

**Appendix 5**  
**Dipole Characterization Certificate**

# Schmid & Partner Engineering AG

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## Calibration Certificate

### 835 MHz System Validation Dipole

Type:

D835V2

Serial Number:

420

Place of Calibration:

Zurich

Date of Calibration:

September 26, 2002

Calibration Interval:

24 months

Schmid & Partner Engineering AG hereby certifies, that this device has been calibrated on the date indicated above. The calibration was performed in accordance with specifications and procedures of Schmid & Partner Engineering AG.

Wherever applicable, the standards used in the calibration process are traceable to international standards. In all other cases the standards of the Laboratory for EMF and Microwave Electronics at the Swiss Federal Institute of Technology (ETH) in Zurich, Switzerland have been applied.

Calibrated by:

D. Vetter

Approved by:

Manfred Vetter

**Schmid & Partner  
Engineering AG**

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**DASY**

**Dipole Validation Kit**

**Type: D835V2**

**Serial: 420**

**Manufactured: December 23, 1999**  
**Calibrated: September 26, 2002**

## 1. Measurement Conditions

The measurements were performed in the flat section of the SAM twin phantom filled with head simulating solution of the following electrical parameters at 835 MHz:

Relative Dielectricity	41.3	± 5%
Conductivity	0.88 mho/m	± 5%

The DASY System with a dosimetric E-field probe ET3DV6 (SN:1507, Conversion factor 6.6 at 835 MHz) was used for the measurements.

The dipole was mounted on the small tripod so that the dipole feedpoint was positioned below the center marking of the flat phantom section and the dipole was oriented parallel to the body axis (the long side of the phantom). The standard measuring distance was 15mm from dipole center to the solution surface. The included distance holder was used during measurements for accurate distance positioning.

The coarse grid with a grid spacing of 20mm was aligned with the dipole. The 5x5x7 fine cube was chosen for cube integration. Probe isotropy errors were cancelled by measuring the SAR with normal and 90° turned probe orientations and averaging.

The dipole input power (forward power) was 250mW ± 3 %. The results are normalized to 1W input power.

### 2.1. SAR Measurement with DASY3 System

Standard SAR-measurements were performed according to the measurement conditions described in section 1. The results (see figure supplied) have been normalized to a dipole input power of 1W (forward power). The resulting averaged SAR-values measured with the dosimetric probe ET3DV6 SN:1507 and applying the worst-case extrapolation are:

averaged over 1 cm <sup>3</sup> (1 g) of tissue:	9.68 mW/g
averaged over 10 cm <sup>3</sup> (10 g) of tissue:	6.24 mW/g

### 2.2. SAR Measurement with DASY4 System

Standard SAR-measurements were performed according to the measurement conditions described in section 1. The results (see figure supplied) have been normalized to a dipole input power of 1W (forward power). The resulting averaged SAR-values measured with the dosimetric probe ET3DV6 SN:1507 and applying the advanced extrapolation are:

averaged over 1 cm <sup>3</sup> (1 g) of tissue:	9.08 mW/g
averaged over 10 cm <sup>3</sup> (10 g) of tissue:	6.00 mW/g

### 3. Dipole Impedance and Return Loss

The impedance was measured at the SMA-connector with a network analyzer and numerically transformed to the dipole feedpoint. The transformation parameters from the SMA-connector to the dipole feedpoint are:

Electrical delay: 1.402 ns (one direction)  
Transmission factor: 0.986 (voltage transmission, one direction)

The dipole was positioned at the flat phantom sections according to section 1 and the distance holder was in place during impedance measurements.

Feedpoint impedance at 835 MHz:  $\text{Re}\{Z\} = 50.6 \Omega$

$\text{Im}\{Z\} = 5.4 \Omega$

Return Loss at 835 MHz: -25.4 dB

### 4. Modification

Small end caps (3 mm in length) made of Teflon have been added to the dipole arms by the Client.

