

휴대폰 전파 SAR 자동 측정장치 구현

박위상 교수

전자전기공학과
전자파특화연구센터
포항공과대학교

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Contents

- **Specific Absorption Rate**
- **System Configuration**
- **Probe**
- **Calibration**
- **Conclusion**

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SAR Definition

- **SAR : Rate of RF absorption over time in a small volume of tissue of given weight**
- **$SAR = \sigma |E|^2 / \rho$**
 - σ : Conductivity (S/m)**
 - ρ : Tissue Density (g/m³)**
 - E : Electric Field Intensity (rms V/m)**
- **ANSI Standard for 1g Tissue**
 - Averaged over whole body : 0.08 W/kg**
 - Local peak level : 1.6 W/kg**

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System Requirement

- **SAR automated measurement system is based on a highly accurate computer controlled robotic arm with position repeatability of 0.1mm.**
- **The robot is used to position a high sensitivity E-field probe inside a human-shaped phantom filled with a liquid having the electrical characteristics of human brain or muscle tissue.**

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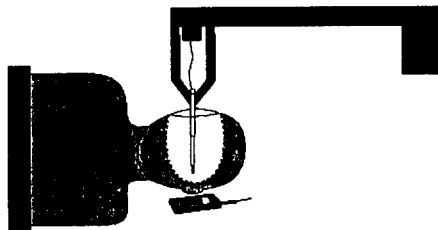
Components for Measurement

- **Isotropic E-Field Probes**
- **Automated Positioning System**
- **Calibration Set**
- **Tissue Equivalent Material**

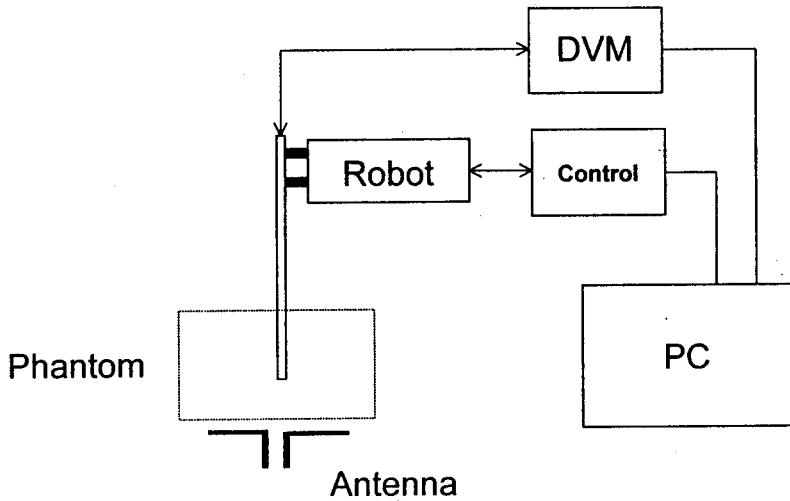
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Typical SAR Measurement Setup

SAR MEASUREMENT SETUP



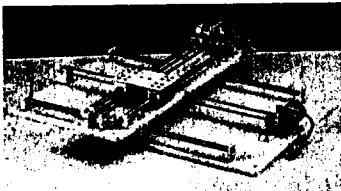
SAR Measurement Block Diagram



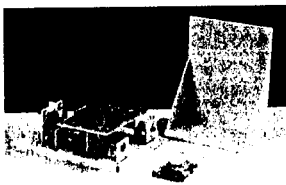
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3-Axis Positioner

XY-Stage



Z-Stage



Manufacturer :

Arrick Robotics

- **Travel Distance :**
9 inch (X,Y axis), 2 inch (Z-axis)
- **Accuracy :** 0.01" /inch.
- **Repeatability :** 0.005"
- **Resolution :** 0.05" / step
- **Speed :** 2" / sec

E-Field Measurement

- **Direct Measurement of E-Field in Tissue Simulated Phantom**
- **E-Field based dosimetry requires specialized equipment like non-perturbing probes and accurate positioning.**

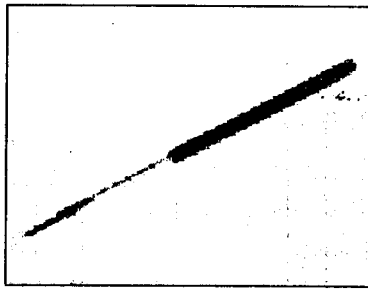
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Requirement for Probe

- **Non-Perturbing EM Field**
- **Isotropic Response**
- **Small Size**
- **High Sensitivity**
- **Reliable**

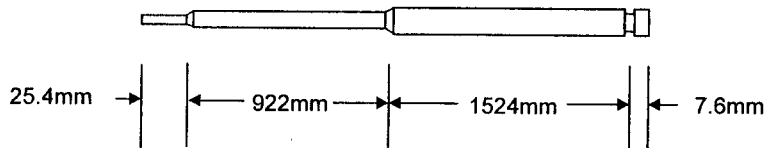
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Miniature E-Field Probe



Specification

- Operating Frequency :
400MHz - 26GHz
- Probe Output :
1.0mV \pm 0.3mV for 1mW/cm²
- Isotropic Response : \pm 1dB



Probe Calibration

- Flat phantom simulation by FDTD code
- Determination of conversion Factor between FDTD and measured data

