PIC MICROCONTROLLER BASED LIFE SAVING SYSTEM (EMBEDDED SYSTEMS)

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ABSTRACT

A new revolutionary microwave life detection system. Which is used to locate human beings buried (or) trapped under earthquake rubble has been designed. This system operating at certain frequency can remotely detect the breathing and heart beat signals of human beings buried under earthquake rubble. By proper processing of these signals, the status of the person under trap can be easily judged. The entire process takes place within a few seconds as the system is controlled by a PIC Microcontroller unit. By using this project we might have saved hundreds of precise lifes in "HAITI ISLAND " .

INTRODUCTION

At present as we know the need of the hour is to find an effective method for rescuing people buried under earthquake rubble (or) collapsed building. It has to be done before we experience another quake. Present methods for searching and rescuing victims buried (or) trapped under earthquake rubble are not effective. Taking all these factors in mind, a system which will be really effective to solve problem has been designed.

PRINCIPLE OF OPERATION

The basic principle is that when a microwave beam of certain frequency [L (or) S band (or) UHF band] is aimed at a portion of rubble (or) collapsed building under which a person has been trapped, the microwave beam can penetrate through the rubble to reach the person.

When the person is focused by the microwave beam, the reflected wave from the person's body will be modulated (or) changed by his/her movements, which include breathing and heart beat. Simultaneously, reflected waves are also received from the collapsed structures. So, if these reflected waves from the immovable debris are cancelled and the reflected wave from the person's body is properly distinguished, the breathing and heart beat signals can be detected.

By proper processing of these signals, the status of the person under trap can be easily judged. Thus a person under debris can be identified.

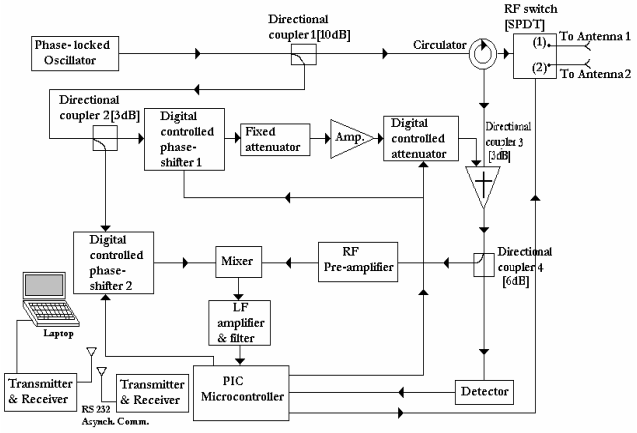
MAJOR COMPONENTS OF THE CIRCUIT

The microwave life detection system has four components. They are

1. A microwave circuit which generates amplifies and distributes microwave signals to different microwave components.
2. A microcontroller controlled clutter cancelled system, which creates an optimal signal to cancel the clutter cancellation system from the rubble.
3. A dual antenna system, which consists of two antennas, energized sequentially.
4. A laptop computer which controls the microcontroller and acts as the monitor for the output signal.

WORKING FREQUENCY

The frequency of the microwave falls under two categories, depending on the type and nature of the collapsed building. They are



Schematic diagram of microwave life-detecting system

CIRCUIT DESCRIPTION

The circuit description is as follows:

Phase Locked Oscillator:

The phase locked oscillator generates a very stable electromagnetic wave say 1150 MHz with output power say 400mW.

Directional Coupler 1 (10 dB):

This wave is then fed through a 10 db directional coupler and a circuital before reaching a radio frequency switch, which energizes the dual antenna system. Also, the ten dB directional coupler 2 (3 dB).

Directional coupler 2 (3 dB):

Antenna system:

The dual antenna system has two antennas, which are energized sequentially by an electronic switch. Each antenna acts separately.