### 5. Handling

Do not apply excessive force to the dipole arms, because they might bend. Bending of the dipole arms stresses the soldered connections near the feedpoint leading to a damage of the dipole.

### 6. Design

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals.

### 7. Power Test

After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

09/26/02

### Validation Dipole D835V2 SN420, $d = 15$ mm

Frequency: 835 MHz; Antenna Input Power: 250 [mW]

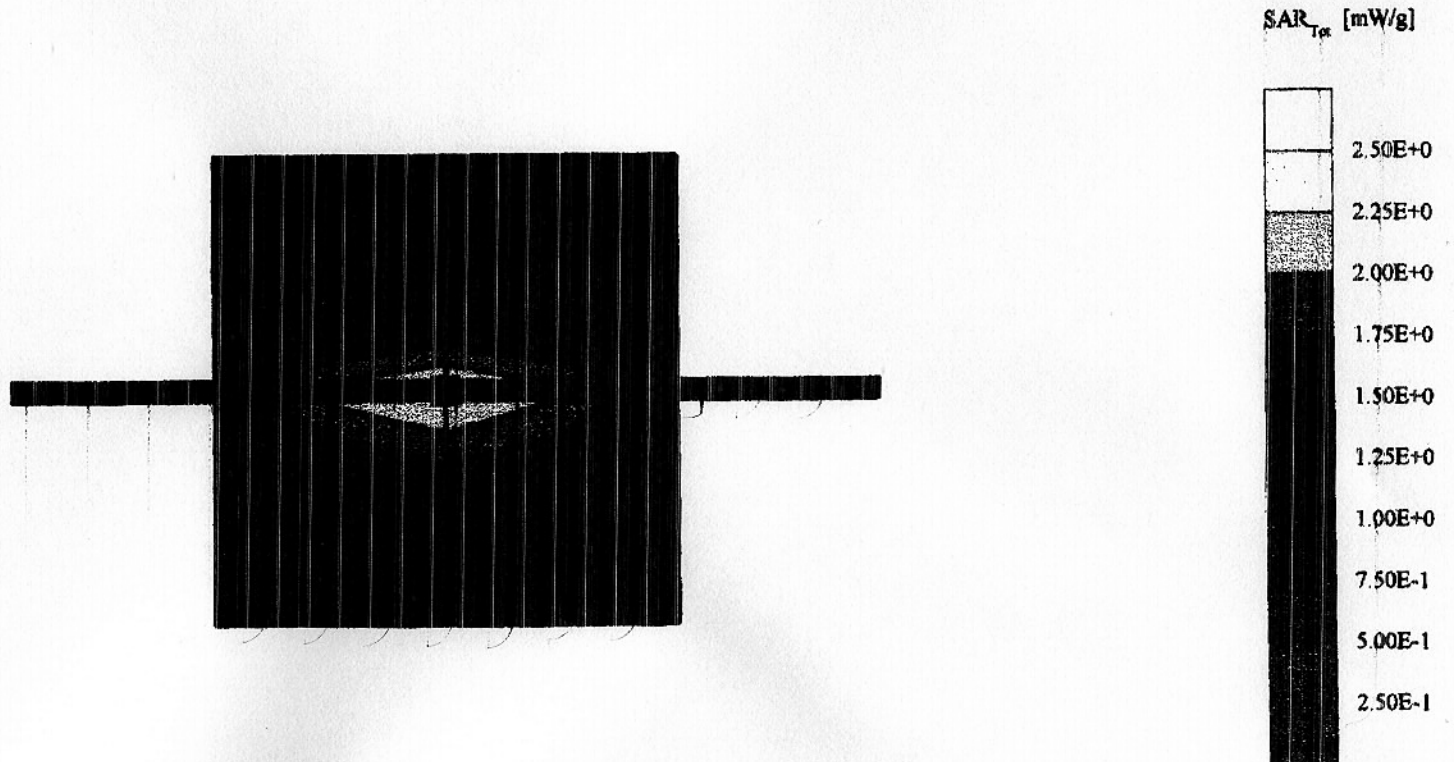
SAM Phantom; Flat Section; Grid Spacing:  $D_x = 20.0$ ,  $D_y = 20.0$ ,  $D_z = 10.0$

