



SAR Evaluation Report

in accordance with the requirements of
FCC Report and Order: ET Docket 93-62, and OET Bulletin 65 Supplement C

for

802.11b/g Radio Module Installed in CK-31/CK31NI Handheld Scanner

MODEL: 802MIG2

FCC ID: HN2CK31MIG2

October 29, 2004

REPORT NO: 04U2917-1

Prepared for

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Prepared by

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CERTIFICATE OF COMPLIANCE (SAR EVALUATION)

DATES OF TEST: October 29, 2004

APPLICANT:	Intermec Technologies Corporation
ADDRESS:	6001 36th Avenue West Everett, WA 98203-9280 United States
FCC ID:	HN2CK31MIG2
MODEL:	802MIG2
DEVICE CATEGORY:	Portable Device
EXPOSURE CATEGORY:	General Population/Uncontrolled Exposure

802.11b/g Radio Module Installed in CK-31/CK31NI Handheld Scanner

Test Sample is a:	Identical prototype unit		
Modulation type:	DSSS for 802.11b OFDM for 802.11g		
FCC Rule Parts	Frequency Range [MHz]	The Highest SAR Values [1g_mW/g]	Max. Power Output [dBm]
47 CFR 15.247	2412 - 2462	0.471	17.4

This wireless portable device has been shown to be capable of compliance for localized specific absorption rate (SAR) for General Population/Uncontrolled Exposure limits specified in ANSI/IEEE Std. C95.1-1992 and had been tested in accordance with the measurement procedures specified in FCC OET 65 Supplement C (Edition 01-01).

I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

Released For CCS By:		
		
Hsin-Fu Shih (Sunny Shih) COMPLIANCE CERTIFICATION SERVICES		

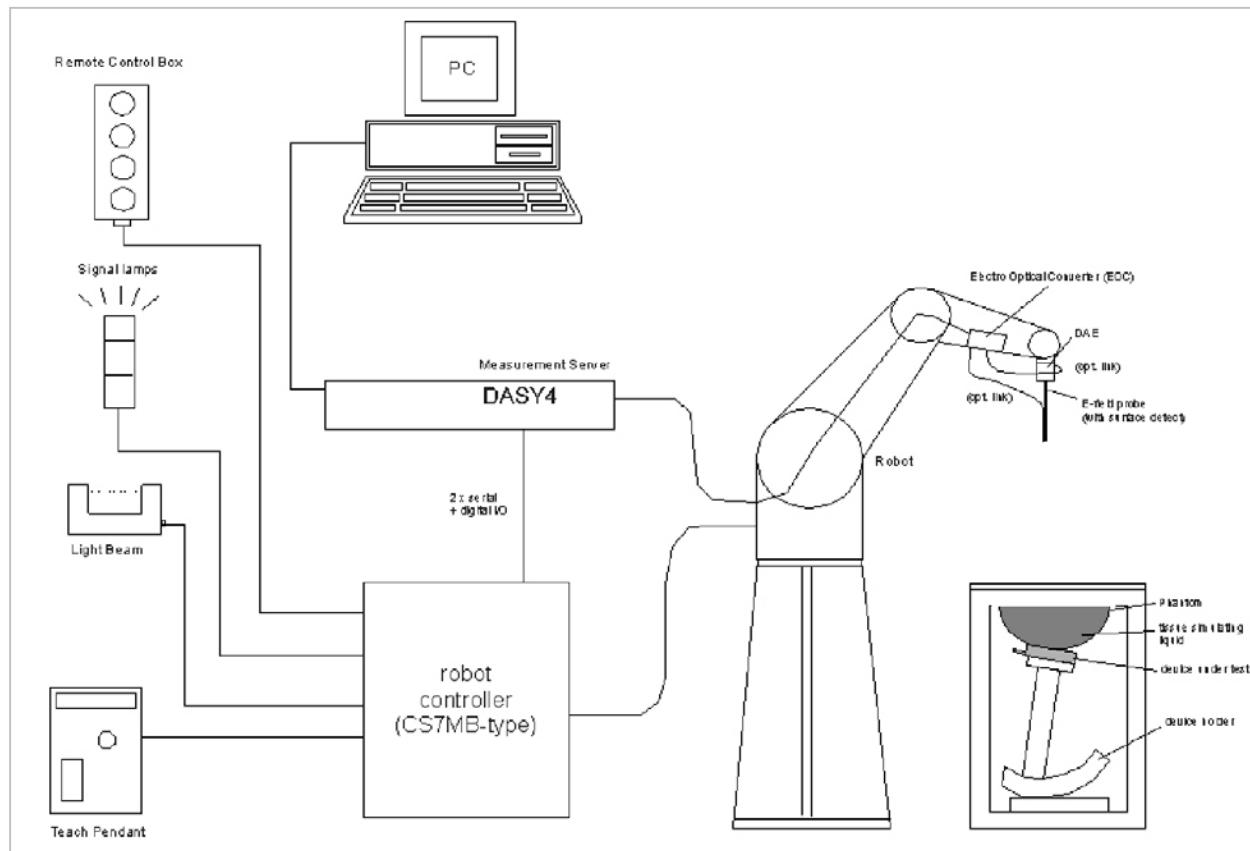
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1 EQUIPMENT UNDER TEST (EUT) DESCRIPTION