Clutter cancellation unit:

The clutter cancellation unit consists of

1. A digital controlled phase shifter 1
2. A fixed attenuator
3. A RF amplifier
4. A digitally controlled attenuator.

WORKING

- The output of the clutter cancellation circuit is automatically adjusted to be of equal amplitude and opposite phase as that of the clutter from the rubble.
- Thus when the output of the clutter cancellation circuit is combined with the directional coupler 3(3 dB), the large clutter from the rubble is completely cancelled.
- Now, the output of the directional coupler 3(3dB) consists only of the small wave from the person's body.
- This output of the directional coupler 3(3dB) is passed through a directional coupler 4(6 dB).
- One-fourth of this output is amplified by a RF pre amplifier and then mixed with a local reference signal in a double balanced mixer.
- Three-fourth of the output is directed by a microwave detector to provide a dc output, which serves as the indicator for the degree of clutter cancellation.
- When the settings of the digitally controlled phase shifter and the attenuator are swept by the microcontroller control system, the output of the microwave detector varies accordingly.

Clutter cancellation of the received signal:

- The wave radiated by the antenna 1 penetrates the earth quake rubble to reach the buried person.
- The reflected wave received by the antenna 2 consists of a large reflected wave from the rubble
- The large clutter from the rubble can be cancelled by a clutter canceling signal.
- The small reflected wave from the person's body can not be cancelled by a pure sinusoidal canceling signal because it is modulated by his/her movements.

Demodulation of the cluttered signal:

- At the double balanced mixer, the amplifier signal of the reflected wave from the person's body is mixed with the local reference signal.
- The phase of the local reference signal is controlled by another digitally controlled phase shifter 2 for an optimal output from the mixer.
- The output of the mixer consists of the breathing and heart beat signals of the human plus some unavoidable noise.
- This output is fed through a low frequency amplifier and a band pass filter (0.1 -4 Hz) before being displayed on the monitor.
- The function of the digitally controlled phase shifter 2 is to control the phase of the local reference signal for the purpose of increasing the system sensitivity.
- The reflected signal from the person's body after amplification by the pre-amplifier is mixed with the local reference signal in a double balanced mixer.
- The local reference signal is assumed to be $A_1\cos(wt+\varphi_1)$

Where A_1->amplitude of the local reference signal.

φ_1-> phase of the local reference signal.

Let the reflected wave (or) signal from the person's body=

$$A_r * \cos(wt+ \varphi_e +\Delta(\varphi(t)))$$

Where Ar->amplitude of the reflected wave.

φ_e-> phase of the reflected wave.

Δ(φ(t))-> phase modulation due to the person's body movements.

When these two inputs are mixed in the double balanced mixer, the output of the mixer will be A_1A_2* Δφ((t)) cos(φ_1- φ_e -Δφ(t))

From this expression of the mixer output, it is seen that,

- If $\varphi_1-\varphi_e=(n+1/2)\prod$ where n=0,1,2… the system has a maximum sensitivity ;
- $\varphi_1-\varphi_e=(\pm n)\prod$ where n=0,1,2…

The system has a minimum sensitivity;

because (δ/ δ(Δφ(t)) cos(φ_1- φ_e -Δφ(t))= - sin(φ_1- φ_e -Δφ(t)) .Δφ(t) is usually a small phase angle created by the body movement of the person.

φ_e is the constant phase associated with the reflected signal from the person's body and it cannot be changed.

φ_1 is the phase of the local reference signal and it can be controlled by the digitally controlled phase shifter 2.

The phase shifter will automatically shift φ_1 in such a way that $\varphi_1 - \varphi_e$ is nearly = (n+1/2) $\prod$ to attain a maximum sensitivity.