Probe: ET3DV6 - SN1507; ConyF(6.60,6.60,6.60) at 835 MHz; IEEE1528 835 MHz:  $\sigma = 0.88$  mho/m  $\epsilon_r = 41.3$   $\rho = 1.00$  g/cm<sup>3</sup>

Cubes (2): Peak: 3.78 mW/g  $\pm 0.03$  dB, SAR (1g): 2.42 mW/g  $\pm 0.03$  dB, SAR (10g): 1.56 mW/g  $\pm 0.03$  dB, (Worst-case extrapolation)

Penetration depth: 12.2 (11.1, 13.5) [mm]

Powerdrift: 0.02 dB



### Validation Dipole D835V2 SN420, d = 15 mm

Frequency: 835 MHz; Antenna Input Power: 250 [mW]

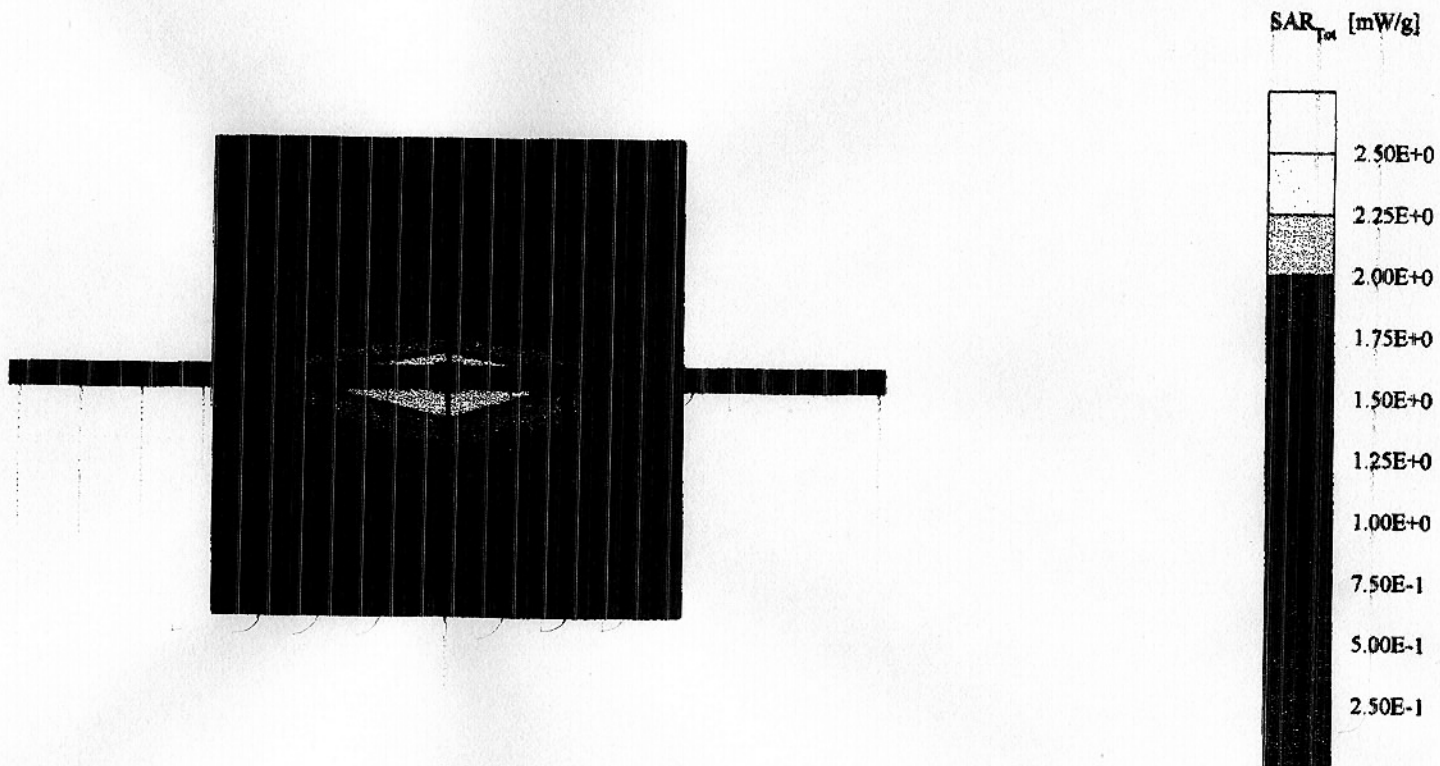
SAM Phantom; Flat Section; Grid Spacing:  $D_x = 20.0$ ,  $D_y = 20.0$ ,  $D_z = 10.0$