802.11b/g Radio Module Installed in CK-31/CK31NI Handheld Scanner	
Normal operation:	<input type="checkbox"/> Held to ear <input checked="" type="checkbox"/> Worn on body <input type="checkbox"/> Held to face
Accessory:	<input type="checkbox"/> belt clip <input checked="" type="checkbox"/> holster <input type="checkbox"/> neck-strap or lanyard <input type="checkbox"/> not supplied or available as options <input checked="" type="checkbox"/> pistol grip
Earphone/Headset Jack:	<input type="checkbox"/> Earphone <input type="checkbox"/> Headset Manufactured by , type/part no. .
Duty cycle:	100% for both 802.11bg
Battery:	Manufactured by Intermec, Model AB1G, 7.4Vdc, 2400mA/h

2 SYSTEM DESCRIPTION



The DASY4 system for performing compliance tests consists of the following items:

- A standard high precision 6-axis robot (Stäubli RX family) with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- A dosimetric probe, i.e., an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is equipped with an optical surface detector system.
- A data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- A probe alignment unit which improves the (absolute) accuracy of the probe positioning.
- A computer operating Windows 2000 or Windows XP.
- DASY4 software.
- Remote control with teach pendant and additional circuitry for robot safety such as warning lamps, etc.
- The SAM twin phantom enabling testing left-hand and right-hand usage.
- The device holder for handheld mobile phones.
- Tissue simulating liquid mixed according to the given recipes.
- Validation dipole kits allowing to validate the proper functioning of the system.

3 SYSTEM COMPONENTS

3.1 DASY4 MEASUREMENT SERVER



The DASY4 measurement server is based on a PC/104 CPU board with a 166MHz low-power Pentium, 32MB chip disk and 64MB RAM. The necessary circuits for communication with either the DAE3 electronic box as well as the 16-bit AD-converter system for optical detection and digital I/O interface are contained on the DASY4 I/O-board, which is directly connected to the PC/104 bus of the CPU board.

The measurement server performs all real-time data evaluation for field measurements and surface detection, controls robot movements and handles safety operation. The PC-operating system cannot interfere with these time critical processes. All connections are supervised by a watchdog, and disconnection of any of the cables to the measurement server will automatically disarm the robot and disable all program-controlled robot movements. Furthermore, the measurement server is equipped with two expansion slots which are reserved for future applications. Please note that the expansion slots do not have a standardized pinout and therefore only the expansion cards provided by SPEAG can be inserted. Expansion cards from any other supplier could seriously damage the measurement server. Calibration: No calibration required.

3.2 DATA ACQUISITION ELECTRONICS (DAE)

The data acquisition electronics (DAE3) consists of a highly sensitive electrometer grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD converter and a command decoder and control logic unit. Transmission to the measurement server is accomplished through an optical downlink for data and status information as well as an optical uplink for commands and the clock. The mechanical probe mounting device includes two different sensor systems for frontal and sideways probe contacts. They are used for mechanical surface detection and probe collision detection. The input impedance of the DAE3 box is 200MOhm; the inputs are symmetrical and floating. Common mode rejection is above 80 dB.



3.3 EX3DV3 ISOTROPIC E-FIELD PROBE FOR DOSIMETRIC MEASUREMENTS

Construction: Symmetrical design with triangular core Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)

Frequency: 10 MHz to > 6 GHz; Linearity: ± 0.2 dB (30 MHz to 3 GHz)

Directivity: ± 0.3 dB in HSL (rotation around probe axis);
 ± 0.5 dB in tissue material (rotation normal to probe axis)

Dynamic Range: 10 μ W/g to > 100 mW/g; Linearity: ± 0.2 dB (noise: typically < 1 μ W/g)

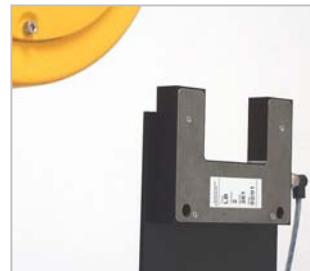
Dimensions: Overall length: 330 mm (Tip: 20 mm)
Tip diameter: 2.5 mm (Body: 12 mm)
Typical distance from probe tip to dipole centers: 1 mm

Application: High precision dosimetric measurements in any exposure scenario (e.g., very strong gradient fields). Only probe which enables compliance testing for frequencies up to 6 GHz with precision of better 30%.



3.4 LIGHT BEAM UNIT

The light beam switch allows automatic "tooling" of the probe. During the process, the actual position of the probe tip with respect to the robot arm is measured, as well as the probe length and the horizontal probe offset. The software then corrects all movements, so that the robot coordinates are valid for the probe tip. The repeatability of this process is better than 0.1 mm. If a position has been taught with an aligned probe, the same position will be reached with another aligned probe within 0.1 mm, even if the other probe has different dimensions. During probe rotations, the probe tip will keep its actual position.



