A8 – 1

DESIGN OF GENERAL PURPOSE SAR MONITOR

Kang-Hyun Lee[1], Yong-Sik Kim[1], Jung-Il Park[1], Kim Sung-Eun Choi[1], Heung-Kyu Lee[1,2]
Tae-Suk Suh[2], Bo-Young Choe[2], Hyoung-Koo Lee[2]

1. Hanme System,
2. Dept. of Biomedical Engineering, The Catholic University, 505 Banpo-dong, Seocho-ku, Seoul 137-701, Korea

INTRODUCTION

It is well known that the RF power is deposited in the human body during the RF puls e excitation due to the finite small electrical conductivity of biological tissue . The RF Power is principally deposited as joule heating associated with induced currents by the R F inductive field. Consequently, it is mandatory to facilitate an accurate and fault free SA R monitor for the patient safety. Among the conventional SAR monitors, the analog vers ion is not satisfactory due to the insufficient accuracy and flexibility. On the contrary, th e digital version of SAR monitor is usually vendor and magnetic field dependant and not flexible enough. It is the aim of the study to design a SAR monitor which is truly fle xible, compatible to various magnetic field intensities and suitable for the stand-alone ope ration.

METHOD

For the design of SAR monitor, the 68302 16 bits microprocessor was adopted mainly f or the faster RF power calculation and the flexible communication with external worlds i ncluding a host computer, a SAR display unit and a RF amplifier. The three different in put options, directional coupler, RF power sensor or RF power-meter, are provided for its flexible operation. For the 8 bits analog to digital converter, the National ADC0801 wa s used. Two serial ports and one bi-directional digital I/O port were included considering either the stand-alone or loosely coupled multi-processor operation. Owing to the enhan ced computing power, the computing accuracy and response time could be improved towa rd a real time SAR monitor. A self-diagnostic software and hardware set was included f or the purpose of fault free operation.

The operational procedure is as follows. As a prior information, all the calibration data such as the power losses of RF cables and coils, the coupling constant of directional po wer and etc. are stored in the designated area of SAR monitor. Per scan, the SAR moni tor acquire the scan parameters such as the coil identification, pulse duration and intensit y, repetition time, number of slice and weight of the object in the coil from the host co mputer via either a serial or a digital port. In the situation of object in the RF coil, the peak power is calculated as

$$P_{object} = P_{(forward)} - P_{(reflected)} - P_{coil} \quad (1)$$

During the MR scan, the SAR monitor continuously measures the RF power delivered to the object and calculates the average power (P_{avg}) as

$$SAR = P_{avg} / W$$

where W represents the weight of object. (2)

In the case of power deposition above the FDA limit, the SAR monitor immediately disa bles the RF amplifier and interrupts the host computer to notify the overpower and abort the MR scan.

.RESULT

The SAR monitor was applied to the 3.0 T MRI. For the volunteer brain scan, the spin echo pulse sequence was used with scan parameters of TR 500ms, 15 slices and volunteer's weight 62 Kg..

DISCUSSION

The RF pulse duration's are 4.6 ms at 90° and 3.9 ms at 180° flip angle. The calculated SAR averaged value was 2.53 W/Kg which was below the standard limit of 3.2 W/Kg in the FDA guideline and 3.0 W/Kg in the European standard
Among the conventional SAR monitors, the analog version is not satisfactory due to the insufficient accuracy and flexibility

CONCLUSION

We have designed and tested a general purpose SAR monitor fully flexible to various MRI's at different magnetic fields without any modification. It can be also utilized for the other power measurement applications by a minor software modification.