Appendix C – Dipole Calibration

Schmid & Partner
Engineering AG

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DASY

Dipole Validation Kit

Type: D2450V2

Serial: 712

Manufactured: July 5, 2002
Calibrated: July 15, 2002

1. Measurement Conditions

The measurements were performed in the flat section of the new SAM twin phantom filled with head simulating solution of the following electrical parameters at 2450 MHz:

Relative permitivity	**38.3**	± 5%
Conductivity	**1.90 mho/m**	± 10%

The DASY3 System (Software version 3.1d) with a dosimetric E-field probe ET3DV6 (SN:1507, conversion factor 5.0 at 2450 MHz) was used for the measurements.

The dipole feedpoint was positioned below the center marking and oriented parallel to the body axis (the long side of the phantom). The standard measuring distance was 10mm 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^3 (1 g) of tissue: **58.0 mW/g**

averaged over 10 cm^3 (10 g) of tissue: **26.6 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^3 (1 g) of tissue: **54.8 mW/g**

averaged over 10 cm^3 (10 g) of tissue: **25.4 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:	**1.155 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 2450 MHz:	Re{Z} = **51.2 Ω**
	Im {Z} = **2.7 Ω**
Return Loss at 2450 MHz	**- 30.7 dB**

4. Measurement Conditions

The measurements were performed in the flat section of the new SAM twin phantom filled with body simulating solution of the following electrical parameters at 2450 MHz:

Relative permitivity	**51.7**	± 5%
Conductivity	**2.01 mho/m**	± 10%

The DASY3 System (Software version 3.1d) with a dosimetric E-field probe ET3DV6 (SN:1507, conversion factor 4.5 at 2450 MHz) was used for the measurements.

The dipole feedpoint was positioned below the center marking and oriented parallel to the body axis (the long side of the phantom). The standard measuring distance was 10mm 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.

5.1. SAR Measurement with DASY3 System

Standard SAR-measurements were performed according to the measurement conditions described in section 4. 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^3 (1 g) of tissue: **57.6 mW/g**

averaged over 10 cm^3 (10 g) of tissue: **26.8 mW/g**

5.2 SAR Measurement with DASY4 System

Standard SAR-measurements were performed according to the measurement conditions described in section 4. 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^3 (1 g) of tissue: **52.0 mW/g**

averaged over 10 cm^3 (10 g) of tissue: **25.0 mW/g**

6. 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.