Probe: ET3DV6 - SN1507; ConvF(6.60,6.60,6.60) at 835 MHz; IEEE1528 835 MHz:  $\sigma = 0.88$  mho/m  $\epsilon_r = 41.3$   $\rho = 1.00$  g/cm<sup>3</sup>

Cubes (2): Peak: 3.35 mW/g  $\pm 0.03$  dB, SAR (1g): 2.27 mW/g  $\pm 0.03$  dB, SAR (10g): 1.50 mW/g  $\pm 0.03$  dB, (Advanced extrapolation)

Penetration depth: 13.2 (12.8, 13.7) [mm]

Powerdrift: 0.02 dB



CH1 S11 1 U FS

1: 50.555  $\Omega$  5.3652  $\Omega$  1.0226 nH

835.000 000 MHz

Del

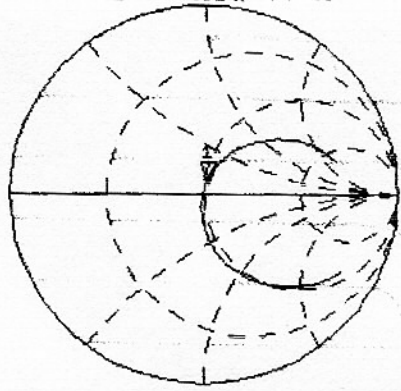
PRM

Cor

Avg

16

↑

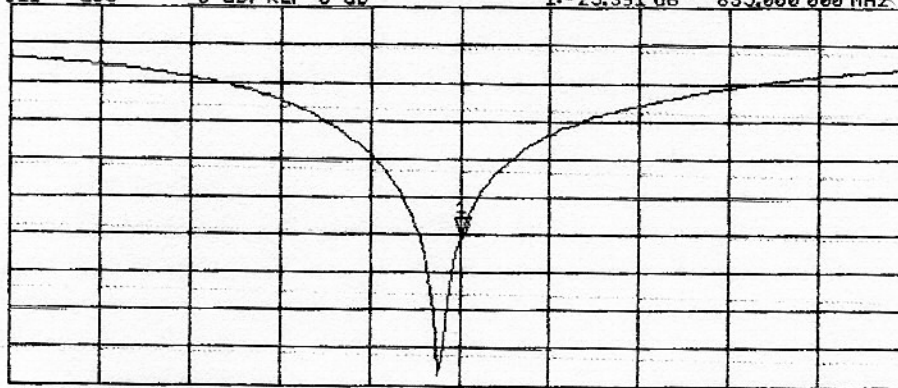


CH2 S11 LOG 5 dB/REF 0 dB 1: -25.391 dB 835.000 000 MHz

PRM

Cor

↑



START 635.000 000 MHz

STOP 1 835.000 000 MHz

# Interim Dipole Correlation Certificate

FCD-0359, Rev.001

Dipole Serial Number:	250 (TR)	Last Calibration Date:	24-Aug-01
Dipole Type (MHz):	D180V2 w/ Teflon Rings	Calibration Due:	24-Aug-03
		Manufacturer:	SPEAG