PIC MICROCONTROLLERS:

The PIC16F84A belongs to the mid-range family of the PICmicro ® microcontroller devices. A block diagram of the device is shown below

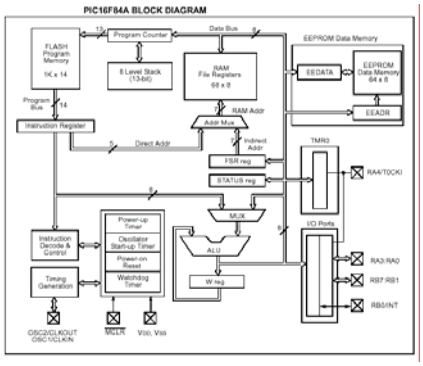
The program memory contains 1K words, which translates to 1024 instructions, since each 14-bit program memory word is the same width as each device instruction. The data memory (RAM) contains 68 bytes. Data EEPROM is 64 bytes. There are also 13 I/O pins that are user-configured on a pin-to-pin basis. Some pins are multiplexed with other

device functions. These functions include:

• External interrupt

• Change on PORTB interrupt

• Timer0 clock input



Memory Organization Unit:

There are two memory blocks in the PIC16F84A. These are the program memory and the data memory. Each block has its own bus, so that access to each block can occur during the same oscillator cycle.

The data memory can further be broken down into the general purpose RAM and the Special Function Registers (SFRs).

The data memory area also contains the data EEPROM memory. This memory is not directly mapped into the data memory, but is indirectly mapped. That is, an indirect address pointer specifies the address of the

data EEPROM memory to read/write. The 64 bytes of data EEPROM memory have the address range 0h-3Fh

Timer0 module:

The Timer0 module timer/counter has the following features:

- 8-bit timer/counter
- Readable and writable
- Internal or external clock select
- Edge select for external clock
- 8-bit software programmable prescaler
- Interrupt-on-overflow from FFh to 00h

.**Timer0 Operation:**

Timer0 can operate as a timer or as a counter. Timer mode is selected by clearing bit T0CS

(OPTION_REG<5>). In Timer mode, the Timer0 module will increment every instruction cycle (without prescaler). If the TMR0 register is written, the increment is inhibited for the following two instruction cycles. The user can work around this by writing an adjusted value to the TMR0 register. Counter mode is selected by setting bit T0CS (OPTION_REG<5>). In Counter mode, Timer0 will increment, either on every rising or falling edge of pin RA4/T0CKI. The incrementing edge is determined by the Timer0 Source Edge Select bit, T0SE (OPTION_REG<4>). Clearing bit T0SE selects the rising edge. Restrictions on the external clock input are discussed below. When an external clock input is used for Timer0, it must meet certain requirements. The requirements ensure the external clock can be synchronized with the internal phase clock (TOSC). Also, there is a delay in the actual incrementing of Timer0 after synchronization.

MICROCONTROLLER UNIT

The algorithm and flowcharts for the antenna system and clutter cancellation system are as follows:

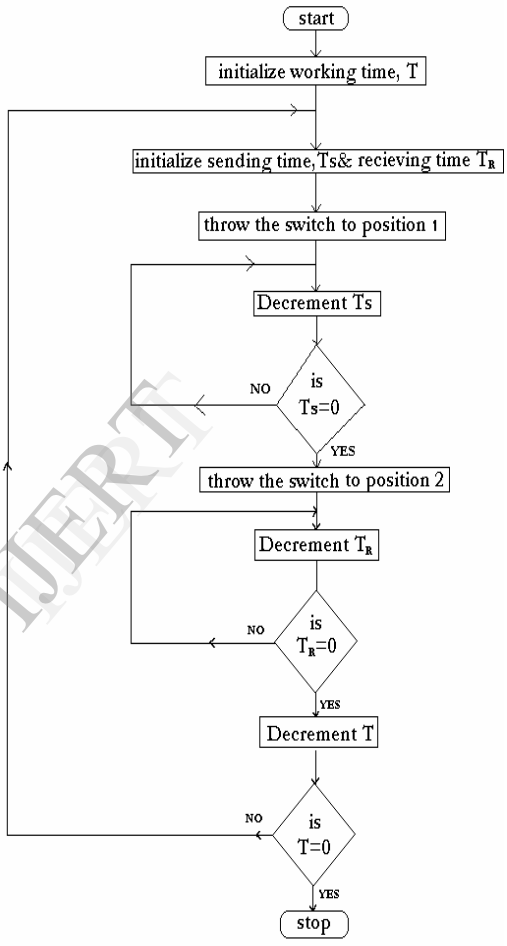
Antenna system:

1) Initially the switch is kept in position 1(signal is transmitted through antenna 1).
2) Wait for some predetermined sending time, Ts.
3) Then the switch is thrown to position 2(signal is received through antenna 2).
4) Wait for some predetermined receiving time, Tr.
5) Go to step1.
6) Repeat the above procedure for some predetermined time, T.

