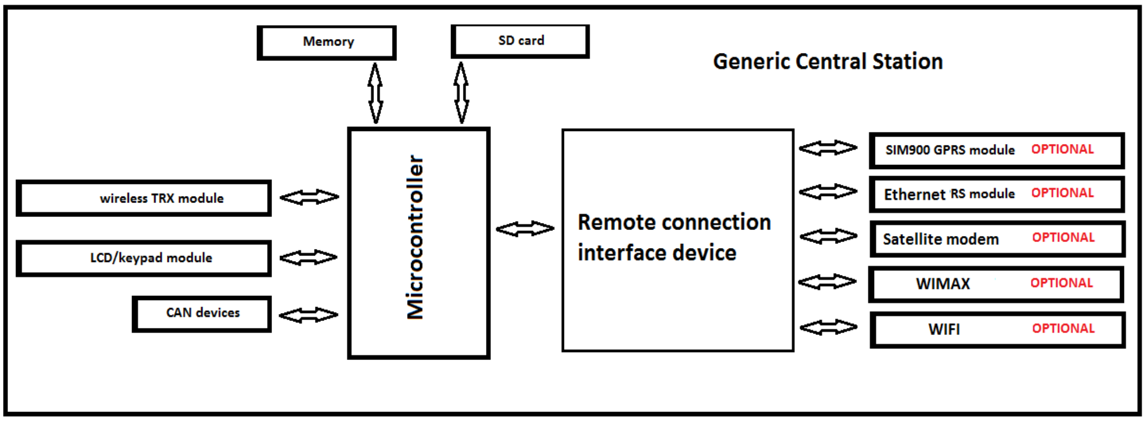

Fig.4 WBAN Generic Central station

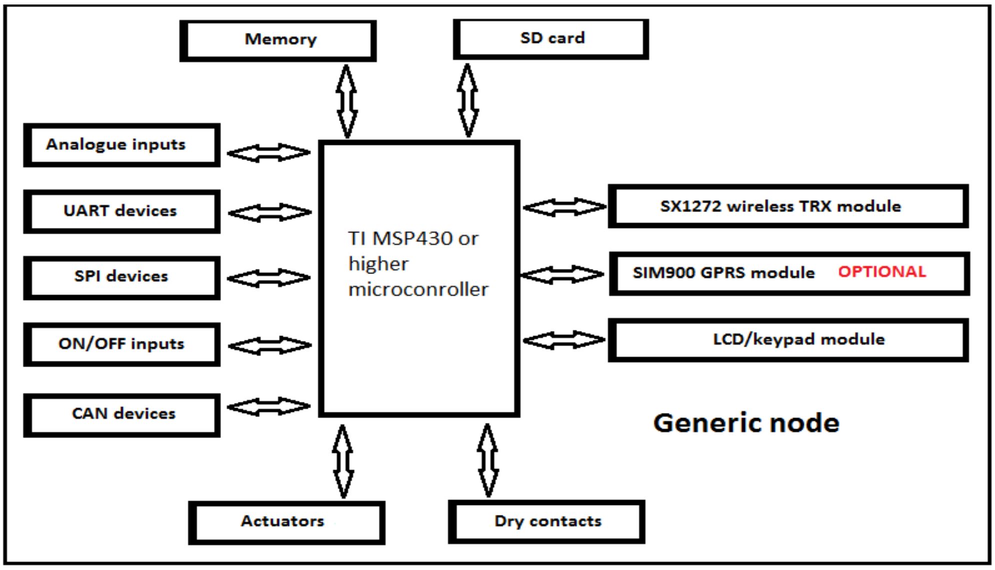

Fig.5 WBAN nodes

A.4 WBAN Medical Server :

It will be used to receive data from different zones station, to compare them with critical values that require intervention, to decide whether to store them in the database or send an SMS to ambulance and responsible doctor. It will be the platform which aims to computerize the medical process for doctors & patients with access permissions granted by an administrator to achieve the following:

- Establish medical record for each patient, the record contain all medical visits, analyzes, treatment recommended by doctor, and other information that qualifies the doctor to be important. - The medical record include management of medical documents (Analysis, ECG, X-ray, ultrasound…), all prescriptions and treatments recommended by doctor, and he traces the medical state of patien[7]t.

IV. Medical Implantable Communication System (MICS) :

Implantable medical devices (IMDs) have a history of outstanding success in the treatment of many diseases, including heart diseases, neurological disorders, and deafness (Cochlear Implants). New ultra-low-power radio-frequency (RF) technologies are spurring the development of innovative medical tools, from endoscopic camera capsules that are swallowed, to implanted devices that wirelessly transmit patient health data. Communication links between external programming devices (or base stations) and medical implants are critical to the success of IMDs[8]. The communication link enables a clinician to reprogram therapy and obtain useful diagnostic information. The design of transceivers for implantable medical devices is challenged by the following basic requirements:

• Low power consumption during 400 MHz communication is required. Implant battery power is limited, and the impedance of implant batteries is relatively high. This combination limits peak currents that may be drained from the supply. During communication sessions, current should be limited to <5 mA for most implantable devices.