## -Manufacturer's Original Calibration Information-

Dipole to be correlated: [Serial Number: 250(TR) ]

1g SAR normalized to 1W forward power (mW/g):	38.4 mW/g
Relative Dielectric:	40.2
Conductivity:	1.38
Probe Serial Number:	1307
Forward Power:	250mW

Primary Dipole Referenced: [Serial Number: 246(TR) ]

1g SAR normalized to 1W forward power (mW/g):	38.8 mW/g
Relative Dielectric:	39.6
Conductivity:	1.37
Probe Serial Number:	1307
Forward Power:	250mW

## -Correlation Method Utilized- per DOI-1265

(select one)

By Similarity:  By Transfer Calibration:

## -Measured Data-

Probe S/N: 175 Conductivity (meas.): 1.38  
Robot Cell #: RVD-4 Permittivity (meas.): 38.4

Primary Standard (average of 0-degree & 90-degree 1g cubes):

38.5 mW/g (if required) (if required)

Secondary Standard (average of 0-degree & 90-degree 1g cubes):

38.8 mW/g (if required) (if required)

## -NEW Correlated Target-

1g SAR normalized to 1W forward power (mW/g):	38.8 mW/g
Relative Dielectric:	39.6
Conductivity:	1.37

Approved by: *Antonio Ferencik*

Date: 3/8/02

Comments:

Secondary dipole measured +0.7% from primary dipole.

**Appendix 6**  
**Measurement Uncertainty Budget**

<b>Uncertainty Budget for Device Under Test</b>									
<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>	<i>e = f(d,k)</i>	<i>f</i>	<i>g</i>	<i>h = c x f / e</i>	<i>i = c x g / e</i>	<i>k</i>
<b>Uncertainty Component</b>	Sec.	Tol. (± %)	Prob. Dist.	Div.	<i>c<sub>i</sub></i> (1 g)	<i>c<sub>i</sub></i> (10 g)	1 g <i>u<sub>i</sub></i> (±%)	10 g <i>u<sub>i</sub></i> (±%)	<i>v<sub>i</sub></i>
<b>Measurement System</b>									
Probe Calibration	E.2.1	9.5	N	2.00	1	1	4.8	4.8	∞
Axial Isotropy	E.2.2	4.7	R	1.73	0.707	0.707	1.9	1.9	∞
Spherical Isotropy	E.2.2	9.6	R	1.73	0.707	0.707	3.9	3.9	∞
Boundary Effect	E.2.3	5.8	R	1.73	1	1	3.3	3.3	∞
Linearity	E.2.4	4.7	R	1.73	1	1	2.7	2.7	∞
System Detection Limits	E.2.5	1.0	R	1.73	1	1	0.6	0.6	∞
Readout Electronics	E.2.6	1.0	N	1.00	1	1	1.0	1.0	∞
Response Time	E.2.7	0.8	R	1.73	1	1	0.5	0.5	∞
Integration Time	E.2.8	1.3	R	1.73	1	1	0.8	0.8	∞
RF Ambient Conditions	E.6.1	3.0	R	1.73	1	1	1.7	1.7	∞
Probe Positioner Mechanical Tolerance	E.6.2	0.3	R	1.73	1	1	0.2	0.2	∞
Probe Positioning with respect to Phantom Shell	E.6.3	1.1	R	1.73	1	1	0.6	0.6	∞
Extrapolation, interpolation and Integration Algorithms for Max. SAR Evaluation	E.5	3.9	R	1.73	1	1	2.3	2.3	∞
<b>Test sample Related</b>									
Test Sample Positioning	E.4.2	3.6	N	1.00	1	1	3.6	3.6	29
Device Holder Uncertainty	E.4.1	2.8	N	1.00	1	1	2.8	2.8	8
Output Power Variation - SAR drift measurement	6.6.2	5.0	R	1.73	1	1	2.9	2.9	∞
<b>Phantom and Tissue Parameters</b>									
Phantom Uncertainty (shape and thickness tolerances)	E.3.1	4.0	R	1.73	1	1	2.3	2.3	∞
Liquid Conductivity - deviation from target values	E.3.2	5.0	R	1.73	0.64	0.43	1.8	1.2	∞
Liquid Conductivity - measurement uncertainty	E.3.3	10.0	R	1.73	0.64	0.43	3.7	2.5	∞
Liquid Permittivity - deviation from target values	E.3.2	10.0	R	1.73	0.6	0.49	3.5	2.8	∞
Liquid Permittivity - measurement uncertainty	E.3.3	5.0	R	1.73	0.6	0.49	1.7	1.4	∞
<b>Combined Standard Uncertainty</b>			RSS				11.72	11.09	1363
<b>Expanded Uncertainty (95% CONFIDENCE LEVEL)</b>			<i>k</i> =2				22.98	21.75	