3.5 SAM PHANTOM (V4.0)

Construction: The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528-200X, CENELEC 50361 and IEC 62209. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents evaporation of the liquid. Reference markings on the phantom allow the complete setup of all predefined phantom positions and measurement grids by manually teaching three points with the robot.

Shell Thickness: 2 ± 0.2 mm

Filling Volume: Approx. 25 liters

Dimensions: Height: 810mm; Length: 1000mm; Width: 500mm



3.6 DEVICE HOLDER FOR SAM TWIN PHANTOM

Construction: In combination with the Twin SAM Phantom V4.0 or Twin SAM, the Mounting Device (made from POM) enables the rotation of the mounted transmitter in spherical coordinates, whereby the rotation point is the ear opening. The devices can be easily and accurately positioned according to IEC, IEEE, CENELEC, FCC or other specifications. The device holder can be locked at different phantom locations (left head, right head, flat phantom).



3.7 SYSTEM VALIDATION KITS

Construction: Symmetrical dipole with l/4 balun Enables measurement of feedpoint impedance with NWA Matched for use near flat phantoms filled with brain simulating solutions Includes distance holder and tripod adaptor.

Frequency: 450, 900, 1800, 2450, 5800 MHz

Return loss: > 20 dB at specified validation position

Power capability: > 100 W (f < 1GHz); > 40 W (f > 1GHz)

Dimensions: 450V2: dipole length: 270 mm; overall height: 330 mm
 D900V2: dipole length: 149 mm; overall height: 330 mm
 D1800V2: dipole length: 72 mm; overall height: 300 mm
 D835V2: dipole length: 161; overall height: 330
 D1900V2: dipole length: 68; overall height: 300
 D2450V2: dipole length: 51.5 mm; overall height: 300 mm D5GHzV2: dipole length: 25.5 mm; overall height: 290 mm

3.8 COMPOSITION OF INGREDIENTS FOR TISSUE SIMULATING LIQUID

The following tissue formulations are provided for reference only as some of the parameters have not been thoroughly verified. The composition of ingredients may be modified accordingly to achieve the desired target tissue parameters required for routine SAR evaluation.

Ingredients (% by weight)	Frequency (MHz)									
	450		835		915		1900		2450	
Tissue Type	Head	Body	Head	Body	Head	Body	Head	Body	Head	Body
Water	38.56	51.16	41.45	52.4	41.05	56.0	54.9	40.4	62.7	73.2
Salt (NaCl)	3.95	1.49	1.45	1.4	1.35	0.76	0.18	0.5	0.5	0.04
Sugar	56.32	46.78	56.0	45.0	56.5	41.76	0.0	58.0	0.0	0.0
HEC	0.98	0.52	1.0	1.0	1.0	1.21	0.0	1.0	0.0	0.0
Bactericide	0.19	0.05	0.1	0.1	0.1	0.27	0.0	0.1	0.0	0.0
Triton X-100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	36.8	0.0
DGBE	0.0	0.0	0.0	0.0	0.0	0.0	44.92	0.0	0.0	26.7
Dielectric Constant	43.42	58.0	42.54	56.1	42.0	56.8	39.9	54.0	39.8	52.5
Conductivity (S/m)	0.85	0.83	0.91	0.95	1.0	1.07	1.42	1.45	1.88	1.78

Salt: 99+% Pure Sodium Chloride

Sugar: 98+% Pure Sucrose

Water: De-ionized, 16 MΩ+ resistivity

HEC: Hydroxyethyl Cellulose

DGBE: 99+% Di(ethylene glycol) butyl ether, [2-(2-butoxyethoxy)ethanol]

Triton X-100 (ultra pure): Polyethylene glycol mono [4-(1,1,3,3-tetramethylbutyl)phenyl]ether

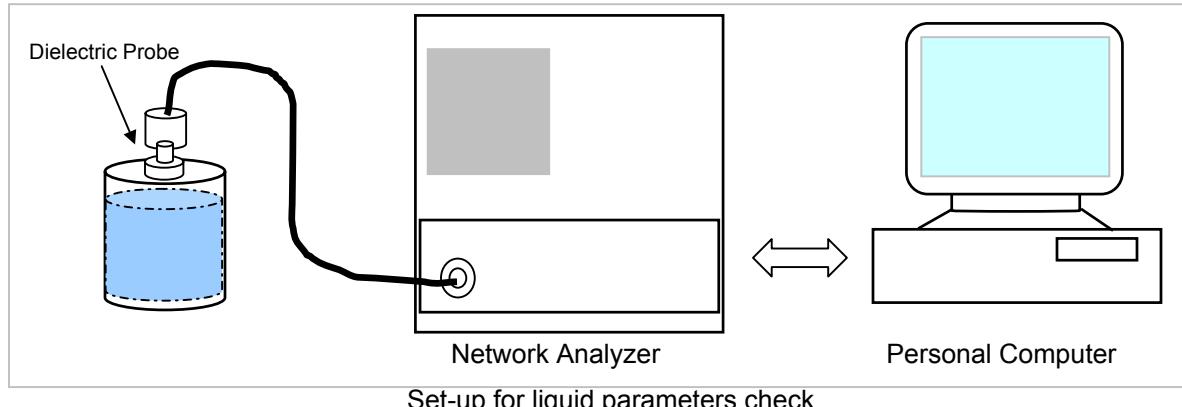
4 TEST POSITIONS FOR BODY-WORN

With the holster

Body-worn operating configurations should be tested with the holsters attached to the host device and positioned against a flat phantom in normal use configurations.

