Answer A

SAR DATA SUMMARY (Continued)

Mixture Type: 835MHz Brain

Dielectric Constant: 43.44

Conductivity: 0.87

14.3 MEASUREMENT RESULTS (AMPS Left Head SAR - Touch)

FREQUENCY		Modulation	Begin / End POWER‡			Device Test Position	Antenna Position	SAR (W/kg)
MHz	Ch.		(dBm)		Battery			
824.04	0991	AMPS	26.0	26.0	Standard	Cheek / Touch	In	**1.03**
824.04	0991	AMPS	26.0	26.0	Standard	Cheek / Touch	Out	**0.39**
836.49	0383	AMPS	26.0	26.0	Standard	Cheek / Touch	In	**1.20**
836.49	0383	AMPS	26.0	26.0	Standard	Cheek / Touch	Out	**0.49**
848.97	0799	AMPS	26.0	26.0	Standard	Cheek / Touch	In	**1.31**
848.97	0799	AMPS	26.0	26.0	Standard	Cheek / Touch	Out	**0.76**
848.97	0799	AMPS	26.0	26.0	Extended	Cheek / Touch	In	**1.26**
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population						**Brain 1.6 W/kg (mW/g)** averaged over 1 gram		

NOTES:

1. The test data reported are the worst-case SAR value with the antenna-head position set in a typical configuration. Test procedures used are according to FCC/OET Bulletin 65, Supp.C [July 2001].
2. All modes of operation were investigated, and worst-case results are reported.
3. Battery is fully charged for all readings.

	‡Power Measured	☒	Conducted	☐	ERP	☐	EIRP
4.	SAR Measurement System	☐	DASY3	☒	IDX	☐	
	Phantom Configuration	☒	Left Head	☐	Flat Phantom	☐	Right Head
5.	SAR Configuration	☒	Head	☐	Body	☐	Hand
6.	Test Signal Call Mode	☒	Manu. Test Codes	☐	Base Station Simulator		

Randy Ortanez
President

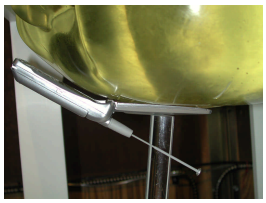

Figure 14.3 Left Head SAR Test Setup -- Cheek / Touch Position --

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SAR DATA SUMMARY (Continued)

Mixture Type: 835MHz Brain

Dielectric Constant: 43.44

Conductivity: 0.87

14.5 MEASUREMENT RESULTS (CELLULAR CDMA Right Head SAR – Touch)

FREQUENCY		Modulation	Begin / End POWER‡			Device Test Position	Antenna Position	SAR (W/kg)
MHz	Ch.		(dBm)		Battery			
848.31	0777	CDMA	25.5	25.5	Standard	Cheek / Touch	In	**1.11**
848.31	0777	CDMA	25.5	25.5	Standard	Cheek / Touch	Out	**0.68**
848.31	0777	CDMA	25.5	25.5	Extended	Cheek / Touch	In	**1.09**
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population						**Brain 1.6 W/kg (mW/g)** averaged over 1 gram		

NOTES:

1. The test data reported are the worst-case SAR value with the antenna-head position set in a typical configuration. Test procedures used are according to FCC/OET Bulletin 65, Supp.C [July 2001].
2. All modes of operation were investigated, and worst-case results are reported.
3. Battery is fully charged for all readings.

‡Power Measured	☒ Conducted	☐ ERP	☐ EIRP	
4. SAR Measurement System	☐ DASY3	☒ IDX	☐	
Phantom Configuration	☐ Left Head	☐ Flat Phantom	☒ Right Head	
5. SAR Configuration	☒ Head	☐ Body	☐ Hand	
6. Test Signal Call Mode	☒ Manu. Test Codes	☐ Base Station Simulator		

Randy Ortanez
President

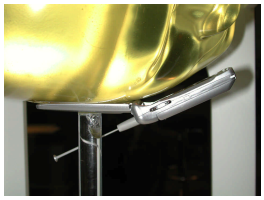

Figure 14.5 Right Head SAR Test Setup -- Cheek / Touch Position --

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SAR DATA SUMMARY (Continued)

