

UNDP-1 Module with host HP HSTNN-Q44C SAR Probe/Dielectric Material Analysis

Introduction

According to FCC KDB450824 , if the probe used for SAR testing is >50Mhz from center frequency of the measured band, the dielectric property of tissue should be evaluated to ensure that they are within +/- 5% tolerance of target value as provided in IEEE1528.

Dielectric Properties

The following plots show dielectric properties permittivity (ϵ_r) and conductivity (σ) of body simulating liquid as measured at the time of testing.

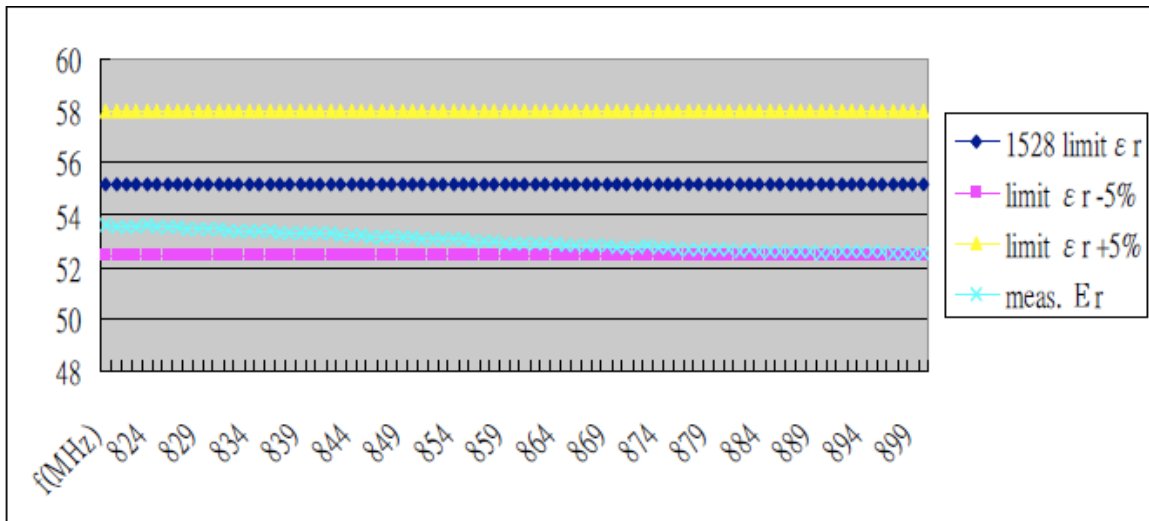
BODY (835MHz)