• Minimum external component count and small physical size are important factors. An RF module for a pacemaker must be no larger than ~5 x 5 x 10 mm. Furthermore, implant-grade components are expensive, and using high levels of integration may significantly reduce costs. Integration has the additional benefit of increasing overall system reliability.

• Reasonable data rates are demanded; pacemaker applications are currently demanding>20 Kb/sec, with higher data rates projected for the future.

• High reliability in both data transmission and system operation.

• An operating range is typically >2 m because the MICS band is designed to improve upon the very-short-range inductive link. Longer operating ranges imply that good sensitivity is needed, because small antennas and body loss affect link budget and allowable range. Antenna matching and body loss can typically be more than 40 dB.

• Selectivity is required and interference must be rejected.

The MICS, shown in Fig.6, regulations provide additional requirements. Given the important requirements defined above, it is essential that medical device designers and system architects meet the demands of RF medical implant communication. Of the available modulation schemes, FSK modulation has been found to provide a good compromise between data rate, complexity, and requirements on linearity. FSK allows for a high-data-rate, low-power receiver.

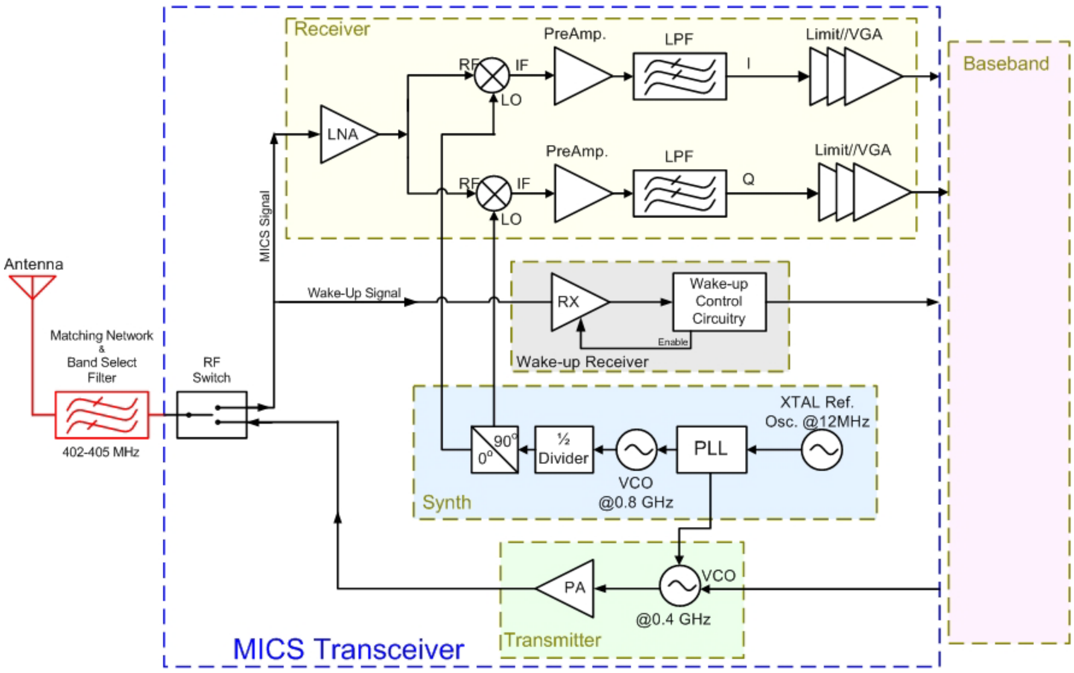

Fig.6MICS Transceiver

Direct conversion architecture is used for low-power single-chip implementation (System-on-Chip, SoC). Low supply voltage (1 V.) is employed to reduce power consumption. Process and supply voltage variations are major challenges in low voltage CMOS designs because of the limited voltage headroom and small overdrive volage (Vgs-Vt). Dynamic body biasing has been used extensively to cope with process and supply voltage variations. The proposed system will be able to integrate with MICS module implanted in the patient Human body. Thus realizing a real WBAN system utilizing MICS technology[9].