Mixture Type: 1900MHz Brain

Dielectric Constant: 40.29

Conductivity: 1.44

14.10 MEASUREMENT RESULTS (PCS CDMA Left Head SAR – Touch)

FREQUENCY		Modulation	Begin / End POWER‡			Device Test Position	Antenna Position	SAR (W/kg)
MHz	Ch.		(dBm)		Battery			
1851.25	0025	CDMA	25.0	25.0	Standard	Cheek / Touch	In	**1.00**
1851.25	0025	CDMA	25.0	25.0	Standard	Cheek / Touch	Out	**0.45**
1880.00	0600	CDMA	25.0	25.0	Standard	Cheek / Touch	In	**1.09**
1880.00	0600	CDMA	25.0	25.0	Standard	Cheek / Touch	Out	**0.57**
1908.75	1175	CDMA	25.0	25.0	Standard	Cheek / Touch	In	**1.40**
1908.75	1175	CDMA	25.0	25.0	Standard	Cheek / Touch	Out	**0.57**
1908.75	1175	CDMA	25.0	25.0	Extended	Cheek / Touch	In	**1.31**
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population						**Brain 1.6 W/kg (mW/g)** averaged over 1 gram		

NOTES:

1. The test data reported are the worst-case SAR value with the antenna-head position set in a typical configuration. Test procedures used are according to FCC/OET Bulletin 65, Supp.C [July 2001].
2. All modes of operation were investigated, and worst-case results are reported.
3. Battery is fully charged for all readings.

	‡Power Measured	☒	Conducted	☐	ERP	☐	EIRP
4.	SAR Measurement System	☐	DASY3	☒	IDX	☐	
	Phantom Configuration	☒	Left Head	☐	Flat Phantom	☐	Right Head
5.	SAR Configuration	☒	Head	☐	Body	☐	Hand
6.	Test Signal Call Mode	☒	Manu. Test Codes	☐	Base Station Simulator		

Randy Ortanez
President

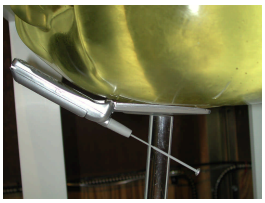

Figure 14.10 Left Head SAR Test Setup -- Cheek / Touch Position --

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Answer B

4. Probe Calibration Process

Dosimetric Assessment Procedure

Each E-Probe/Probe amplifier combination has unique calibration parameters. A TEM calibration procedure is conducted to determine the proper amplifier settings to enter in the probe parameters. The amplifier settings are determined for a given frequency by subjecting the Probe to a known E-field density (1mW/cm^2) using an RF Signal generator, TEM cell, and RF Power Meter. The SAR measurement software is used for Probe calibration.

Free Space Assessment

The free space E-field from amplified probe outputs is determined in a test chamber. This calibration can be performed in a TEM cell if the frequency is below 1 GHz and in a waveguide or some other methodologies above 1 GHz for free space. For the free space calibration, we place the probe in the volumetric center of the cavity and at the proper orientation with the field. We then rotate the probe 360 degrees until the three channels show the maximum reading. The power density readings equates to 1mW/cm^2.

Temperature Assessment*

E-field temperature correlation calibration is performed in a flat phantom filled with the appropriate simulated brain tissue. The measured free space E-field in the medium correlates to temperature rise in a dielectric medium. For temperature correlation calibration a RF transparent thermistor-based temperature probe is used in conjunction with the E-field probe (see Fig. 4.2).

$$\text{SAR} = C\frac{\Delta T}{\Delta t}$$

where:

Δt = exposure time (30 seconds),

C = heat capacity of tissue (brain or muscle),

ΔT = temperature increase due to RF exposure.

SAR is proportional to $\Delta T / \Delta t$, the initial rate of tissue heating, before thermal diffusion takes place. Now it's possible to quantify the electric field in the simulated tissue by equating the thermally derived SAR to the E- field;

$$\text{SAR} = \frac{|E|^2 \cdot s}{r}$$

where:

σ = simulated tissue conductivity,

ρ = Tissue density (1.25 g/cm^3 for brain tissue)

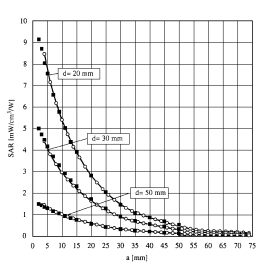

Figure 4.1 E-Field and Temperature measurements at 900MHz [7]

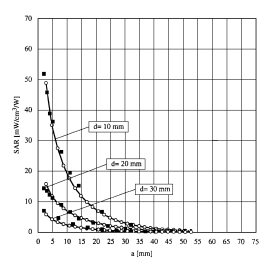

Figure 4.2 E-Field and temperature measurements at 1.9GHz [7]

NOTE: The temperature calibration was not performed by PCTEST. For information use only.

