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Generation of different waveforms to stimulate the body mechanism

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ABSTRACT

This paper discusses same of the advances and limitation of the field of functional electrical Stimulation (FES) and recent advancements in the field of stimulation and how electrical signals can be utilized for pain relief and to cure other diseases of human body by using stimulation. This paper aims to create advancement in stimulators and also focuses on their advantages as compared to the conventional medicine. More one it also being for it that how on electrical signal can be utilized for treating various human disorder and disease.

Keywords— *Stimulators, Waveform generation, FES, TENS*

1. INTRODUCTION

Stimulators are basically the electronics circuits that are used to generate the electrical signals and transmit them to patients' body. The arrangements are made in this stimulator the intensity of signals by means frequency and amplitude. In this project we have developed two units one is Electrical Muscle Stimulator (EMS) and other is Transcutaneous Electrical Nerve Stimulator (TENS). The electrical impulses generated by these two units are applied to the effected portion of the patient's body using electrode. The most common application Stimulator is to relief the patient from the pain.

In this case it is analogous to taking an logistic, but it reduces the depending and the any reaction. As the name suggest Stimulators are devices that provides mild Stimulations of nerves using electrical signal. These signals abstract the pain signals before they can reach the brain and hence the sensation of pain is reduced. The Stimulators are basically used to treat pain. But every human is body has different bearing capacity. For example, an adult human body and the child human body has different bearing capacity. So, in this project we have developed the Stimulators that has facility for Stimulation of both child human body and adult human body and the controlling of pain can be well explained by two theories.

2. TRANSCUTANEOUS ELECTRICAL NERVE STIMULATION (TENS)

As it suggests, Transcutaneous refers to the application of electrode on the coetaneous or the superficial skin. A Transcutaneous Electrical Nerve Stimulation (TENS) is a therapy that uses low voltage electrical current to provide pain relief. A TENS unit provides impulses through electrodes placed on the surface of a skin.

There are two theories about how Transcutaneous electrical nerve stimulation (TENS) works. One theory is that the electric current stimulates nerve cells that block the transmission of pain signals, modifying your perception of pain. The other theory is that nerve stimulation raises the level of endorphins, which are the body's natural pain-killing chemical. The endorphins then block the perception of pain.

