

Chapter 11

Safety System Design Simulation for Transcutaneous Electrical Nerve Stimulator using Electrode Contact Test

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ABSTRACT

TENS (Transcutaneous Electrical Nerve Stimulator) is a therapeutic device used to deliver electric current through one's skin. As the device is used on the human body, safety concern becomes a matter that needs special attention. One option for electrical safety is testing whether the electrode has attached properly to the skin. The test is done in the interval of the simulator pulse. This option is used to protect users from electrical shock that can be caused from this device. Using 74HC4066 as the analog switch, this design can support the TENS specification.

INTRODUCTION

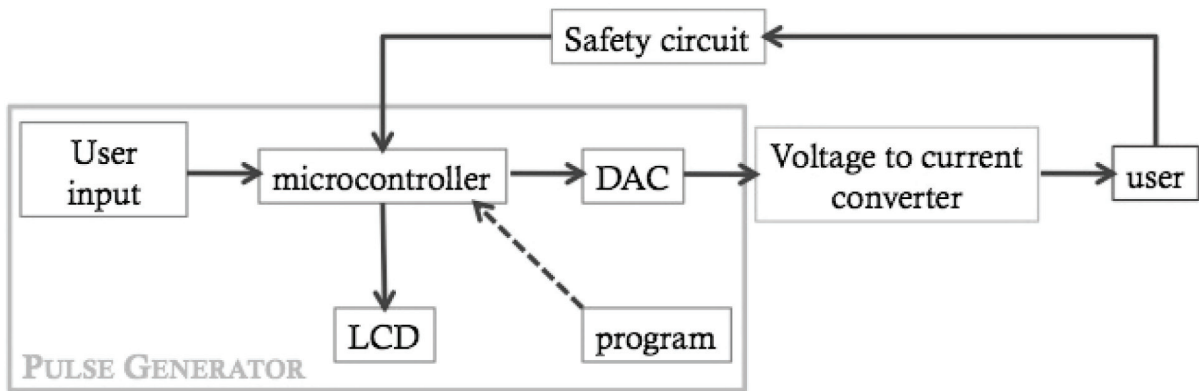
The purpose of medical equipment is to monitor, treat patient, and improve their condition. Nowadays, medical equipments are mostly automated as electronic control provides high precision and lifetime. Thus, the safety of the device that is use electricity should also be considered, to avoid electrical hazard that can be dangerous and cause death.

OVERVIEW

By definition, any stimulating device that delivers electrical currents across the intact surface of the skin is TENS (Johnson, 2007). In medical term, TENS is one of a simple non-invasive analgesic technique that is used to decrease pain sensation in many conditions such as labor pain, chronic pain, and acute pain. TENS is widely use as its non-invasive characteristic, easy to use, and less of side effects.

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Figure 1. Systems block diagram (Soedirdjo, 2009)



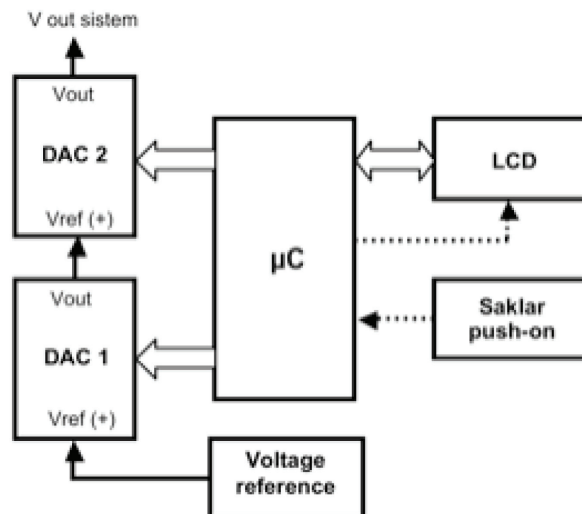
The electrical characteristics of TENS are chosen with a view to selectively activate different populations of nerve, as this is believed to produce different analgesic outcomes. A standard TENS device provides a range of possible ways that TENS currents could be delivered.

TENS provide four shape of electric current: monophasic, symmetric biphasic, asymmetric biphasic, and spike like biphasic. This electric current is produced with pulse duration within 100 μ s and 1000 μ s, pulse frequency within 2 pulses per second and 200 pulses per second. The

electric pulse is generated in three pattern such as continuous, burst, and amplitude modulation. The amplitude of electric current can also be adjusted from -50mA to 50mA with maximum load of 500 Ω .

Melzack and Wall (1965) provide a physiological rationale for electro analgesic effects. They said that the transmission of pain stimulus could be inhibited by activation of peripheral afferent with big diameter or by activation of descending pain inhibitory pathways.

Figure 2. Microcontroller-based pulse generator (Putra, 2005)



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