Permittivity

IEEE1528 limit: 55.2

Limit +5%: 57.96

Limit -5%: 52.44

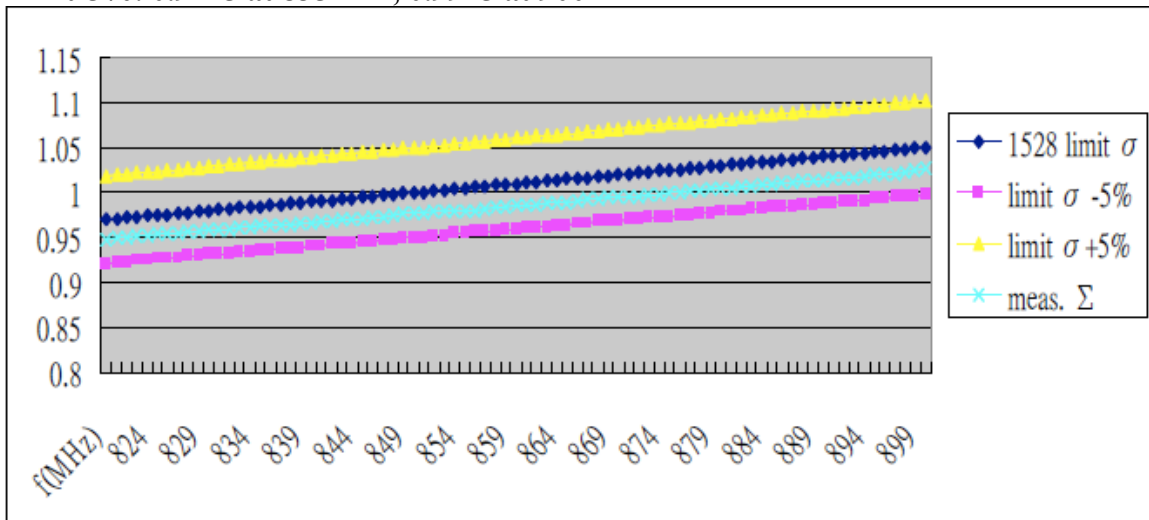


Conductivity

IEEE1528 limit: 0.97 at 835Mhz , 1.05 at 900Mhz

Limit +5%: 1.0185 at 835Mhz , 1.1025 at 900Mhz

Limit -5%: 0.9215 at 835Mhz , 0.9975 at 900Mhz



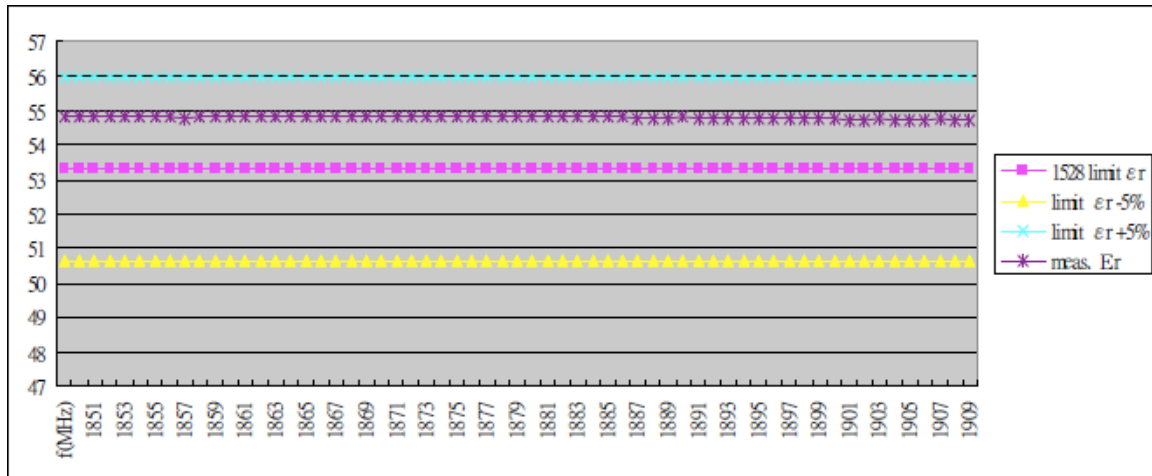
BODY (1900MHz)

Permittivity

IEEE1528 limit: 53.3

Limit +5%: 55.965

Limit-5%: 50.635

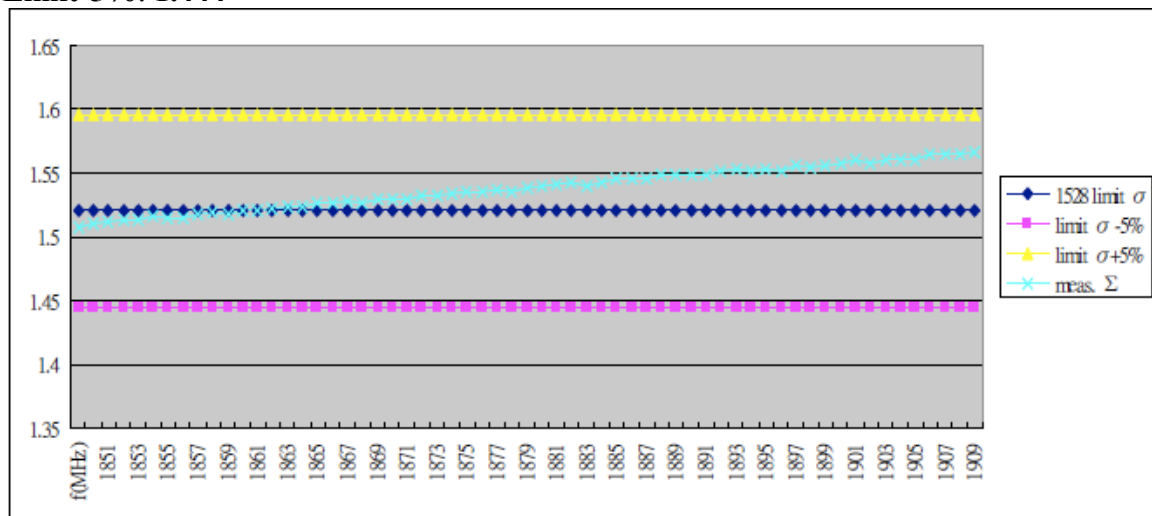


Conductivity

IEEE1528 limit: 1.52

Limit +5%: 1.596

Limit-5%: 1.444



The graphs above show that measured permittivity and conductivity values stayed within their respective tolerances of $\pm 5\%$ of target as required by KDB 450824. Then SAR is recalculated, considering the variation of σ (conductivity) and ϵ (permittivity) from target.