**Uncertainty Budget for System Performance Check (dipole & flat phantom)**

<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>	$e = f(d,k)$	<i>f</i>	<i>g</i>	$h = c \times f / e$	$i = c \times g / e$	<i>k</i>
<b>Uncertainty Component</b>	Sec.	Tol. (± %)	Prob. Dist.	Div.	<i>c<sub>i</sub></i> (1 g)	<i>c<sub>i</sub></i> (10 g)	1 g <i>u<sub>i</sub></i> (±%)	10 g <i>u<sub>i</sub></i> (±%)	<i>v<sub>i</sub></i>
<b>Measurement System</b>									
Probe Calibration	E.2.1	9.5	N	2.00	1	1	4.8	4.8	∞
Axial Isotropy	E.2.2	4.7	R	1.73	1	1	2.7	2.7	∞
Spherical Isotropy	E.2.2	9.6	R	1.73	0	0	0.0	0.0	∞
Boundary Effect	E.2.3	5.8	R	1.73	1	1	3.3	3.3	∞
Linearity	E.2.4	4.7	R	1.73	1	1	2.7	2.7	∞
System Detection Limits	E.2.5	1.0	R	1.73	1	1	0.6	0.6	∞
Readout Electronics	E.2.6	1.0	N	1.00	1	1	1.0	1.0	∞
Response Time	E.2.7	0.0	R	1.73	1	1	0.0	0.0	∞
Integration Time	E.2.8	0.0	R	1.73	1	1	0.0	0.0	∞
RF Ambient Conditions	E.6.1	3.0	R	1.73	1	1	1.7	1.7	∞
Probe Positioner Mechanical Tolerance	E.6.2	0.3	R	1.73	1	1	0.2	0.2	∞
Probe Positioning with respect to Phantom Shell	E.6.3	1.1	R	1.73	1	1	0.6	0.6	∞
Extrapolation, interpolation and Integration Algorithms for Max. SAR Evaluation	E.5	3.9	R	1.73	1	1	2.3	2.3	∞
<b>Dipole</b>									
Dipole Axis to Liquid Distance	8, E.4.2	1.0	R	1.73	1	1	0.6	0.6	∞
Input Power and SAR Drift Measurement	8, 6.6.2	4.7	R	1.73	1	1	2.7	2.7	∞
<b>Phantom and Tissue Parameters</b>									
Phantom Uncertainty (shape and thickness tolerances)	E.3.1	4.0	R	1.73	1	1	2.3	2.3	∞
Liquid Conductivity - deviation from target values	E.3.2	5.0	R	1.73	0.64	0.43	1.8	1.2	∞
Liquid Conductivity - measurement uncertainty	E.3.3	10.0	R	1.73	0.64	0.43	3.7	2.5	∞
Liquid Permittivity - deviation from target values	E.3.2	10.0	R	1.73	0.6	0.49	3.5	2.8	∞
Liquid Permittivity - measurement uncertainty	E.3.3	5.0	R	1.73	0.6	0.49	1.7	1.4	∞
<b>Combined Standard Uncertainty</b>			RSS				10.16	9.43	99999
<b>Expanded Uncertainty (95% CONFIDENCE LEVEL)</b>			<i>k</i> =2				19.92	18.48	

