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

Mervin T. Hutabarat, Institut Teknologi Bandung, Indonesia
Subaryani D. H. Soedirdjo, Institut Teknologi Bandung, Indonesia

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.

Keywords: Electrical Safety, Electrical Shock, Skin Electrode, TENS, Therapeutic Devices

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.

DOI: 10.4018/jehmc.2010070108

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.

The electrical characteristics of TENS are chosen with a view to selectively activate dif-
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 µs and 1000µs, 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 500Ω.

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.

**THE CIRCUIT**

This instrument can be divided to three main units (Soedirdjo & Hutabarat, 2009). There are signal generator unit, voltage to current converter unit, and protection unit (Figure 1). The specifications are provided in Table 1.

Signal generator unit: composed from a microcontroller, digital to analogue converter (DAC), and LCD. The function of this part is to generate particular signal. Microcontroller produced by ATMEL with type of AT89S8252 is used for its big flash memory to save the program. The program use assembly language with look up table to forming signal. An LCD is attached to the microcontroller as an interface to users.

DAC provide a conversion from digital data to analog data. Total bit used in DAC imply the resolution of the instrument. To support the specification, a 16-bit DAC is needed. As 16 bit DAC is an expensive component, it is replaced with 8 bit DAC with cascade configuration.

---

*Figure 1. Systems block diagram (Soedirdjo, 2009)*

*Table 1. Specification of the system*

<table>
<thead>
<tr>
<th>Pulse Shape</th>
<th>monophasic, symmetric biphasic, asymmetric biphasic, spike-like biphasic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output pattern</td>
<td>continuous, burst, amplitude modulation</td>
</tr>
<tr>
<td>Amplitude</td>
<td>-50mA to 50mA</td>
</tr>
<tr>
<td>Frequency</td>
<td>10 – 250 Hz</td>
</tr>
<tr>
<td>Active pulse duration</td>
<td>10 -1000µs</td>
</tr>
<tr>
<td>Maximum load</td>
<td>500Ω</td>
</tr>
</tbody>
</table>

---

Copyright © 2010, IGI Global. Copying or distributing in print or electronic forms without written permission of IGI Global is prohibited.
Rhetoric of Private Healthcare Offers Presented to SMEs over the Internet
www.igi-global.com/chapter/rhetoric-private-healthcare-offers-presented/40665?camid=4v1a

Virtual Reality for Supporting Surgical Planning
www.igi-global.com/chapter/virtual-reality-supporting-surgical-planning/40668?camid=4v1a