The SAR values measured at their respective frequencies are listed below.

Band	Channel	Frequency (MHz)	Conducted Output Power (Average dBm)	Measured 1-g SAR (W/kg)
835 MHz	128	824.2	25.4	0.041
	190	836.6	25.6	0.061
	251	848.8	25.6	0.069

Band	Channel	Frequency (MHz)	Conducted Output Power (Average dBm)	Measured 1-g SAR (W/kg)
1900 MHz	25	1851.25	24.89	0.064
	600	1880	24.87	0.068
	1175	1908.75	24.82	0.074

The liquid properties and their errors to target value for the above frequencies are listed below (data from the first two pages, from real measurement of liquid)

f (MHz)	1528 target ϵ_r	Measured ϵ_r	Delta %	Target σ	Measured σ	Delta %
824	55.2	55.8	1.09%	0.97	0.967	-0.31%
837	55.2	55.7	0.91%	0.97	0.982	1.24%
849	55.2	55.6	0.72%	0.97	0.991	2.16%

f (MHz)	1528 target ϵ_r	Measured ϵ_r	Delta %	Target σ	Measured σ	Delta %
1851	53.3	53.1	-0.38%	1.52	1.53	0.66%
1880	53.3	53.1	-0.38%	1.52	1.56	2.63%
1909	53.3	53	-0.56%	1.52	1.6	5.26%

With the SAR sensitivity calculation formula,

$$S(x) = \frac{dSAR/SAR}{dx/x},$$

rearranged to solve for dSAR:

$$dSAR = SAR \left[\left(sensitivity_{\epsilon} \times \frac{dx}{x_{\epsilon}} \right) + \left(sensitivity_{\sigma} \times \frac{dx}{x_{\sigma}} \right) \right]$$

and the sensitivity table in IEEE1528:

Parameter	ϵ	σ	ρ
f=1900 MHz, d=10 mm			
($\epsilon_r=40.0$, $\sigma=1.40$ S/m)			
SAR Peak	- 0.73	+ 0.93	-
SAR 1 g	- 0.53	+ 0.51	0.14
SAR 10 g	- 0.39	+ 0.22	0.24
f=800 MHz, d=15 mm			
($\epsilon_r=41.5$, $\sigma=0.90$ S/m)			
SAR Peak	- 0.70	+ 0.86	-
SAR 1 g	- 0.57	+ 0.59	0.10
SAR 10 g	- 0.45	+ 0.35	0.18

The following table was created using the equation for dSAR above.

f (MHz)	sensitivity ϵ_r	dx/x(ϵ_r)	sensitivity (σ)	dx/x(σ)	Measured SAR	dSAR	Recalculated SAR
824.2	-0.57	1.09%	0.59	-0.31%	0.041	-0.000329	0.040671
836.6	-0.57	0.91%	0.59	1.24%	0.061	0.000130	0.061130
848.8	-0.57	0.72%	0.59	2.16%	0.069	0.000596	0.069596
1851.25	-0.53	-0.38%	0.51	0.66%	0.064	0.000342	0.064342
1880	-0.53	-0.38%	0.51	2.63%	0.068	0.001048	0.069048
1908.75	-0.53	-0.56%	0.51	5.26%	0.074	0.002207	0.076207

Below are modified SAR tables showing measured and recalculated SAR values.

Band	Channel	Frequency (MHz)	Conducted Output Power (Average dBm)	Measured 1-g SAR (W/kg)	Recalculated 1-g SAR (W/kg)
835 MHz	128	824.2	25.4	0.041	0.040671
	190	836.6	25.6	0.061	0.061130
	251	848.8	25.6	0.069	0.069596

Band	Channel	Frequency (MHz)	Conducted Output Power (Average dBm)	Measured 1-g SAR (W/kg)	Recalculated 1-g SAR (W/kg)
1900 MHz	25	1851.25	24.89	0.064	0.064342
	600	1880	24.87	0.068	0.069048
	1175	1908.75	24.82	0.074	0.076207

End of Analysis.