3. Healthcare Monitoring using MICS network :

A patient could be monitored at home, while traveling, or at the hospital. The number of parameters that must be monitored depends on the disease that a patient suffers from. For example, when a patient suffers from diabetes, an insulin diffuser could be implanted to monitor blood sugar and to control the sugar level in the blood. Similarly a patient with a heart problem may have a cardioverter-defibrillator implanted to monitor and adjust their heart rate[10]. On the other hand, if a patient is in the intensive care unit (ICU), then different physiological signals, such as blood pressure, temperature, respiratory rate, heart rate, ECG, and EEG are simultaneously monitored. Traffic for medical instruments is categorized in three different ways, i.e., constant bit rate (CBR), ON–OFF, and impulsive [8]. Signals for body area network applications are categorized in three different ways, i.e., on-demand, emergency, and normal [9]. In the MICS band, network data transmission from an implanted device must undergo a channel monitoring process and one-way telemetry is not permitted. The P/C must monitor the channel to find a free channel and then, it will initiate a communication session with the implanted device in the free channel, except in the case of a medical implant event (emergency or time-critical data). In this case, the implant devices immediately transmit data without performing any channel monitoring process. Therefore, there are two basic types of traffic in an MICS band, namely, on-demand and emergency[11]. The situation of MICS devices are summarized the technical requirements for successful MICS network implementation based on the recommendations published by different frequency management authorities around the world. To avoid the limitations imposed by inductive link communication, an universal radio frequency (RF) band of 401–406 MHz, for which the core band is 402–405 MHz, has been proposed for medical implant communication systems (MICSs). This band has good conductivity in the human body, a higher data rate, and a communication range up to 2 m. A MICS network comprises with devices implanted inside a body called as Implanted Device (IMD) or devices put on the body or wearable addressed as wearable device (WD) and a programmer /controller (P/C). In an MICS network, IMDs perform sensing and therapeutic functions, and the P/C is used to reprogram and send commands to the implanted devices, in addition to collecting data from the implanted devices[12].

4. Architecture of WSN Node :

As shown in Fig.7, a sensor node is composed of four major blocks: processing unit, communication interface, sensors and power supply.

• Microcontroller : Since the main functionalities of a sensor node consists in communicating, processing and gathering sensor data, sensor nodes must be equipped with a microcontroller unit (MCU). The MCU is responsible for execution of algorithms and communication protocols, controlling of the sensor and actuators, processing of gathered data, and it can be used also for the management of the energy harvesting block [13]. The MCU is required to be energy-efficient with a very short wake-up time

• Transceiver : Wireless communications between sensor nodes and also with the base station are carried by means of a wireless transceiver interface. A wireless transceiver implements all the necessary functionalities to convert bits data to radio waves and vice- versa. There exists many wireless standards operating in different frequency bands such as Z igBee, Bluetooth Low Energy (BLE) , Ultra- W ide Band (UW B) , etc

• Sensors and actuators : Environment and target application is monitored using sensors which are responsible of converting physical world information into electrical signals. There exists a plethora of sensor nodes that measure environmental parameters such as light, temperature, gas content in the air, sound, etc. These sensors can be classified as either analog or digital depending on the characteristics and speed req
uirements of the microcontroller and actuators used.

• Power supply : The power supply block has the functionality of supplying the required energy to power the sensor node. W hile typically consisting of a battery, it might also consists of an energy harvesting block which scavenges environmental energy, a power manager which is usually based on DC- DC converters that regulate the harvested energy, and finally a storage element responsible for storing the energy needed by the sensor node when the environmental energy to harvest is unavailable.

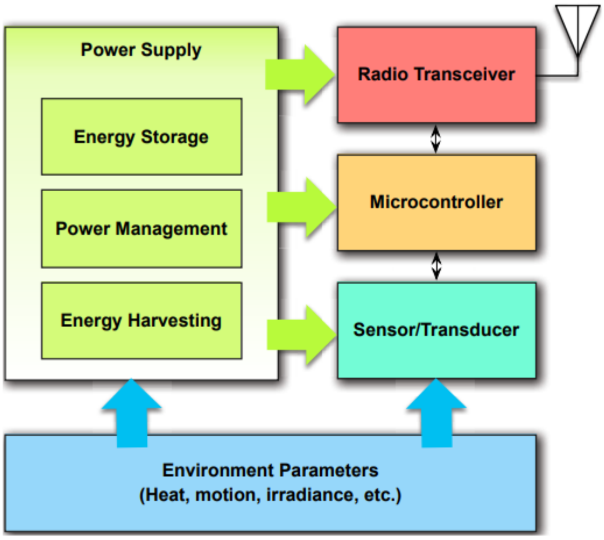

Fig. 7. Block diagram of a wireless sensor node .

In order to assess the lifetime issue in a WSN, The application lifetime is calculated by:

$$Application\ Lifetime = \frac{C_{battery}}{I_{Application-avg}} = \frac{C_{battery}}{\dfrac{(I_{ON-avg}\ x\ t_{ON}) + (I_{OFF-avg}\ x t_{OFF})}{(t_{ON} + t_{OFF})}}$$

The result using this equation seems to be overestimated for two reasons: The first one is due to the hypothesis that the battery voltage is always sufficient to supply the sensor node. The second is related to the leakage of the battery which was not taken into account. This example clearly shows that a network supplied only by batteries has a very limited lifespan. Therefore, in order to maximize network operation without battery replacement, it is necessary to reduce the power consumption of each component of the sensor node or add an additional energy source such as energy harvesting.