Calibration Factor

- $V_i = B_M E_i^2 ; i=1,2,3$
- $V_T = V_1 + V_2 + V_3 = B_M E_T^2$
- $SAR = C_M V_T$

where

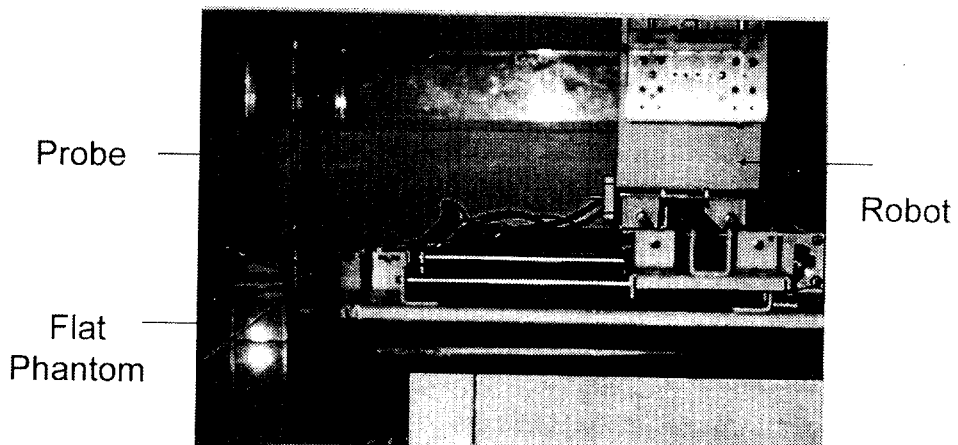
V_i : Measured Voltage induced at Probe

E_i : Calculated Electric Field by FDTD

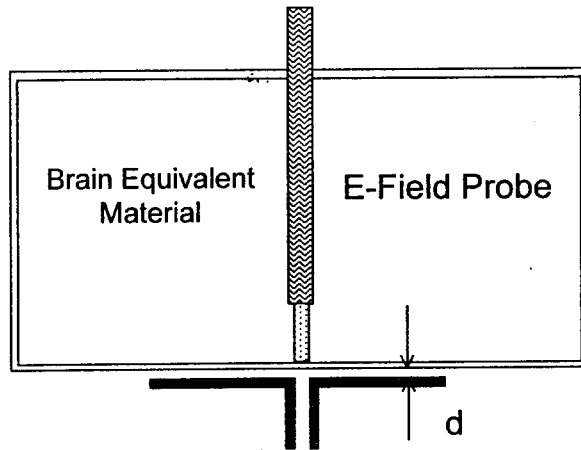
B_M : Conversion factor depending on media filled

C_M : Calibration Factor

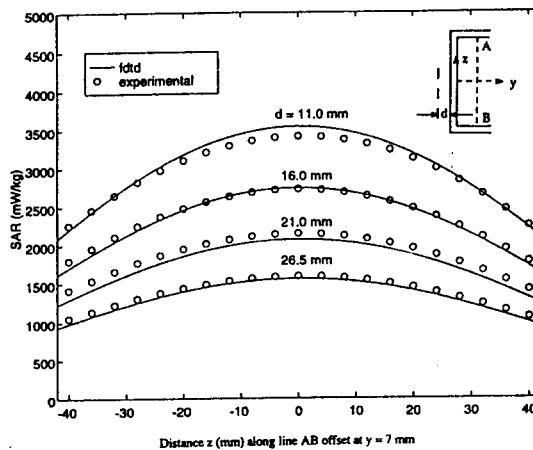
SAR Calibration Setup



Calibration of E-Field Probe Using Dipole Antenna with Flat Phantom

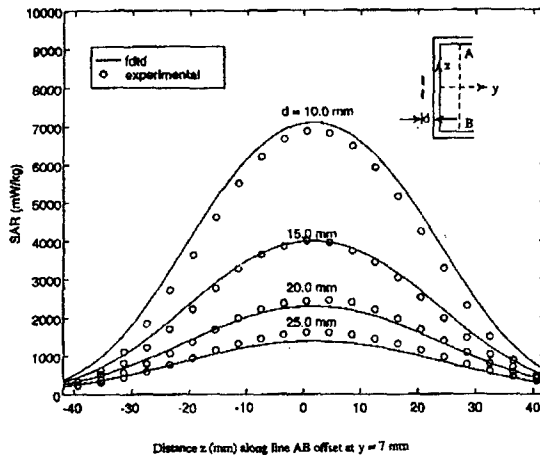


Calculated and Measured SAR Variations (840MHz)



- Dimension: 30x15x50cm
- Calibration Factor: 0.49(mW/kg)/ μ V

Calculated and Measured SAR Variations (1900MHz)



- Dimension: 30x15x50cm
- Calibration Factor: 0.849(mW/kg)/ μ V

결론

- 휴대폰 전파 SAR 자동 측정장치를 포지셔너, 프로우브 및 팬텀을 이용하여 구현하였다.
- 모형 팬텀을 FDTD 로 수치해석한 결과와 측정된 결과를 비교하여 Calibration 지수를 구하였다.
 - ⇒ 0.40(mW/kg/ μ V) at 840MHz
 - ⇒ 0.84(mW/kg/ μ V) at 1900MHz