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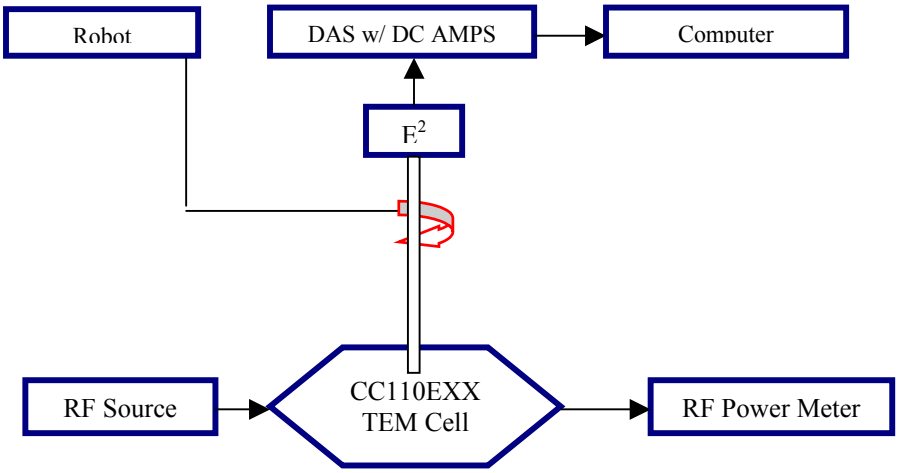
FREE SPACE CALIBRATION

Sensitivities are determined under the waveguide (free space) calibration feature of the software. The free space calibration determines the output from each of the probe channels in the known RF field.

Test Configuration:



Determining the E-field from Amplified Probe Outputs

The power density of the field in the TEM is set to 1 mW/cm^2.
The probe is rotated 360° in 10° increments.
The voltage output of each channel is recorded at each rotation.
The following are the equations used to find the sensititvity of each channel of the probe:

$$V_{avg} = ((V_{maxn} - OFF_n) + (V_{max2n} - OFF_n)) / 2$$
$$\eta_n = V_{avgn} / \sin^2(DA) / AmpGain_n$$

Where η is the sensitivity for channel *n* (mV/(mW/cm^2)).

DA=Dipole Angle (nominally 54.7^o)
V_{maxn} = maximum voltage recorded for channel *n* during a 360° rotation of the probe about its long axis within a TEM Cell contaning an E-field perpendicular to the probe axis.
V_{max2n} = voltage of other peak (180° from max peak)
V_{avgn} = average voltage of both peaks in a single channel
OFF_n = DC voltage offset of channel *n* (i.e. the voltage output with the probe amplifier on and the RF-power off)
$AmpGain_n$ = Amplifier Gain (nominally 20x)

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WAVEGUIDE CALIBRATION

Conversion Factor, γ, is determined by the fundamental SAR equation[1]:

$$SAR = \sigma/\rho\ |E|^2 = \sigma/\rho * [f_x/(\eta_x*\gamma_x) + f_y/(\eta_y*\gamma_y) + f_z/(\eta_z*\gamma_z)]$$

$$= \sigma/(\rho*\gamma) * [f_x/(\eta_x) + f_y/(\eta_y) + f_z/(\eta_z)]$$

And $f_i = 3770 * avg(Ch_i) * Gain_i$.

The relationship between the SAR at the cross-sectional center of the lossy waveguide and the longitudinal distance, z, from the dielectric separator in the waveguide[2] is:

$$SAR\ (mW/cm^3/W) = 4(P_f-P_b) / \rho ab\delta \quad * \quad \exp[-2z/\delta]$$

Where
a,b are the dimensions of the conventional waveguide in cm
δ is the penetration depth in cm
z is the distance from the bottom of the waveguide separator and the diodes in the probe in cm
ρ is the density of brain tissue, assumed to be 1.0 g/cm^3.

When the system measures SAR, it outputs a z-scan plot which shows a retraction curve at the center of the waveguide. The line is extrapolated from the distance between the diodes in the probe to the bottom of the liquid via a software interpolation method.