6. Contradictions between RF design and WSN Requirements :

For the SoC implementation of a WSN node chip, the RF transceiver is the designing bottleneck because there are several intrinsic contradictions between RF design and the common requirements of WSN, as shown in Fig. 8. Firstly, low cost is necessary because large quantities of nodes are needed for a comprehensive monitoring task[14]. In this case, a complementary metal oxide semiconductor (CMOS) full-integrated SoC is obviously a good candidate. Unfortunately, the RF part usually has to use inductors and capacitors, which occupy a large die area and are not easy to integrate, and then the overall cost of the nodes will be increased. Secondly, the distribution of communication nodes is often irregular and flexible, and then the distance between two nodes may be very long (several hundred meters) or very short (several centimeters). So the input signal amplitude of receiver may be very large (larger than 0 dBm) or very small (less than −100 dBm), which means that each receiver should have a large dynamic range. As a result, the receiver must contain a high-performance automatic gain control (AGC) loop, which is a traditional difficulty in CMOS analog design. Thirdly, reliability is also an important issue, especially for the nodes in hazardous environments, while the RF part is sensitive to the variations of process, voltage, and temperature (PVT). Fourthly, the RF part costs a much longer design period when compared to the digital part, and this is inconsistent with the "Easy to Design" requirement of WSN. Lastly, power consumption is the most significant factor because the WSN nodes are usually battery powered, while the RF part usually consumes larger than 90 % power of a node chip. Therefore, the RF transceiver design of a node chip is a challenging research topic in the WSN field.

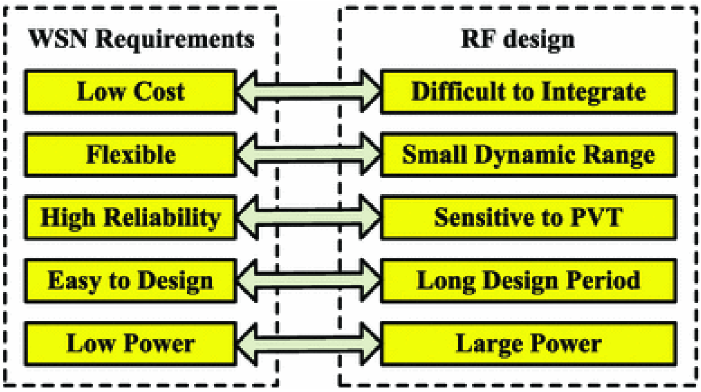

Fig.8. Contradictions between RF design and WSN requirements

Several companies have developed series of commercial chips for WSN. The basic specifications of these commercial chips and some common characters of these chips:

- Low data rate: In many WSN applications, the physical quantities to be monitored are often temperature, voice, or images with a low frame rate.
- Low power: The purpose is to extend the lifetime of battery-powered nodes.
- High sensitivity: It's used for long-distance communication to satisfy the WSN requirement on flexibility.
- Low emitting power: The multi-hop topology is usually adopted [2, 3], and then the output power of transmitter can be reduced to further reduce the power consumption.

Simple modulation schemes: Both the cost and design difficulty can be reduced.

4. Proposed MICS communication Network :

A complete network configuration of MICS is shown in Fig. 9. Patients and physicians can monitor the implanted devices within 2 m. Furthermore, the P/C unit can transmit data collected from the implanted devices to a physician's monitoring device with a longer range by employing the existing communication systems. An implant can also receive commands from a health professional via wireless communication links. This paper covers MICS transceivers, including relevant rules and regulations. We also discuss MICS devices and networks , including the challenges associated with implementation.

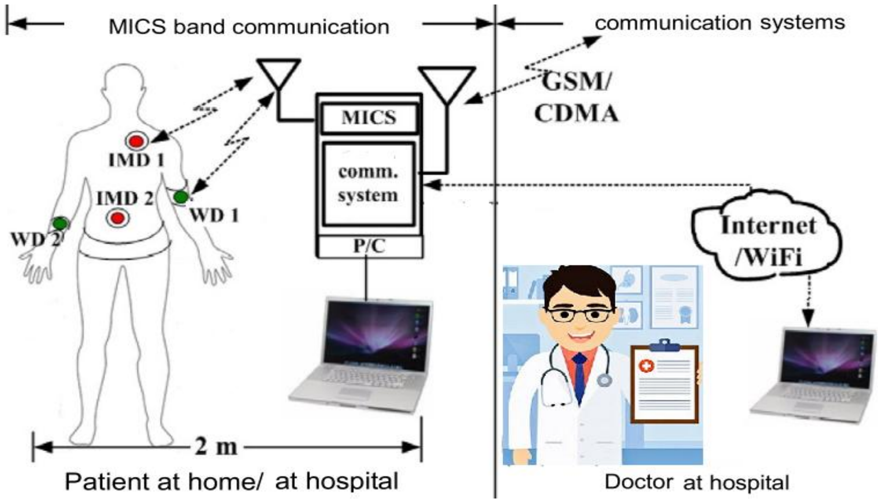

Fig. 9. Complete MICS communication network

8. Proposed Design of RF MICS Transceivers :

The design of RF transceivers is the bottleneck of SoC implementation for WSN. To meet the requirements of low cost, low complexity, low power consumption, high security, and high data-rate wireless communication capabilities, which can be widely adopted in **wideband** high-speed telecommunication system, Wireless Local Area Networks (Wireless LANs), and Wireless Personal Area Networks (Wireless PANs), simple modulation schemes are usually adopted. The wideband amplifier as shown in Fig.10. using the **inductive-series peaking method** with Cascode Common-Source Circuit is used in this Transciever which is designed by 0.18 μm CMOS technology. The circuits simulations were done using CADENCE Design Tools to optimize the design and get the required specifications for the proposed cascode amplifier. . This amplifier circuit was designed to fully match the input and output impedance of 50 ohm without any external circuit. Fig.11. Shows the Small signal equivalent circuit of cascade amplifier with gain peaking Inductor.