5 SIMULATING LIQUID PARAMETERS CHECK

The simulating liquids should be checked at the beginning of a series of SAR measurements to determine if the dielectric parameters are within the tolerances of the specified target values. The relative permittivity and conductivity of the tissue material should be within $\pm 5\%$ of the values given in the table below.



Reference Values of Tissue Dielectric Parameters for Head and Body Phantom

The head tissue dielectric parameters recommended by the IEEE SCC-34/SC-2 in IEEE Standard 1528 have been incorporated in the following table. These head parameters are derived from planar layer models simulating the highest expected SAR for the dielectric properties and tissue thickness variations in a human head. Other head and body tissue parameters that have not been specified in P1528 are derived from the tissue dielectric parameters computed from the 4-Cole-Cole equations and extrapolated according to the head parameters specified in IEEE Standard 1528.

Target Frequency (MHz)	Head		Body	
	ϵ_r	σ (S/m)	ϵ_r	σ (S/m)
150	52.3	0.76	61.9	0.80
300	45.3	0.87	58.2	0.92
450	43.5	0.87	56.7	0.94
835	41.5	0.90	55.2	0.97
900	41.5	0.97	55.0	1.05
915	41.5	0.98	55.0	1.06
1450	40.5	1.20	54.0	1.30
1610	40.3	1.29	53.8	1.40
1800 – 2000	40.0	1.40	53.3	1.52
2450	39.2	1.80	52.7	1.95
3000	38.5	2.40	52.0	2.73
5800	35.3	5.27	48.2	6.00

(ϵ_r = relative permittivity, σ = conductivity and $\rho = 1000 \text{ kg/m}^3$)

5.1 SIMULATING LIQUID PARAMETER CHECK RESULT

Simulating Liquid Dielectric Parameter Check Result @ Muscle 2450 MHz

Room Ambient Temperature = 23°C, Relative humidity = 40%

Measured by: Sunny Shih

Simulating Liquid			Parameters		Target	Measured	Deviation (%)	Limit (%)
f (MHz)	Temp. (°C)	Depth (cm)	ϵ''	Relative Permittivity (ϵ_r):	52.7	52.6474	-0.10	± 5
2450	22	15	14.8343	Conductivity (σ):	1.95	2.02187	3.69	± 5

Simulating Liquid Dielectric Parameters Check @ 2450 MHz

Room Ambient Temperature: 23 deg. C, Liquid temperature: 22 deg. C

October 29, 2004 03:37 PM

Frequency	ϵ'	ϵ''
2400000000.	52.8244	14.6501
2410000000.	52.7823	14.6764
2420000000.	52.7643	14.7263
2430000000.	52.7108	14.7533
2440000000.	52.6847	14.8151
2450000000.	52.6474	14.8343
2460000000.	52.5933	14.8956
2470000000.	52.5659	14.9228
2480000000.	52.5271	14.9697
2490000000.	52.4969	14.9983
2500000000.	52.4507	15.0606

The conductivity (σ) can be given as:

$$\sigma = \omega \epsilon_0 \epsilon'' = 2 \pi f \epsilon_0 \epsilon''$$

where $f = \text{target } f * 10^6$

$$\epsilon_0 = 8.854 * 10^{-12}$$

6 SYSTEM PERFORMANCE CHECK

The system performance check is performed prior to any usage of the system in order to guarantee reproducible results. The system performance check verifies that the system operates within its specifications of $\pm 10\%$.

System Performance Check Measurement Conditions

- The measurements were performed in the flat section of the SAM twin phantom filled with Head simulating liquid of the following parameters.
- The DASY4 system with an Isotropic E-Field Probe EX3DV3-SN: 3531 was used for the measurements.
- The dipole was mounted on the small tripod so that the dipole feed point 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 10 mm (above 1 GHz) and f 15 mm (below 1 GHz) from dipole center to the simulating liquid surface.
- The coarse grid with a grid spacing of 15 mm was aligned with the dipole.
- Special 5 x 5 x 7 fine cube was chosen for cube integration($dx=dy=7.5\text{mm}$; $dz=5\text{mm}$).
- Distance between probe sensors and phantom surface was set to 2.5 mm.
- The dipole input power (forward power) was $250\text{ mW} \pm 3\%$.
- The results are normalized to 1 W input power.