With the computer generated interpolation, SAR(z=0) can be determined from the "Zoom Scan SAR" (peak reading in scan area). This measured value can be compared to the theoretical value of SAR (z=0) via term substitution.

Using proprietary PCTEST curve-fitting software, the conversion factor is found. Calculations at three sample retraction depths are detailed below:

<u>Sample Calculation</u>: For 1900 MHz in the waveguide

$SAR_{theoretical}$ (z=0) $= 4(P_f-P_b) / \rho ab\delta \quad * \quad \exp[-2z/\delta]$
$= 4\ (249) / (1.0 * 10.92 * 5.46 * 2.415) \ * \exp(0)$
$SAR_{theoretical}$ (z=0) $= 6.917$ mW/g

Also $SAR_{theoretical}$ (z=3) $= 4\ (249) / (1.0 * 10.92 * 5.46 * 2.415) \ * \exp(-2*0.3/2.415)$
$= 5.395$ mW/g

And $SAR_{theoretical}$ (z=10) $= 4\ (249) / (1.0 * 10.92 * 5.46 * 2.415) \ * \exp(-2*1.0/2.415)$
$= 3.022$ mW/g

From the measurement taken in the waveguide,

$SAR_{measured}(z=0, \gamma=1.0) = 32.65$ mW/g
$SAR_{measured}(z=3, \gamma=1.0) = 25.23$ mW/g
$SAR_{measured}(z=10, \gamma=1.0) = 14.26$ mW/g

[1] IEEE Std P1528-200X, A1
[2] *Ibid*., A5

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WAVEGUIDE CALIBRATION (CONTINUED)

For z=0,

γ = SAR $_{measured}$ / SAR $_{theoretical}$

γ = 32.65 / 6.917

γ = **4.720**

And z=3,

γ = SAR $_{measured}$ / SAR $_{theoretical}$

γ = 25.23 / 5.395

γ = **4.677**

And z=10,

γ = SAR $_{measured}$ / SAR $_{theoretical}$

γ = 14.26 / 3.022

γ = **4.719**

Applying the conversion factor into the software, another measurement is taken in the waveguide for verification. SAR(z=0, γ = 4.7) = 6.83 (-1.3% error)

Validation with γ = 4.7 resulted in ±10% of specification

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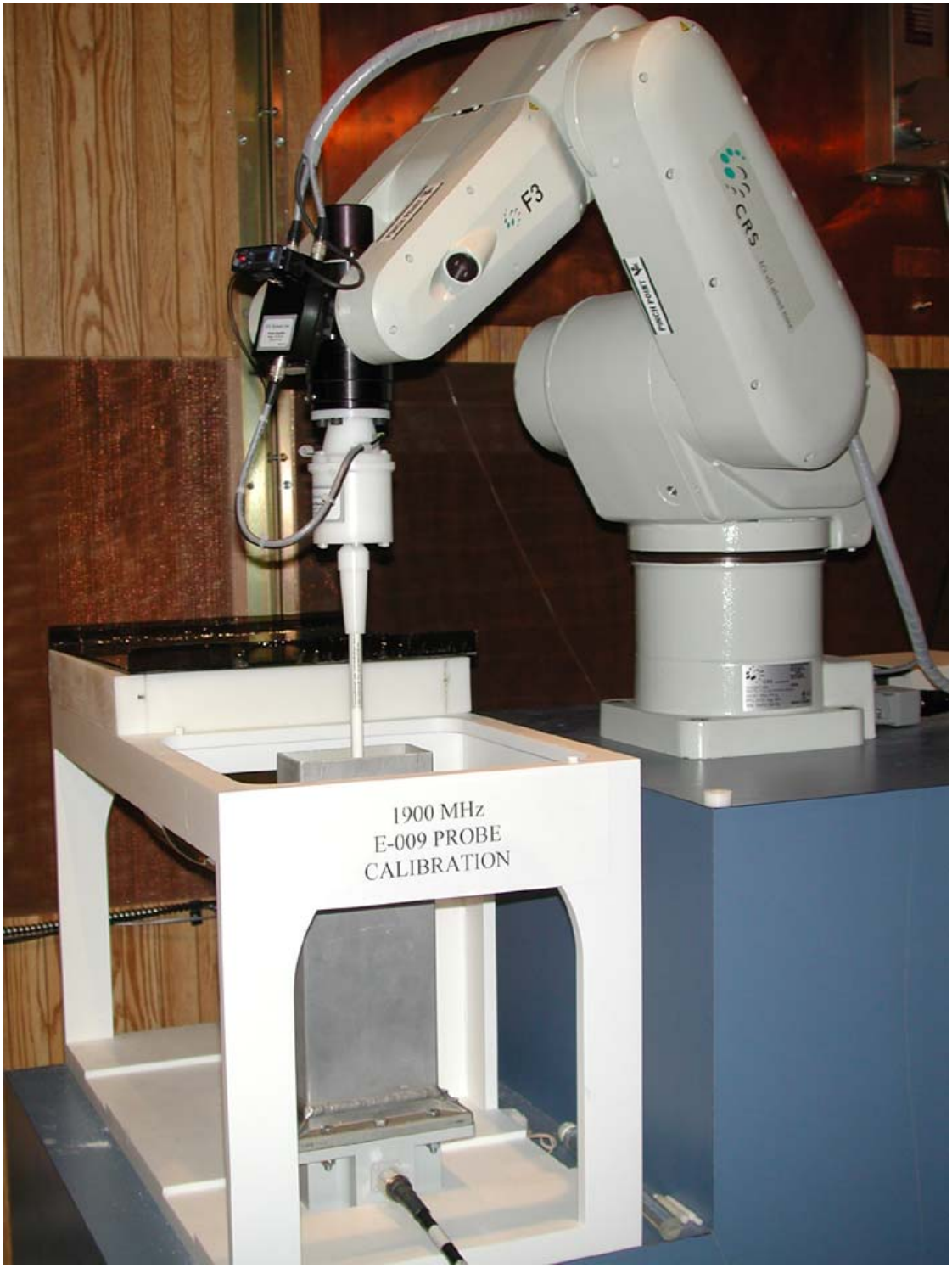
WAVEGUIDE TEST SETUP PHOTOS (1900 MHZ)