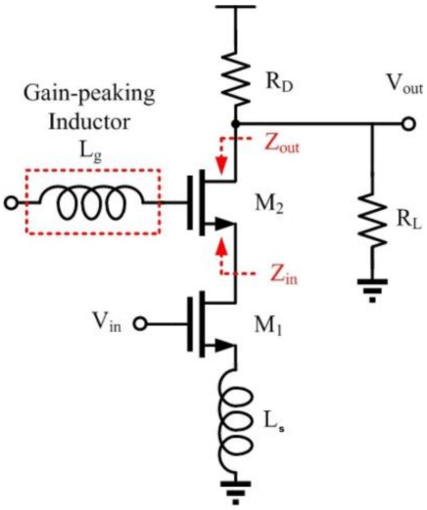

Fig. 10. CMOS Cascode amplifier with gate inductive gain peaking technique

The input impedance is given by :

$$Z_{IN}(\omega)=\frac{g_m L_g}{C_{gs}}+j(\omega L_g+\omega L_s-\frac{1}{\omega C_{gs}})$$

Where g_m is the transconductance of the transistor

Choose Lg such that , The operating frequency is given by

$$\omega=\frac{1}{\sqrt{(L_g+L_s)C_{gs}}}$$

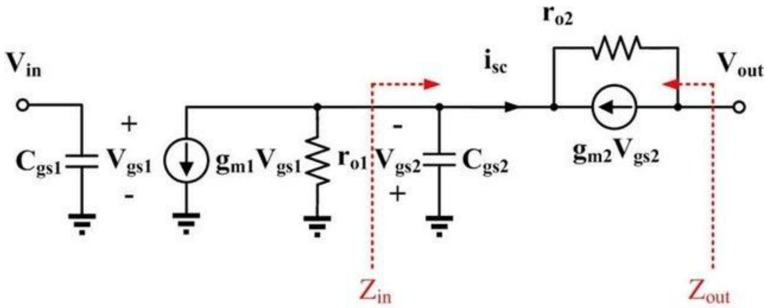

Fig. 11. Small signal equivalent circuit of cascade amplifier with gain peaking Inductor

Note that the inductor (Lpeak) and capacitor (Cg) was employed as inter-stage, which performed a series-resonant to generate a peaking characteristic for compensation the high frequency gain roll-off in the wide bandwidth [8]. In other words, the inductor (Lpeak) was introduced to this inter-stage, which should extend the bandwidth and realize the flatness in the wide bandwidth. Finally, the inter-stage matching network could carry out both the flatness signal gain and impedance matching simultaneously. The output stage was fully adopted for achieving the maximum gain. This output matching network was also adopted the cascode common-source topology. With this inductive peaking design technique, a low noise not only can be obtained, an ultra bandwidth can also be achieved.

Simualtion Results of cascode amplifier with gain-peaking inductor :

The circuits have been designed in UMC 0.18 um CMOS technology. The circuits simulations were done using CADENCE Design Tools to optimize the design and get the required specifications for the proposed cascode amplifier. The simulated RF performances results of the WB Amplifier were summarized as in Fig. 12 the input return loss (S11) was revealed a minimum value of –18 dB , and the simulated result of small signal gain-peaking of (S21) is 18.6 dB within the bandwidth of (401-405) MHz.