Reference SAR Values

The reference SAR values were using measurement results indicated in the dipole calibration document (See attached dipole certificate).

f (MHz)	Head Tissue		Body Tissue	
	SAR _{1g}	SAR _{10g}	SAR _{1g}	SAR _{10g}
2450	52.0	23.8	54.8	25.4

6.1 SYSTEM PERFORMANCE CHECK RESULTS

@ System Validation Dipole: D2450V2 SN: 748

Date: October 29, 2004

Ambient Temperature = 23°C ; Relative humidity = 40%

Measured by: Sunny Shih

Body Simulating Liquid			Measured		Target _{1g}	Deviation[%]	Limit [%]
f (MHz)	Temp. [°C]	Depth [cm]	1g	Normalized to 1 W			
2450	22	15	12.8	51.2	54.8	-6.57	± 10

7 SAR MEASUREMENT PROCEDURES

A summary of the procedure follows:

- a) A measurement of the SAR value at a fixed location is used as a reference value for assessing the power drop of the EUT. The SAR at this point is measured at the start of the test, and then again at the end of the test.
- b) The SAR distribution at the exposed flat section of the flat phantom is measured at a distance of 2.5 mm from the inner surface of the shell. The area covers the entire dimension of the EUT and the horizontal grid spacing is 15 mm x 15 mm. Based on this data, the area of the maximum absorption is determined by Spline interpolation. The first Area Scan covers the entire dimension of the EUT to ensure that the hotspot was correctly identified.
- c) Around this point, a volume of X=Y=Z=30 mm is assessed by measuring 5 x 5 x 7 mm points. On the basis of this data set, the spatial peak SAR value is evaluated with the following procedure:
 - (i) The data at the surface are extrapolated, since the centre of the dipoles is 1.2 mm away from the tip of the probe and the distance between the surface and the lowest measuring point is 1.3 mm. The extrapolation is based on a least square algorithm. A polynomial of the fourth order is calculated through the points in z-axes. This polynomial is then used to evaluate the points between the surface and the probe tip.
 - (ii) The maximum interpolated value is searched with a straightforward algorithm. Around this maximum the SAR values averaged over the spatial volumes (1 g and 10 g) are computed using the 3D-Spline interpolation algorithm. The 3D-Spline is composed of three one-dimensional splines with the "Not a knot"- condition (in x, y and z-direction). The volume is integrated with the trapezoidal – algorithm. One thousand points (10 x 10 x 10) are interpolated to calculate the averages.
 - (iii) All neighbouring volumes are evaluated until no neighbouring volume with a higher average value is found.
 - (iv) The SAR value at the same location as in Step (a) is again measured to evaluate the actual power drift.

DASY4 SAR MEASUREMENT PROCEDURE

Step 1: Power Reference Measurement

The Power Reference Measurement and Power Drift Measurements are for monitoring the power drift of the device under test in the batch process. The Minimum distance of probe sensors to surface determines the closest measurement point to phantom surface. The minimum distance of probe sensors to surface is 2.1 mm. This distance cannot be smaller than the Distance of sensor calibration points to probe tip as defined in the probe properties (for example, 1.2 mm for an EX3DV3 probe type).

Step 2: Area Scan

The Area Scan is used as a fast scan in two dimensions to find the area of high field values, before doing a fine measurement around the hot spot. The sophisticated interpolation routines implemented in DASY4 software can find the maximum locations even in relatively coarse grids. When an Area Scan has measured all reachable points, it computes the field maximal found in the scanned area, within a range of the global maximum. The range (in dB) is specified in the standards for compliance testing. For example, a 2 dB range is required in IEEE Standard 1528, EN 50361 and IEC 62209 standards, whereby 3 dB is a requirement when compliance is assessed in accordance with the ARIB standard (Japan). If only one Zoom Scan follows the Area Scan, then only the absolute maximum will be taken as reference. For cases where multiple maximums are detected, the number of Zoom Scans has to be increased accordingly.

Step 3: Zoom Scan

Zoom Scans are used to assess the peak spatial SAR values within a cubic averaging volume containing 1 g and 10 g of simulated tissue. The Zoom Scan measures 5 x 5 x 7 points within a cube whose base faces are centered on the maxima found in a preceding area scan job within the same procedure. When the measurement is done, the Zoom Scan evaluates the averaged SAR for 1 g and 10 g and displays these values next to the job's label.

Step 4: Power drift measurement

The Power Drift Measurement measures the field at the same location as the most recent power reference measurement within the same procedure, and with the same settings. The Power Drift Measurement gives the field difference in dB from the reading conducted within the last Power Reference Measurement. This allows a user to monitor the power drift of the device under test within a batch process. The measurement procedure is the same as Step 1.

Step 5: Z-Scan

The Z Scan measures points along a vertical straight line. The line runs along the Z-axis of a one-dimensional grid. In order to get a reasonable extrapolation, the extrapolated distance should not be larger than the step size in Z-direction.

8 PROCEDURES USED TO ESTABLISH TEST SIGNAL

The following procedures had been used to prepare the EUT for the SAR test.

The client supplied a special driving program to program the EUT to continually transmit the specified maximum power and also to change the channel frequency.

Maximum conducted power was measured prior to SAR measurement.