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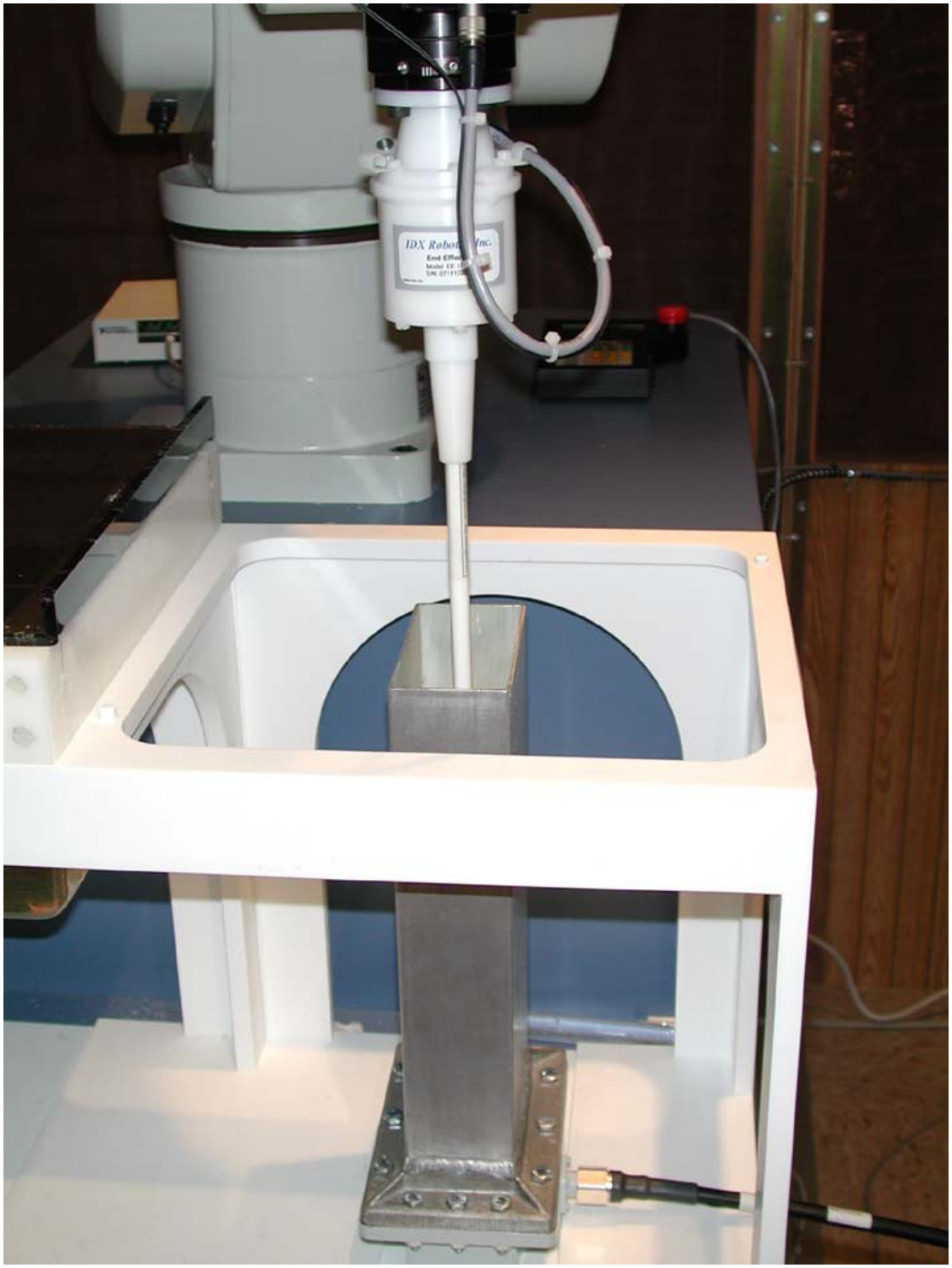
WAVEGUIDE TEST SETUP PHOTOS (1900 MHZ)-CONTINUED