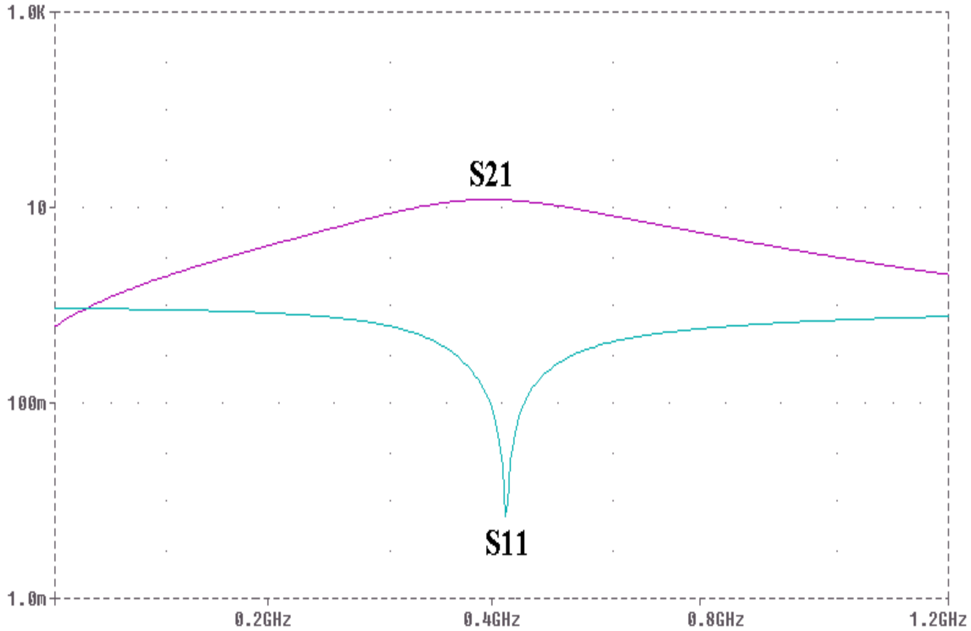

Fig. 12. Simulation results of S21 and S11

V. Proposed Bit Frame format for WBAN

IV. a Generic bit frame format:

As shown in Fig. 13 , Where: No. of bytes in the frame: Indicates the total length of the frame in bytes. SRC node: the CS ID and node ID of the source node. DEST node: the CS ID and node ID of the destination node. Frame type: whether it is a sensor readings frame, or a confirmation to a command frame, or a command. Application type: Indicates whether frame is from medical, security system, Military, SCADA, Home automation, Industrial, agriculture, Medical . No. of sensors in the frame: In case of frame type field is sensor reading, this field will indicate the number of the sensors readings in the frame. Priority level: The degree of importance of the frame for traffic priority , if this frame contains emergency message , or over threshold reading this field is set to high. Frame #: The number of the frame in the sequence, very important in case frame loss, or streaming audio or video. Encryption algorithm code: The algorithm used in the encoding of this frame 0 indicates none. Encryption algorithm key: The decoding key associated with the selected algorithm. Sensor no.: The sensor number whose data will be sent next to this byte. Sensor data length: Overall data length of the sensor or stream packet in case of streaming data into packets, this is the overall size of the packet. Sensor data length in the frame: amount of information sent from the sensor in this packet, used in case of streaming single packet over multiple frames, the max size of data from single sensor in frame is 100 , so if a sensor sends a 345 byte, the data of this sensor will be divided into 4 frames , 3 frames each contains 100 bytes and sensor data length in frame will be set to 100 , and the last frame will contain the last 45 bytes and the data length in the frame will be set to 45, the receiving node will then re-construct the packet using the frame number field and the sensor data length in the frame field along with the frame length field together. Sensor X data: The value of the sensor, if this is a streaming sensor (Audio , Video or data bigger than 100 byte) the data will be divided into blocks each 100 bytes and sent block by block with each frame then the receiver collects these blocks and re-form the original message. Sensor X type: The type of the sensor (temp , pressure, gas , ..Etc.). Sensor X key: Any specific factor or pre-scaler associated with the sensor reading. Response number : the response reference number in case of reply for certain frame or message. End of frame: A specific character sent at the end of the frame, to act along with the no.of frames byte in the beginning of the frame in controlling the traffic. CRC: Cyclic redundancy check.

	SRC node info		DEST node info						Frame # 4 bytes							Sensor data length in bytes (3 bytes)		
No. of bytes in the frame	CS #	Node #	CS #	Node #	Frame type	Application type	no. of sensors in the frame (M)	Priority level	Byte 4	Byte 3	Byte 2	Byte 1	Encryption Algo #	Encryption Algo key	Sensor 1	Byte 3	Byte 2	Byte 1

						Sensor M data length in bytes (3bytes)		
Sensor 1 data length in frame	Sensor 1 type	Sensor 1 key	Sensor 1 data bytes (max 100 byte per frame)		Sensor (M)	Byte 3	Byte 2	Byte 1

Sensor M data length in frame	Sensor M type	Sensor M key	Sensor M data bytes (max 100 byte per frame)	Response number	End of frame	CRC

Fig. 13 Generic bit frame format

IV.b Bit frame format for medical applications in one single zone:

As shown in Fig. 14, Frame sent from the node (ex. 05) this node contains 3 sensors, normal priority to the CS. In this system configuration, the following parameters are set to pre-set values: No. of bytes in the frame: Indicates the total length of the frame in bytes. SRC node: the CS ID and node ID of the source node, CS ID is set to 254 indicating Zone CS not external Zone, node ID 05 as indicated in the example. DEST node: the CS ID and node ID of the destination node, CS ID is set to 254 indicating Zone CS not external Zone, node ID set to 01, where the CS node is always 01, indicating master node. Frame type: set to 01 indicating sensors reading frame. Application type: set to 01 indicating medical application. No. of sensors in the frame: set to 3 sensors. Priority level: set to 05 for normal priority, where 01 priority is the least and 10 is emergency. Frame #: set to 00 as the frame number is not important in this type frames, due to the frames being informative independently not sequential. Encryption algorithm code: set to 01, first degree algorithm. Encryption algorithm key: set to 01, for the sake of the example. Sensor no.: this number will change from 01 to 03. Sensor data length: 01 each sensor sends 1 byte. Sensor data length in the frame: 01 , the frame will contain all the data of this sensor. Sensor X data: for this example , the data will be (sensor no). Sensor X type: sensor 1 type is 01 (for temperature). sensor 2 type is 02 (for pressure). sensor 3 type is 03 (level sensor). Sensor X key: All keys will be set to 01, indicating no pre-scaler is assigned, use data as is. Response number: set to 00 as no need for a confirmation from the CS, if confirmation is needed a confirmation is assigned to this field and the CS must set this value to the response number assigned to the frame. End of frame: 0XAA. CRC: Cyclic redundancy check.