802.11b

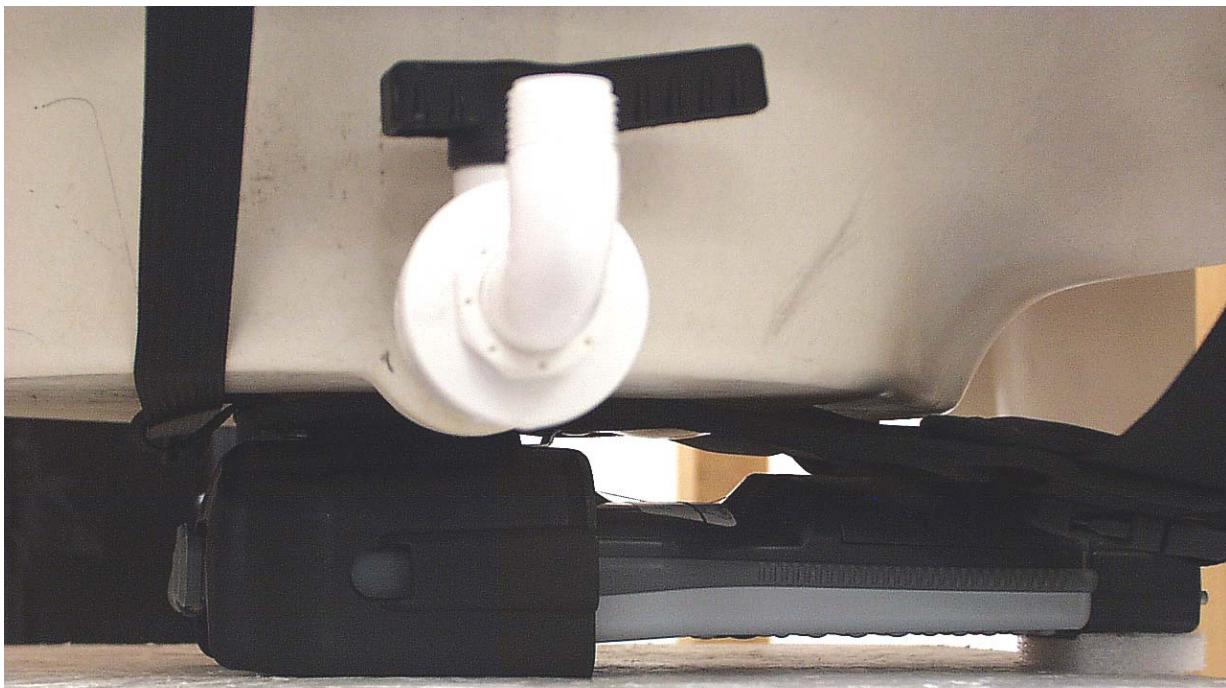
Ch No.	f [MHz]	Conducted Power [dBm]	Data Rate [Mbps]
1	2412	13.10	1
6	2437	17.40	1
11	2462	11.10	1

802.11g

Ch No.	f [MHz]	Conducted Power [dBm]	Data Rate [Mbps]
1	2412	12.20	6
6	2437	16.90	6
11	2462	10.60	6

9 SAR MEASUREMENT RESULTS

9.1 TEST POSITION 1



802.11b - Duty cycle: 100%; Crest factor: 1

Depth of liquid: 15 cm

Sep. dist. [mm]	Antenna	Ch. #	f [MHz]	*Power reference [V/m]		SAR_1g [mW/g]	
				Before	After	Measured	Limit
0	Fixed	1	2412	8.61	8.50	0.183	1.6
0	Fixed	6	2437	18.30	18.15	0.471	1.6
0	Fixed	11	2462	6.81	6.70	0.100	1.6

802.11g - Duty cycle: 100%; Crest factor: 1

0	Fixed	1	2412				1.6
0	Fixed	6	2437	19.60	19.45	0.432	1.6
0	Fixed	11	2462				1.6

Notes:

1. *: Power reference - The power drift measured at same position in liquid before and after each SAR measurement..
2. If the SAR measured at the middle channel for this configuration is at least 3 dB lower than SAR limit, testing at low & high channel is optional.
3. The battery was fully charged in accordance with manufacturer's instructions prior to SAR measurements.
4. Please see attachment for the detailed measurement data and plots showing the maximum SAR location of the EUT.

9.2 TEST POSITION 2



802.11b - Duty cycle: 100%; Crest factor: 1

Depth of liquid: 15 cm

Sep. dist. [mm]	Antenna	Ch. #	f [MHz]	*Power reference [V/m]		SAR_1g [mW/g]	
				Before	After	Measured	Limit
0	Fixed	1	2412				1.6
0	Fixed	6	2437	14.10	13.95	0.049	1.6
0	Fixed	11	2462				1.6

802.11g - Duty cycle: 100%; Crest factor: 1

0	Fixed	1	2412				1.6
0	Fixed	6	2437	13.30	13.20	0.044	1.6
0	Fixed	11	2462				1.6

Notes:

1. *: Power reference - The power drift measured at same position in liquid before and after each SAR measurement..
2. If the SAR measured at the middle channel for this configuration is at least 3 dB lower than SAR limit, testing at low & high channel is optional.
3. The battery was fully charged in accordance with manufacture's instructions prior to SAR measurements.
4. Please see attachment for the detailed measurement data and plots showing the maximum SAR location of the EUT.