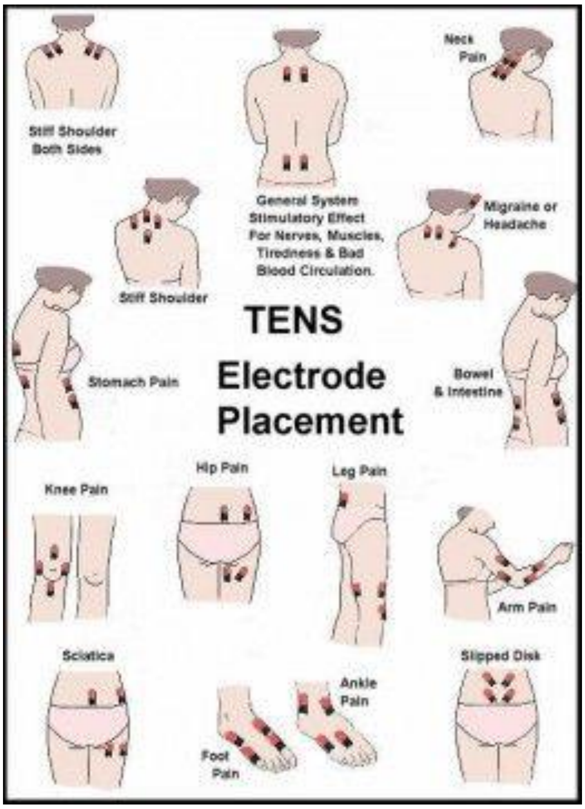


Fig: TENS Electrode placement

3. FUNCTIONAL ELECTRICAL STIMULATION (FES)

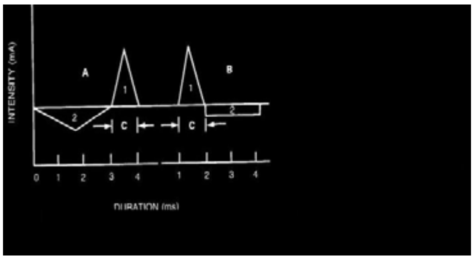
Functional electrical stimulation (FES) is a technique that uses low-energy electrical pulses to artificially generate body movements in individuals who have been paralyzed due to injury to the central nervous system. More specifically, FES can be used to generate muscle contraction in otherwise paralyzed limbs to produce functions such as grasping, walking, bladder voiding and standing. This technology was originally used to develop neuro-prostheses that were implemented to permanently substitute impaired functions in individuals with spinal cord injury (SCI), head injury, stroke and other neurological disorders. In other words, a person would use the device each time he or she wanted to generate a desired function. FES is sometimes also referred to as neuromuscular electrical stimulation (NMES).

FES technology has been used to deliver therapies to retrain voluntary motor functions such as grasping, reaching and walking. In this embodiment, FES is used as a short-term therapy, the objective of which is restoration of voluntary function and not lifelong dependence on the FES device, hence the name functional electrical stimulation therapy, FES therapy (FET or FEST). In other words, the FEST is used as a short-term intervention to help the central nervous system of the person to re-learn how to execute impaired functions, instead of making the person dependent on neuro-prostheses for the rest of her or his life.

4. MUSCLE STIMULATORS

These are used to mainly treat the patients suffering from full or partial paralysis. These stimulators stimulate and hence strengthens the muscle which are weak or paralyzed, by applying electrical signals which creates a somewhat vibration like sensation or the artificial triggeringpulse for the muscle. Using muscle stimulators, we try and give a sort of electrical massage and hence help the muscles to regain their strength and vitality. As the muscle fibres of different body parts have different strength andhardness so we use various types of electronic signals to treat various muscle anomalies. The types of currents or signals used are as follows:

(a) **Faradic Current**: They are a series of triangular pulses with duration of about 1ms to 20ms. It is basically used to treat the muscle weakness.



(b) **Faradic Surging Current**: They are known as surging because their peak current intensity applied to the patient increases or decreases rhythmically at a slow rate. Such currents are mainly used for prolonged application to patient's body, like in the case of treatment of functional paralyses in spasm.
(c) **Galvanic Current**: A steady flow of direct current is passed through the skin producing a chemical effect used in treatment of paralysis and disturbance of blood flow.
(d) **D)Exponential Progressive current**: These signals are used to treat severe paralysis. The variation of current is

exponential in nature in such stimulators.

5. ELECTRODES

Material and Care: There are many choices of electrode shape, size, and configuration to fit the need of the patient and therapeutic goal for electrical stimulation.

5.1 Types of Electrodes

- **Metal Plate Electrodes**- early version, limited sizes, required wet sponge conduction medium, difficult to secure in place.
- **Carbon - Impregnated Rubber Electrodes**- degrade over time and become non-uniform with "hot spots", many shapes and sizes, rinse and dry after each use and replaced every 12 months to ensure conductivity.
- **Self-Adhering or Single use Electrodes**- flexible conductors, convenient application, no strapping or taping to keep in place, resealable bag for multiple uses, often high impedance, possibility of cross-contamination, used most frequently these days. Single use electrodes may not be shared between patients.

5.2 Electrode Size and Current Density

- Current density is the concentration of current under an electrode.
- Electrode surface area is inversely proportional to current flow. (Larger electrode = current is less dense as it is distributed over a larger area; the smaller the electrode, the more intense the same current becomes over a smaller area.
- Keep the electrode in proportion with size of body area being treated. If the electrode is too large for the area, there could be unwanted carryover to other surrounding structures; if too small, the current is too dense and may not be tolerated to elicit the desired response.

Completing the Circuit- an electrical stimulation treatment must include a full circuit. To complete the circuit, there must be:
1. A source of energy creating an electrical potential difference.
2.A conductive pathway - including electrodes, leads, and a conductive surface with good contact.
3. Cleaning the patient's skin with alcohol to remove oil and dirt before electrode application.
4. Clipping excess body hair under electrodes.
5.Minimize warming the treatment area of the body prior to stimulation so there is minimal increased resistance.