	SRC node info		DEST node info						Frame # 4 bytes							Sensor data length in bytes (3 bytes)		
42	254	05	254	01	01	01	03	05	0	0	0	01	01	01	01	0	0	01

			Sensor 1 data		Sensor data length in bytes (3 bytes)						Sensor 2 data		Sensor data length in bytes (3 bytes)						Sensor 2 data
01	01	01	01	02	0	0	01	01	02	01	02	02	0	0	01	01	03	01	03

0	170 (0XAA)	CRC

Fig. 14 Bit frame format for medical applications in one single zone

IV.c Bit frame format for Medical applications in two different zones:

As shown in Fig. 15 , Frame sent from the node (ex.15) this node contains 2 sensors, high priority to the CS from another CS in different zone, the home CS is 12 , the remote CS is 25, response is needed for this frame and given sequence 23. In this system configuration, the following parameters are set to pre-set values: No. of bytes in the frame: Indicates the total length of the frame in bytes. SRC node: the CS ID and node ID of the source node, the home CS is 12 , node ID is 01. DEST node: the CS ID and node ID of the destination node, CS ID is set to 25, node ID set to 15. Frame type: set to 01 indicating sensors reading frame. Application type: set to 02 indicating Medical application. No. of sensors in the frame: set to 2 sensors. Priority level: set to 08 for high priority, where 01 priority is the least and 10 is emergency. Frame #: set to 00 and increments with the frame number. Encryption algorithm code: set to 03, third degree algorithm. Encryption algorithm key: set to 01, for the sake of the example. Sensor no.: this number will change from 01 to 02. Sensor data length: set to 1 for sensor 1 and 1 for sensor 2. Sensor data length in the frame: set to 1 for both sensors. Sensor X data: for this example , the data will be (0XAE for sensor 1 and 0XEA for sensor 2). Sensor X type: Sensor X data: for this example , the data will be (sensor no). Sensor X type: sensor 1 type is 01 (for temperature). sensor 2 type is 02 (for pssure). Sensor X key: All keys will be set to 01, indicating no pre-scaler is assigned, use data as is. Response number: set to 00 as no need for a confirmation from the CS, if confirmation is needed a confirmation is assigned to this field and the CS must set this value to the response number assigned to the frame. End of frame: 0XAA. CRC: Cyclic redundancy check.

	SRC node info		DEST node info						Frame # 4 bytes							Sensor data length in bytes (3 bytes)		
42	12	01	25	15	01	01	2	8	0	0	0	01	03	01	01	0	0	01

			Sensor 1 data		Sensor data length in bytes (3 bytes)						Sensor 2 data		Sensor data length in bytes (3 bytes)						Sensor 2 data
01	01	01	01	02	0	0	01	01	02	01	02	02	0	0	01	01	03	01	03

23	170 (0XAA)	CRC

Fig. 15 Bit frame format for Medical applications in two different zones

VI. Proposed Wireless Medical Telemetry System (WMTS) :

WMTS : measure vital signs from Human body as follow : Develop comfortable and portal medical wireless sensor network that provides continuous monitoring of health status for patients or sports people. The design of these networks must follow the international standard safety guidelines. Another important issue is the security of the patients' data. Develop biomedical wireless sensor networks, compact, low-power, low SAR, plug-and-play for monitoring physiological activities, and environmental parameters using the latest available sensors. A group of wireless sensors networks communicate with a server which is routing their data into one of the connected smart phones. So, the system could be split into three sides with different responsibilities and functionalities. The Network nodes side: -It is a group of sensors gateways, every gateway is managing and collecting the data from one or more surrounded wireless sensor nodes. -It is responsible for data frame creation for a specific patient. -Detection of malfunctions of any node and any sensor in the node. -Data transmission and error reporting to the server. -Specialist Doctor Instruction reception and display. -Server Side: -The Server is responsible for, Data reception from the Sensor Network Gateway. -Data monitoring to the reasonable specialist. -Detection of Specialist response. -Routing the specialist response to the requested patient. -Sensors errors reporting to the Admin Panel for maintenance. -Doctors and hospitals financial calculations. -Configurable doctor Notification for a new patient needs treatment. -Displaying of patient data, position and checks. -Interacting the doctor response and forwarding it to the server. -The Proposed System is using wireless sensor network technology mixed with the Telemedicine service applications to provide fast response, direct patient follow up and high probability of rescue from severe symptoms of some diseases. The system is allowing doctors to give a special treatment for huge network of patient in different places simply from their houses, hospitals or clinic. This will help patients in remote and rural areas to take reasonable treatment in case that it is difficult to provide a specialist doctor suddenly.