9.3 TEST POSITION 3



802.11b - Duty cycle: 100%; Crest factor: 1

Depth of liquid: 15 cm

Sep. dist. [mm]	Antenna	Ch. #	f [MHz]	*Power reference [V/m]		SAR_1g [mW/g]	
				Before	After	Measured	Limit
0	Fixed	1	2412				1.6
0	Fixed	6	2437	10.70	10.50	0.038	1.6
0	Fixed	11	2462				1.6

802.11g - Duty cycle: 100%; Crest factor: 1

0	Fixed	1	2412				1.6
0	Fixed	6	2437	10.30	10.10	0.034	1.6
0	Fixed	11	2462				1.6

Notes:

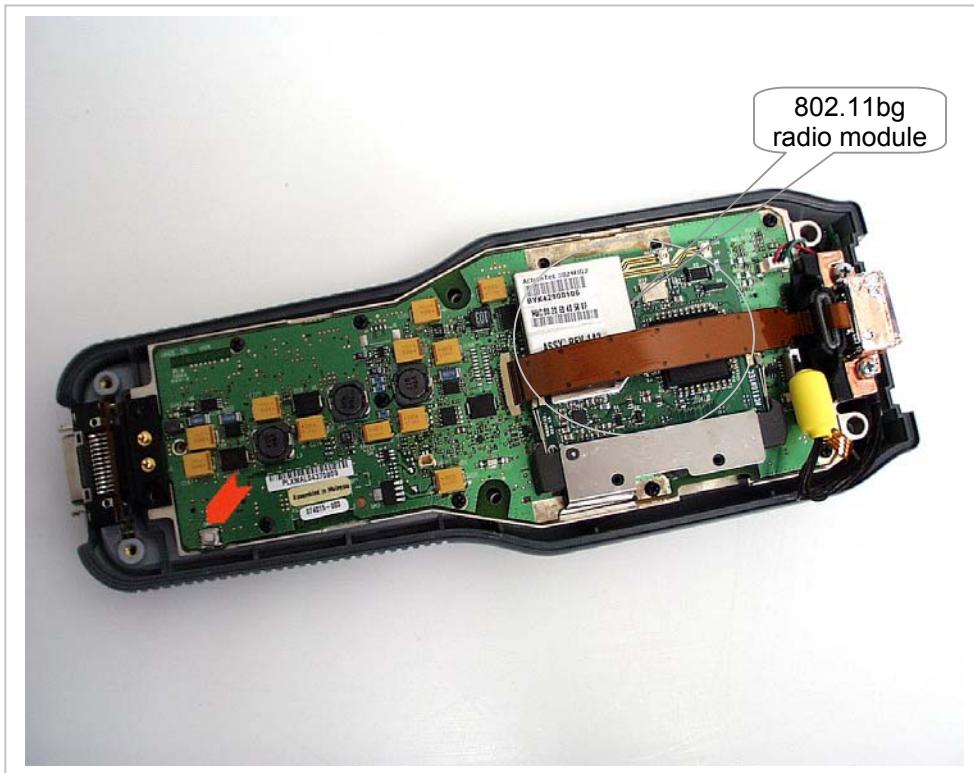
1. *: Power reference - The power drift measured at same position in liquid before and after each SAR measurement..
2. If the SAR measured at the middle channel for this configuration is at least 3 dB lower than SAR limit, testing at low & high channel is optional.
3. The battery was fully charged in accordance with manufacture's instructions prior to SAR measurements.
4. Please see attachment for the detailed measurement data and plots showing the maximum SAR location of the EUT.

10 EUT PHOTOS**HOST DEVICE (1/4)**

HOST DEVICE (2/4)



HOST DEVICE (3/4)

HOST DEVICE (4/4)

EUT PHOTOS (1/1)

