



TENS is applied at high frequency (>50 Hz) with an intensity below motor contraction (sensory intensity) or low frequency (<10 Hz) with an intensity that produces motor contraction [7]. The benefit of TENS for pain management is controversial. TENS applied at low intensity-high frequency, as opposed to "acupuncture-like" TENS administered at high intensity-low frequency. Conventional and acupuncture-like TENS activated similar fiber types, predominantly in the A alpha beta range. Our findings suggested that the effects of these two types of TENS may be mediated by the activation of similar peripheral afferent fibers.

## 2. Microcontroller and Digital Technology in Electrotherapy

### 2.1 ATmega32

The ATmega32 provides the following features: 32Kbytes of In-System Programmable Flash Program memory with Read-While-Write capabilities, 1024bytes EEPROM, 2Kbyte SRAM, 32 general purpose I/O lines, 32 general purpose working registers, a JTAG interface for Boundary scan, On-chip Debugging support and programming, three flexible Timer/Counters with compare modes, Internal and External Interrupts, a serial programmable USART, a byte oriented two-wire Serial Interface, an 8-channel, 10-bit ADC with optional differential input stage with programmable gain, a programmable Watchdog Timer with Internal Oscillator, an SPI serial port, and six software selectable power saving modes.

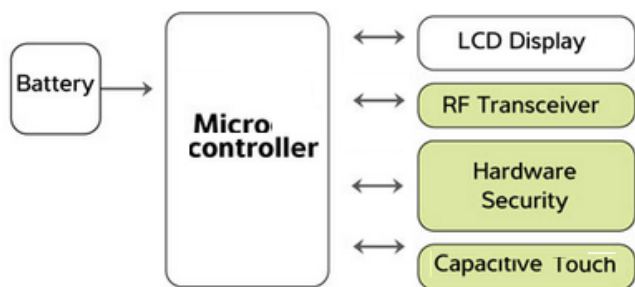


Figure 2: ATmega32 functions with battery, lcd, rf and hardware security

The On chip ISP Flash allows the program memory to be reprogrammed in-system through an SPI serial interface, by a conventional nonvolatile memory programmer, or by an On-chip Boot program running on the AVR core. By combining an 8-bit RISC CPU with In-System Self Programmable Flash on a monolithic chip, the Atmel ATmega32 is a powerful microcontroller that provides a highly-flexible and cost-effective solution to many embedded control applications. The Atmel AVR ATmega32 is supported with a full suite of program and system development tools including: C compilers, macro assemblers, program debugger/simulators, in-circuit emulators, and evaluation kits.

### 2.1 Multi channels digital electrotherapy for acupuncture DC-12 design

The team has designed functional block diagram of Multi channels digital electrotherapy for acupuncture DC-12 design in the figure 3 below:

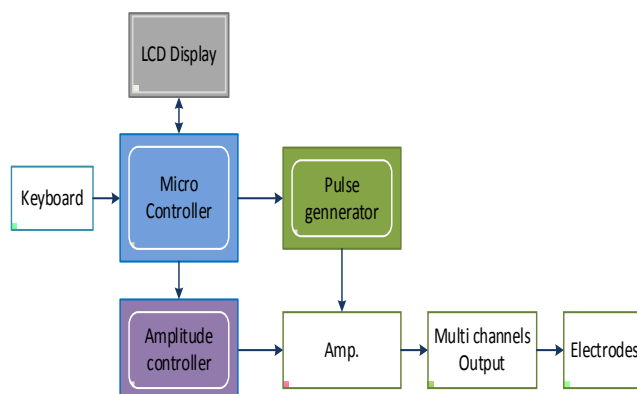


Figure 3: Multi channels digital electrotherapy for acupuncture DC-12 design.

- *LCD display*: This function blocks display parameters such treatment frequency display of pulse therapy, pulse therapy, duration of treatment.
- *Pulse generator*: This function blocks generate different pulse therapy serves as the pulsed oscillation stuffy, spikes, pulses aliasing. This unit also has the function to create modulation (changing) the frequency of the pulse is generated used to reduce the flow of patients.
- *Amplification controller*: This block amplifies the pulse shape was created from blocks around to gain amperage and voltage excitation stimulus large enough to meet the functional treatment.
- *Electrodes*: This block has the function of changing the amplitude of the pulse treatment to achieve a stimulating current intensity and voltage stimulation desired.
- *Multi Channels Output*: This block transfer function of stimulus in the form of electric current to the patient. This block also the entire grid voltage isolation from patients, increase electrical safety for the machine.
- *Amp*: This block can function as a primary controller entire operation of the device, set the function of the machine, the control order, timer and shutdown.
- *Keyboard*: This volume is the key, button, knob. Functional block is the input of the processing service orders, operation and machine operation.

## 3. Multi Channels Digital Electrotherapy for Acupuncture DC-12

### 3.1 Design Standard

The process of analysis and assessment and construction of the DC-12 device functions, the authors follow the European standards of IEEE, ISO and Vietnam standard for devices with embedded programming solutions in medical devices.

Table 1: DC-12 Design standard

No	Index	Standard rangers
1	Power	110 - 240V AC ± 10%
2	Frequence	50 - 60Hz
	Current Pulse	3W/cm2 ±20%
	Current cont.	2W/cm2±20%
	Size	295 x 240 x 108mm
	Weight	2kg

### 3.2 DC-12 Features

Multi channels digital electrotherapy for acupuncture DC-12 has the advantages such as:

- Safety for patients.
- There are electronic timer.
- Has charging system to ensure safety for patients and equipment
- Displays LCD display Vietnamese.
- Pulse frequency from 1Hz to 500Hz numbers, have the ability to adjust the frequency accuracy
- The pulse width maximum is 100 $\mu$ s.
- The intensity of the pulse stream reaches 30mA maximum output.