VII. Simulation results from the Proteus :

Validation Procedure of system functionality : Test the system with different inputs and compare outputs with expected results . Using RF module : NRF24L01 to test wireless connection

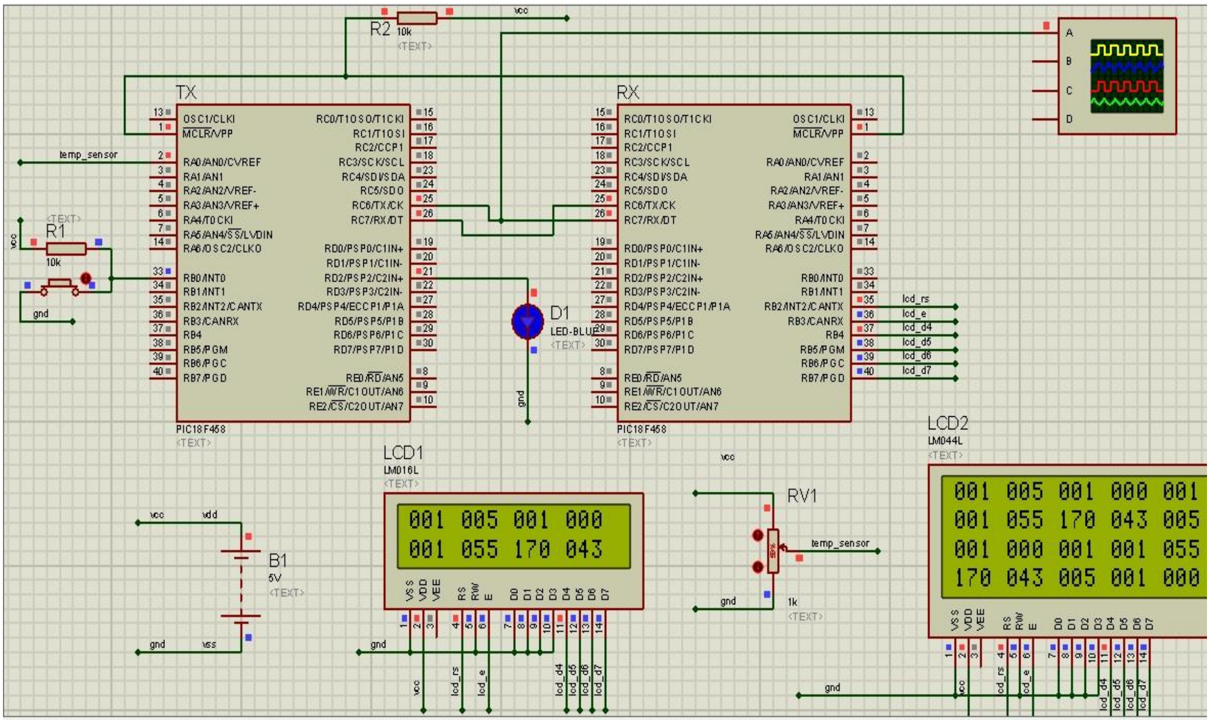

Fig.16 shows the result snap shot taken from Proteus circuit simulation program with actual frame for the proposed bit frame generation of for 1 zone 1 sensor Medical application

VIII. Conclusion

The added contributions in this work are : An Efficient Remote Healthcare Embedded Electronics using Medical Implantable Communication System (MICS) and Wireless Medical Telemetry System (WMTS), using RF Transceiver is proposed for Medical applications. This system is very realiable , The system is portable and compact. The system is customizable according to application needs. The system allows for higher degrees of security and data encryption. The system allows for routing thus extending the coverage area. The system makes a good utilization of the BW by using variable length frames. The proposed system will be able to integrate with MICS module implanted in the patient Human body. Thus realizing a real WBAN system utilizing MICS technology

This work presents a detailed overview of the MICS band and the restrictions imposed on its use. The present situation of MICS devices and several network issues are discussed. Some challenges exist in the design of a successful MICS network. A low-power reliable MAC protocol to meet the rules and restrictions imposed on the use of the MICS band is essential for simultaneously collecting data from different implanted and body-worn devices. Multi purpose wireless sensors nodes for wireless network and control system using MICS Transceiver is proposed. Also, portability of the system and compact, customizable according to the application needs, allows for higher degrees of security and data encryption, and allow for routing thus extending the coverage area. The system makes a good utilization of the BW using variable length frames. Proteus circuit simulation program is used with actual frame for the proposed bit frame generation. The presented system can be used in various fields including but not limited to: Security systems, Military applications, Small scale SCADA system, Home automation, Industrial monitoring, Irrigation and agricultural systems, Telecom applications for small range communication.. CMOS Cascode amplifier with gate inductive gain peaking technique is chosen to obtain ultra wide bandwidth amplifier. The simulated RF performances results of the WB Amplifier were summarized as the input return loss (S11) was revealed a minimum value of –18 dB , and the simulated result of small signal gain-peaking of (S21) is 18.6 dB within the bandwidth of (401-405) MHz.

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