## **Appendix 7**

### **Photographs of the device under test**



Figure 7. Top View of Phone in Accessory.



Figure 8. Separation Distance of 25 mm from Tip of Antenna to Flat Phantom and 8 mm from the bottom of the clip when rotated +90° (Clockwise Direction)



Figure 9. Separation Distance of 33 mm from Tip of Antenna to Flat Phantom and 10 mm from the bottom of the clip when rotated 0°.

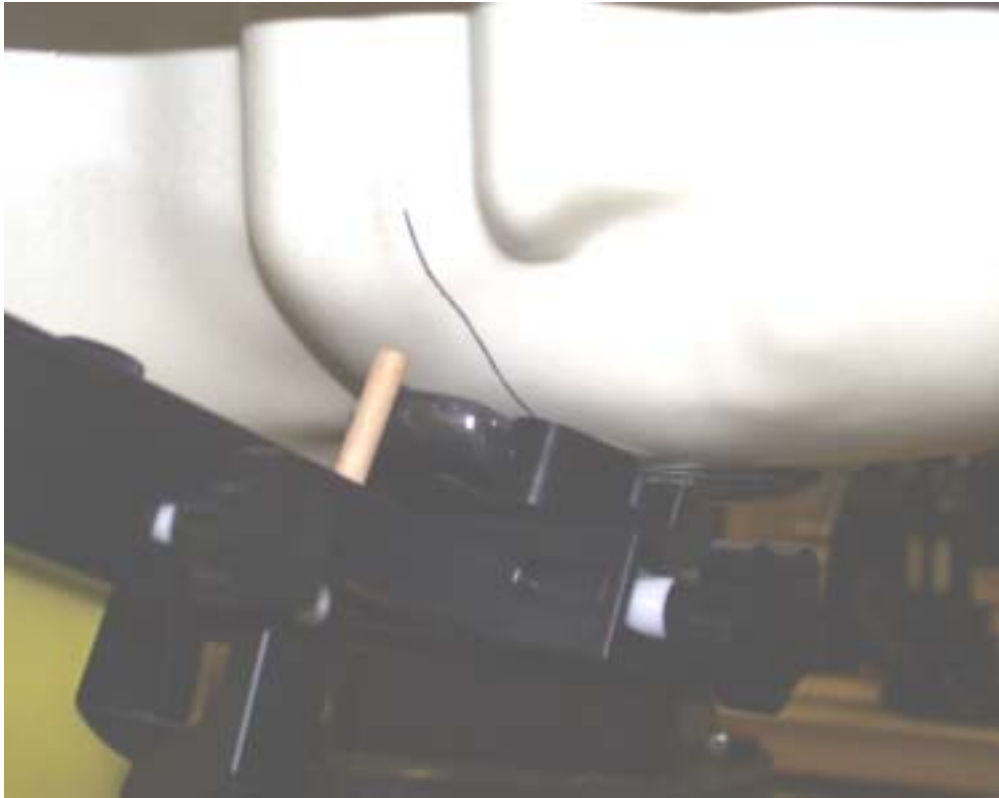


Figure 10. Phone Against the Head (Front View)



Figure 11. Phone Against the Head (Back View)



Figure 12. Phone Against the Head (15° Tilt) Front View



Figure 13. Phone Against the Head (15° Tilt) Back View