### 3.3 DC-12 Models



Figure 4: DC-12 front end and electrodes.



Figure 5: DC-12 power and outputs

## 4. Testing and Evaluation DC-12

### 4.1 Electrotherapy Current Output

Intensity is the output of electrotherapy distributed by the unit to the patient. Depending on the waveform, intensity is measured in milliamps (mA), volts (V), and micro amps ( $\mu$ A).

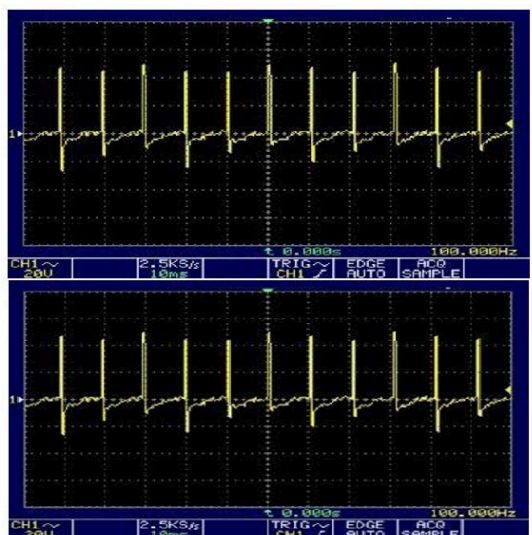


Figure 6: Testing DC-12 output current on oscilloscope.

The output from the machine is pulsed such that the ‘on’ time is considerably shorter than the ‘off’ time, thus the mean power delivered to the patient is relatively low even though the peak power (i.e. during the on pulses) can be quite high (typically around 15 – 20 Watts peak power with modern machines, though some still go up to 35W). The control offered by the machine will enable the user to vary (a) the mean power delivered to the patient and (b) the pulsing parameters governing the mode of delivery of the energy. It would seem from current research that the mean power is probably the most important parameter.

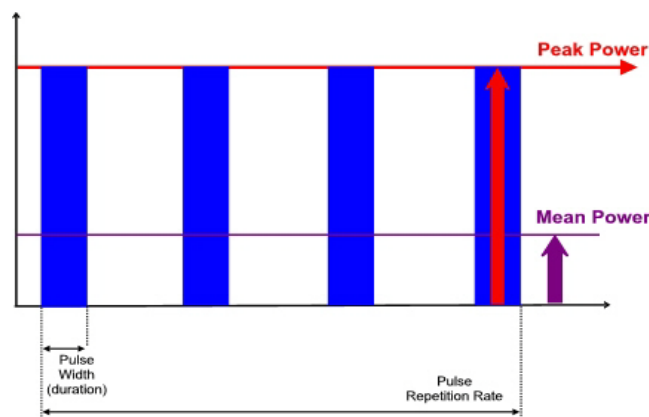
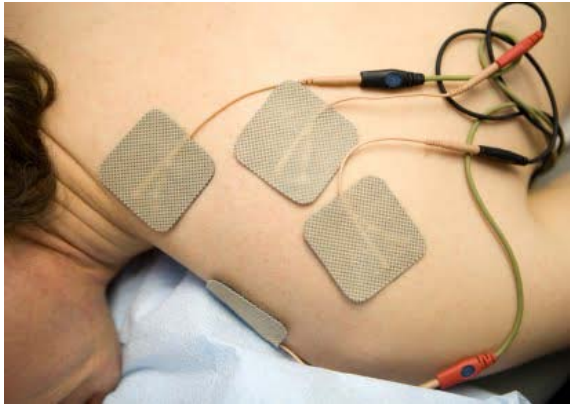


Figure 7: Calculate DC-12 output current

### 4.2 Testing and evaluation DC-12 in biomedical laboratory

Inspection process equipment in the laboratory level for consistent results. Line treatment was safe under the proposed threshold. Sense of line appeared continuous treatment. Effective treatment unsatisfactory. There are still some minor glitches in the quality of electrodes and contacts. Equipment is designed with plastic and rubber soles not very good.



**Figure 8:** Testing and evaluation DC-12 in biomedical laboratory

Electrophysiologic Testing (Third ed.). Lippincott Williams & Wilkins. ISBN 0781744849.

- [7] Josimari M. DeSantana, PT, PhD, Deirdre M. Walsh, PT, PhD, Carol Vance, PT, MSc, Barbara A. Rakel, RN, PhD, and Kathleen A. Sluka, PT, PhD (December 2008). "Effectiveness of Transcutaneous Electrical Nerve Stimulation for Treatment of Hyperalgesia and Pain". *Curr Rheumatol Rep* 10 (6): 492–499. doi:10.1007/s11926-008-0080-z. PMC 2746624. PMID 19007541

General evaluation, equipment design standards and ensure electrical safety. Output number 6 top, serve many different therapeutic purposes. These are improvements that similar devices on the market do not have.

## 5. Conclusions

After research efforts and systems builders "Multi channels digital electrotherapy for acupuncture DC-12", finally we have complete finished product, machine inherits the outstanding features of the models on the market. Equipment using advanced ATmega128 processor, the ability to display the number on the LCD and the various treatment regimens.

DC-12 device with high accuracy, functioning warned of the treatment period, allowing the choice of pulse therapy patients avoid the familiar line, easy to use, and especially the cost of just one-third of imported exchange. Certainly in the near future, with the continuous efforts of our machines will become more complete, with the great value that it brings, certain "magnet electrical machines digital "will be available in all countries worldwide.

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