5.3 Electrode Configuration

Monopolar - always two poles: cathode (-) is active and produces cell depolarization, produces a net charge. Bipolar - two electrodes in a single circuit; each electrode alternates between positive and negative; electrodes are of equal size; no net charge is produced. Patient will feel excitatory response under both electrodes, eliciting motor response or electrode placed over motor point, other electrode over muscle belly and may be larger. Quadripolar - four electrodes in two circuits that operate independently yet interact Interferential, large area, pain management, sensory stimulation of larger fiber.

6. PROPOSED SYSTEM

Since medical professionals would require a device that can be used over a larger spectrum of applications, our research was focused on providing that along with long term effects. Our research indicates that with certain kinds of therapy, we can use intermittent pulses to provide pain relief effects over a longer term. Therefore, in our fabrication we use an intermittent oscillator along with the switching oscillator to provide two modes: continuous and short bursts of frequency impulses. The parameters of Output voltage, Pulse width, and Pulse rate are adjustable to provide a wider range of frequency for therapeutic treatments in a single device. Since intermittent pulses are used, muscle twitching does not occur, thereby leading to future scope for domestic use. The block diagram of the modified proposed system is as follows:

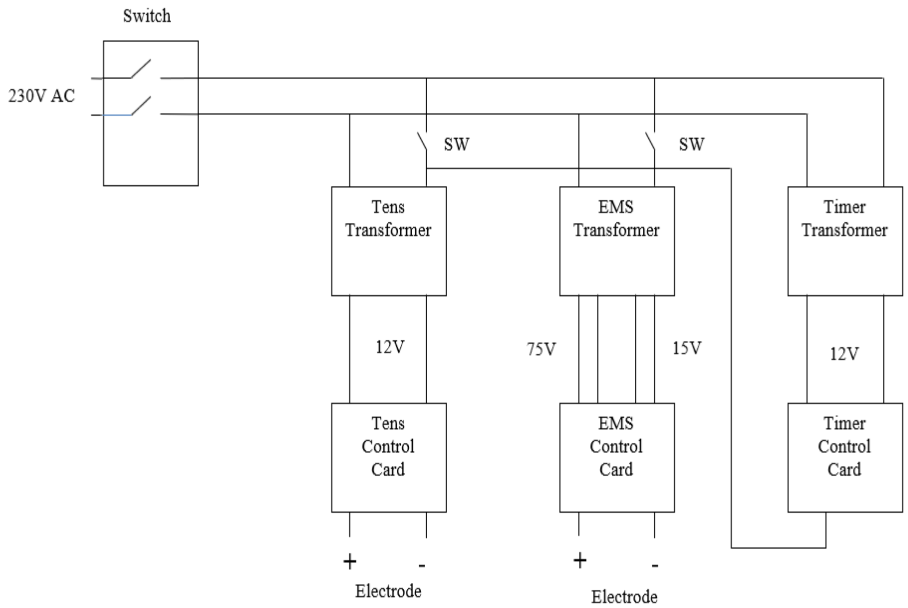


Fig: Block Diagram

7. HARDWARE REQUIREMENT

7.1 TENS

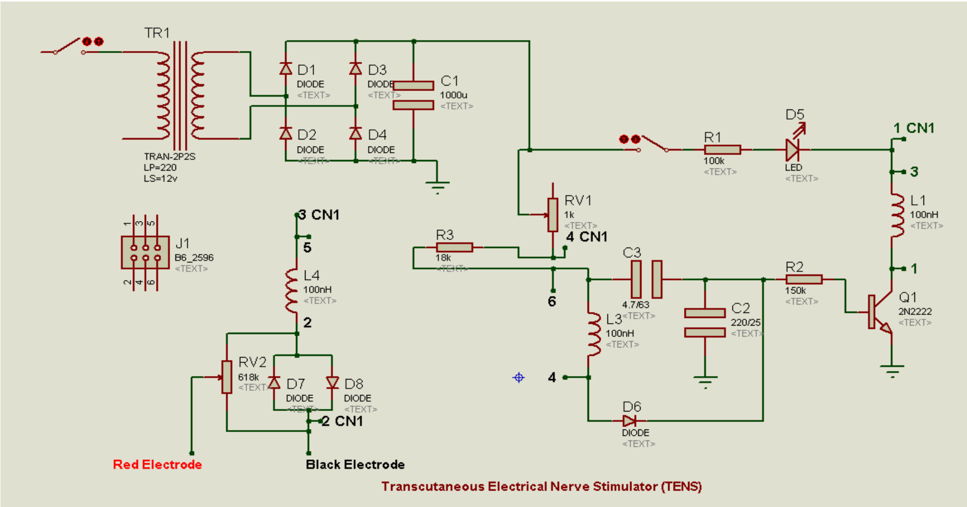


Fig: Transcutaneous Electrical Nerve Stimulator

7.2. EMS

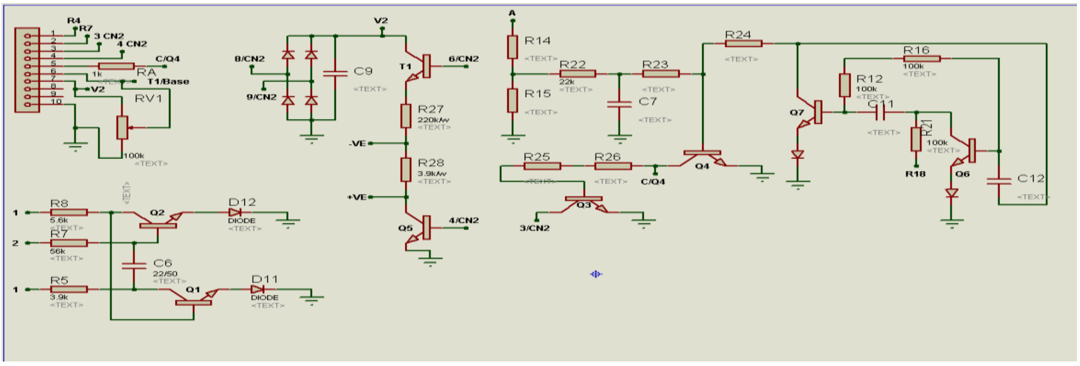


Fig: Electrical Muscle Stimulator (A/CH1)

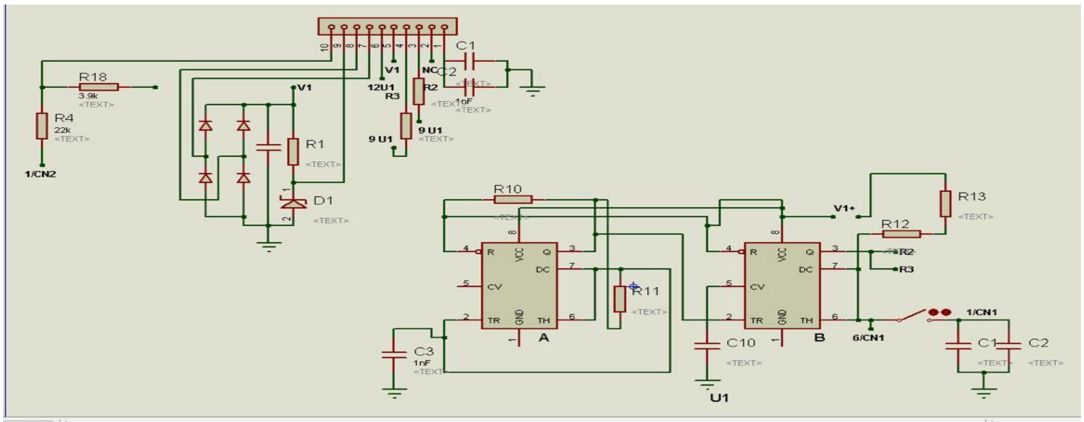


Fig: Electrical Muscle Stimulator (B/CH2)