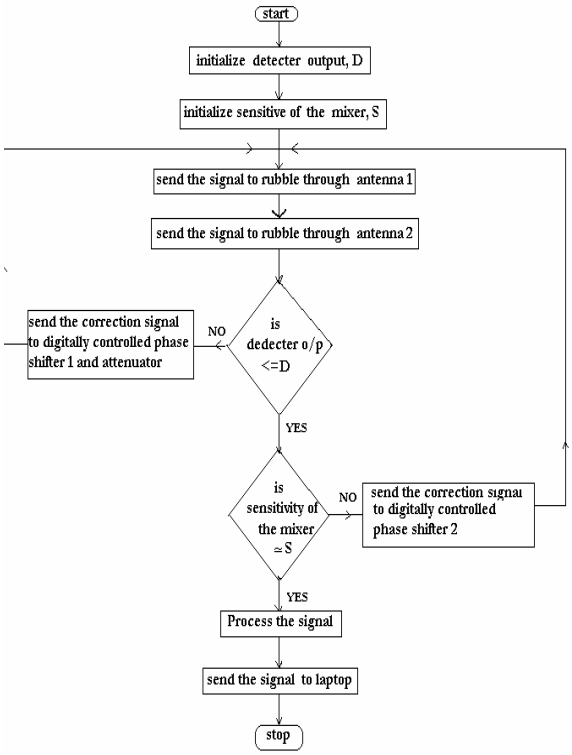
Clutter cancellation system:

1) Receive the signal from the ruble through antenna .
2) Check the detector output. If it is within the predetermined limits go to step5.
3) Send the signal to the ruble through antenna 1
4) Otherwise send the correction signal to the digitally controlled phase shifter1 and the attenuator and go to step1.
5) Check the sensitivity of the mixer. If it is optimum go to step 7
6) Otherwise send the correction signal to the digitally controlled phase shifter 2 to change the phase and go to step 1.
7) Process the signal and send it to laptop.

FLOWCHART FOR ANTENNA SYSTEM



FLOWCHART FOR CLUTTER CANCELLATION SYSTEM



ADVANTAGES OF L (OR) S BAND FREQUENCY SYSTEM

Microwave of l (or) S band frequency can penetrate the rubble with metallic mesh easier than that of UHF band frequency waves.

ADVANTAGES OF UHF BAND FREQUENCY SYSTEM

Microwaves of UHF band frequency can penetrate deeper in rubble (without metallic mesh) than that of L (or) S band frequency waves.

FREQUENCY RANGE OF BREATHING AND HEART BEAT SIGNALS

The frequency range of heartbeat and breathing of human beings lies between 0.2 and 3Hz.

HIGHLIGHTS

1. The location of the person under the rubble can be known by calculating the time lapse between the sending time, T_s and receiving time, T_r.

2. Since it will not be possible to continuously watch the system under critical situations, an alarm system has been set, so that whenever the laptop computer system processes the received signal and identifies that there is a human being, the alarm sound starts.

3. Also under critical situations, where living beings other than humans are not required to be found out, the system can detect the signals of other living beings based on the frequency of the breathing and heart beat signals.

CONCLUSION

Thus a new sensitive life detection system using microwave radiation for locating human beings buried under earthquake rubble (or) hidden various barriers have been designed. This system operating either at L (or) S band (or) UHF band can detect the breathing and heart beat signals of human beings through an earthquake rubble.

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