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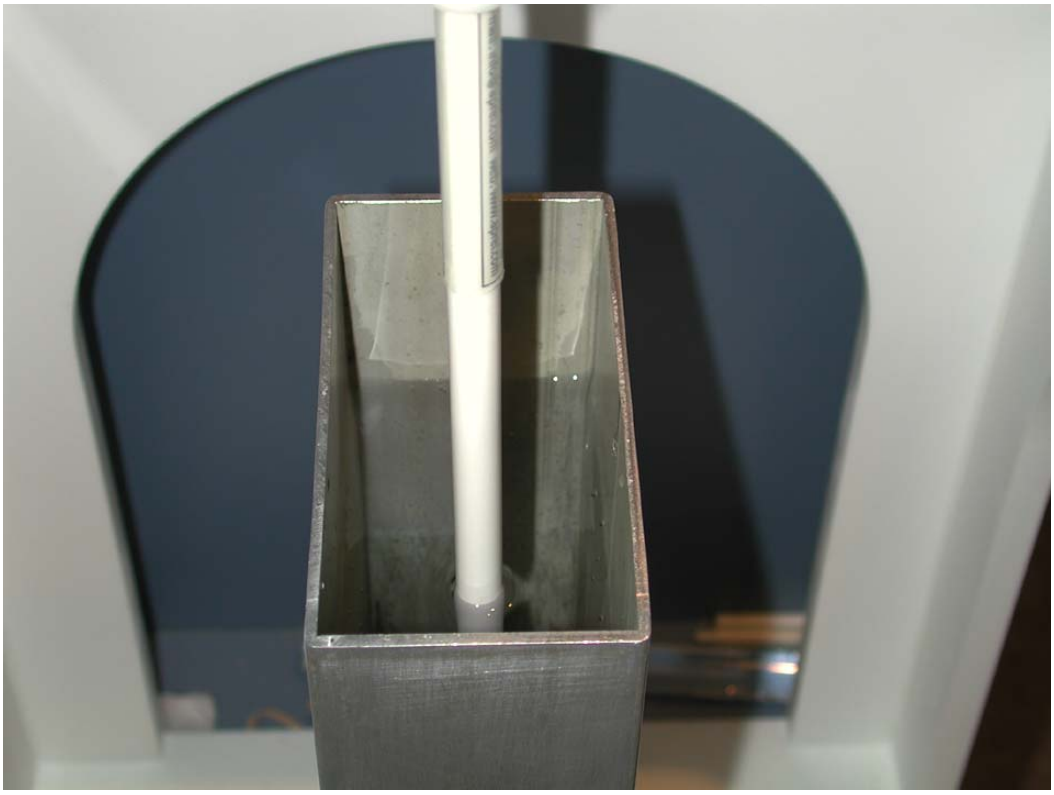
WAVEGUIDE TEST SETUP PHOTOS (1900 MHZ)-CONTINUED



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