7.3. Timer

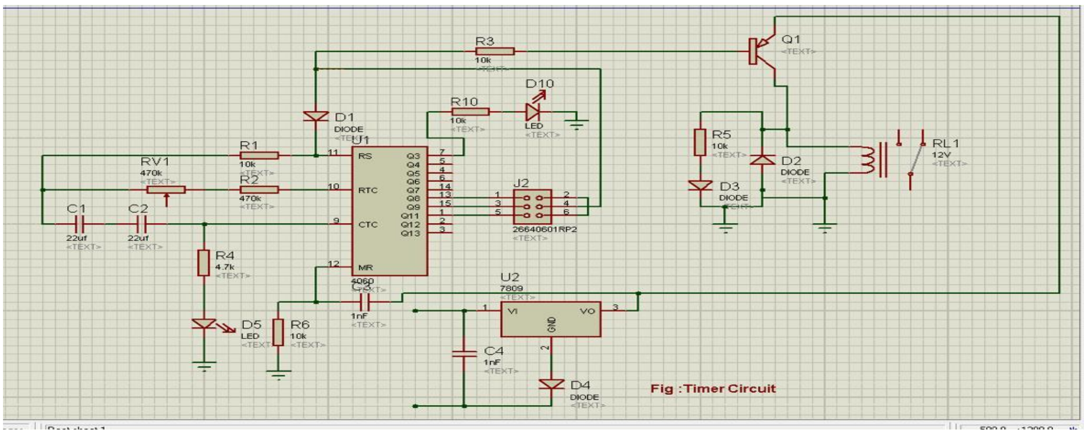


Fig: Timer Circuit

Circuit Details

The timer circuit designed using Ic4060. This is IC 4060 Timer circuit. The 14-stage binary ripple counter Type 4060, IC1, has an on-chip oscillator capable of stable operation over a relatively wide frequency range. In the present circuit, the oscillator frequency is determined by an external RC network connected to pins 9, 10 and 11. When the power is on, the pulse at junction R6-C3 resets the counter and counting starts. When the counter reaches bit 14 (Q13), the output of IC4060 goes high so that the relay is turned on via driver Q1. The output of allows 230 ac supply to TENS transformer and EMS transformer.

TENS

The transformer used in TENS circuit step down transformer. It converts 230v ac to 12v ac. This signal is converted to12v dc using bridge rectifier. Then this rectified signal is amplified and fed to base of transistor Q1.The output from the collector of Q1 and this signal is fed to primary of EI core transformer. The EI core transformer used is a step up transformer. This transformer works as oscillator .This oscillator gives signal up to 75v w.r.t. positive feedback.

EMS

The transformer used in this circuit gives two different voltages 15v and 75v at the secondary windings.15v signal connected to CH1 and 75v signal connected to CH2.The EMS circuit consist of two astable multi-vibrators. One multivibrator is designed using IC556 which is connected to CH1 and other is connected to CH2.

TENS Output Waveform:

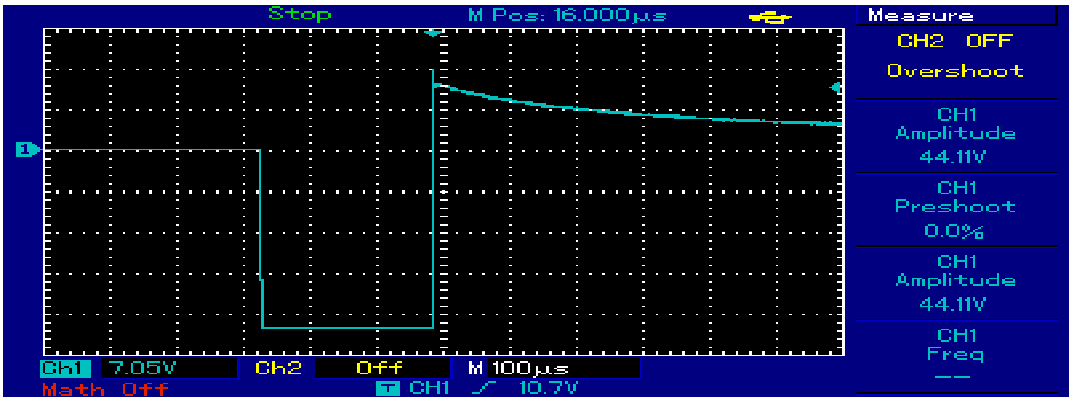


Fig: Transcutaneous Electrical Nerve Stimulator Output Waveform

EMS Output Waveform:

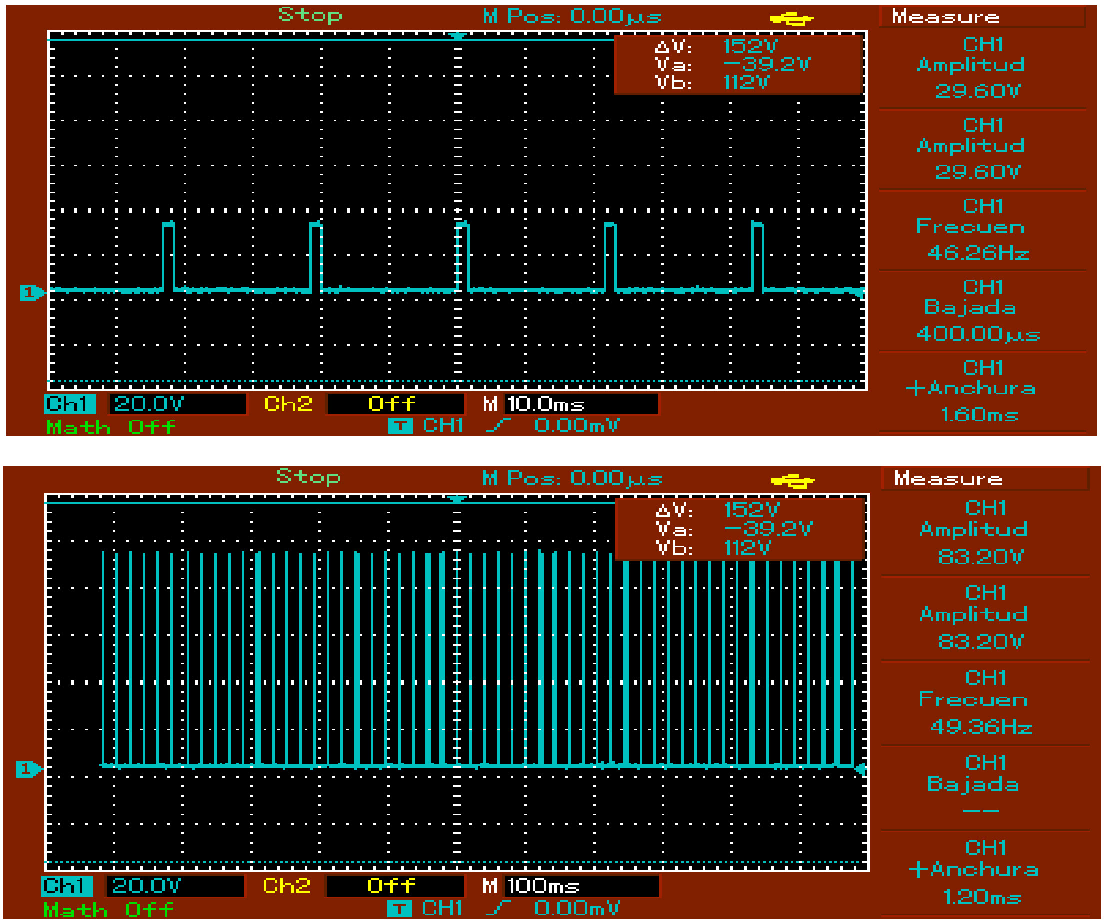


Fig: Electrical Muscle Stimulator Output Waveform

8. CONCLUSION

In this system, we developed two flexible electronic circuits. One is for Electric Muscle Stimulator (EMS) and other one is Transcutaneous Electric Nerve Stimulation (TENS). The output signal has wide range of variation of pulse width, amplitude and frequency. To conclude, electronic stimulators paved a way to the treatment which is less painful, more effective and with very less side effects as compared to the conventional treatments. It had proved very effective, especially for neural disorders and for treatment of pain. Moreover, it is easy to control by varying the frequency or intensity of the electronic signal given to it as an input. However, its use is still limited and not much used worldwide, so proper awareness and research needs to be done in this field.

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