11 MEASUREMENT UNCERTAINTY

UNCERTAINTY BUDGE ACCORDING TO IEEE P1528								
Error Description	Uncertainty Value [%]	Prob. Dist.	Div.	(c_i) 1g	(c_i) 10g	Std. Unc. (1g)	Std. Unc. (10g)	(v_i) V_{eff}
Measurement System								
Probe Calibration	± 4.8	N	1	1	1	$\pm 4.8\%$	$\pm 4.8\%$	∞
Axial Isotropy	± 4.7	R	$\sqrt{3}$	0.7	0.7	$\pm 1.9\%$	$\pm 1.9\%$	∞
Hemispherical Isotropy	± 9.6	R	$\sqrt{3}$	0.7	0.7	$\pm 3.9\%$	$\pm 3.9\%$	∞
Boundary Effects	± 1.0	R	$\sqrt{3}$	1	1	$\pm 0.6\%$	$\pm 0.6\%$	∞
Linearity	± 4.7	R	$\sqrt{3}$	1	1	$\pm 2.7\%$	$\pm 2.7\%$	∞
System Detection Limits	± 1.0	R	$\sqrt{3}$	1	1	$\pm 0.6\%$	$\pm 0.6\%$	∞
Readout Electronics	± 1.0	N	$\sqrt{3}$	1	1	$\pm 1.0\%$	$\pm 1.0\%$	∞
Response Time	± 0.8	R	$\sqrt{3}$	1	1	$\pm 0.5\%$	$\pm 0.5\%$	∞
Integration Time	± 2.6	R	$\sqrt{3}$	1	1	$\pm 1.5\%$	$\pm 1.5\%$	∞
RF Ambient Condition	± 1.59	R	$\sqrt{3}$	1	1	$\pm 0.9\%$	$\pm 0.9\%$	∞
Probe Positioner	± 1.6	R	$\sqrt{3}$	1	1	$\pm 0.2\%$	$\pm 0.2\%$	∞
Probe Positioning	± 2.9	R	$\sqrt{3}$	1	1	$\pm 1.7\%$	$\pm 1.7\%$	∞
Max. SAR Eval.	± 1.0	R	$\sqrt{3}$	1	1	$\pm 0.6\%$	$\pm 0.6\%$	∞
Test sample Related								
Device Positioning	± 1.1	N	1	1	1	$\pm 1.1\%$	$\pm 1.1\%$	145
Device Holder	± 3.6	N	1	1	1	$\pm 3.6\%$	$\pm 3.6\%$	5
Power Drift	± 5.0	R	$\sqrt{3}$	1	1	$\pm 2.9\%$	$\pm 2.9\%$	∞
Phantom and Setup								
Phantom Uncertainty	± 4.0	R	$\sqrt{3}$	1	1	$\pm 2.3\%$	$\pm 2.3\%$	∞
Liquid Conductivity (target)	± 5.0	R	$\sqrt{3}$	0.64	0.43	$\pm 1.8\%$	$\pm 1.2\%$	∞
Liquid Conductivity (meas.)	± 2.5	N	1	0.64	0.43	$\pm 1.6\%$	$\pm 1.1\%$	∞
Liquid Permittivity (target)	± 5.0	R	$\sqrt{3}$	0.6	0.49	$\pm 1.7\%$	$\pm 1.4\%$	∞
Liquid Permittivity (meas.)	± 2.5	N	1	0.6	0.49	$\pm 1.5\%$	$\pm 1.2\%$	∞
Combined Std. Uncertainty						$\pm 9.8\%$	$\pm 9.6\%$	330
Expanded STD Uncertainty						$\pm 19.6\%$	$\pm 19.2\%$	

Table: Worst-case uncertainty for DASY4 assessed according to IEEE P1528.

The budge is valid for the frequency range 300MHz – 3GHz and represents a worst-case analysis.

12 EQUIPMENT LIST & CALIBRATION STATUS

<u>Name of Equipment</u>	<u>Manufacturer</u>	<u>Type/Model</u>	<u>Serial Number</u>	<u>Cal. Due date</u>
Robot - Six Axes	Stäubli	RX90BL	N/A	N/A
Robot Remote Control	Stäubli	CS7MB	3403-91535	N/A
DASY4 Measurement Server	SPEAG	SEUMS001BA	1041	N/A
Probe Alignment Unit	SPEAG	LB (V2)	261	N/A
S-Parameter Network Analyzer	Agilent	8753ES-6	US39173569	8/19/05
Electronic Probe kit	Hewlett Packard	85070C	N/A	N/A
E-Field Probe	SPEAG	EX3DV3	3531	7/18/05
Thermometer	ERTCO	639-1	8402	10/13/2005
Thermometer	ERTCO	639-1	8404	10/21/2005
Thermometer	ERTCO	637-1	8661	10/21/2005
SAM Phantom (SAM1)	SPEAG	TP-1185	QD000P40CA	N/A
SAM Phantom (SAM2)	SPEAG	TP-1015	N/A	N/A
Data Acquisition Electronics	SPEAG	DAE3 V1	500	12/23/04
System Validation Dipole	SPEAG	D2450V2	748	5/14/06
Signal General	R&H	SMP 04	DE34210	5/5/05
Power Meter	Giga-tronics	8651A	8651404	9/16/05
Power Sensor	Giga-tronics	80701A	1834588	9/16/05
Amplifier	Mini-Circuits	ZVE-8G	0360	N/A
Amplifier	Mini-Circuits	ZHL-42W	D072701-5	N/A
Radio Communication Tester	Rohde & Schwarz	CMU 200	838114/032	12/1/04
Simulating Liquid	CCS	M2450	N/A	Within 24 hrs of first test

13 ATTACHMENTS

No.	Contents	No. of page (s)
1	System Performance Check Plots	2
2	SAR Test Plots	11
3	Certificate of E-Field Probe EX3DV3 SN 3521	8
4	Certificate of System Validation Dipole D2450V2 SN 748	9

END OF REPORT