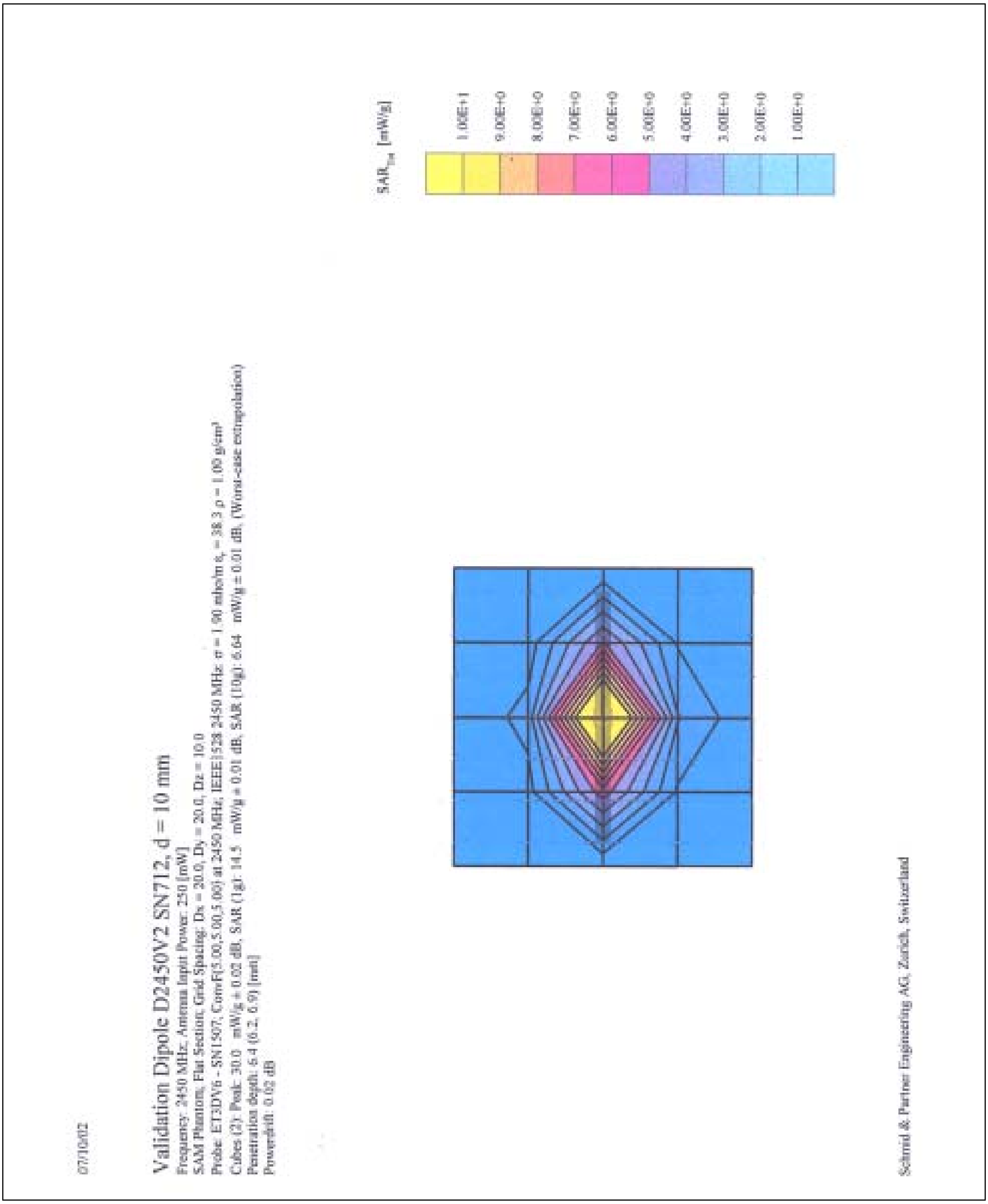
7. Design

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.

Small end caps have been added to the dipole arms in order to improve matching when loaded according to the position as explained in Section 1. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

8. Power Test

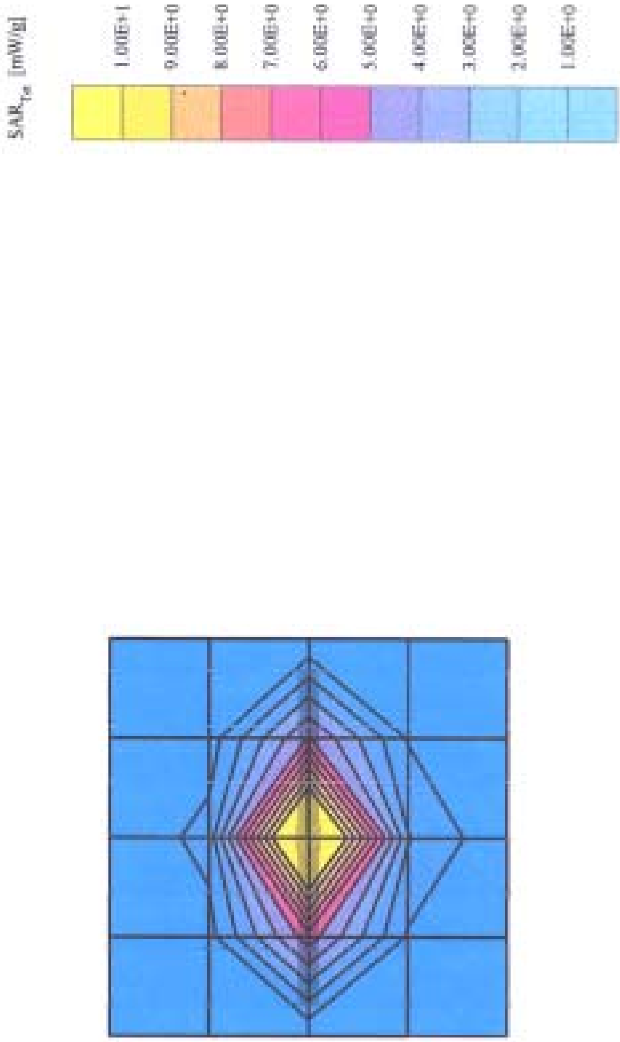
After long term use with 40W radiated power, only a slight warming of the dipole near the feedpoint can be measured.


07/10/02
Validation Dipole D2450V2 SN712, d = 10 mm
Frequency: 2450 MHz; Antenna Input Power: 250 [mW]
SAM Phantom; Flat Section; Grid Spacing: Dx = 20.0, Dy = 20.0, Dz = 10.0
Probe: ET3DV6 - SN1507; ConvF(5.00,5.00,5.00) at 2450 MHz; IEEE1528 2450 MHz: σ = 1.90 mho/m εr = 38.3 ρ = 1.00 g/cm³
Cubes (2): Peak: 30.0 mW/g ± 0.02 dB, SAR (1g): 14.5 mW/g ± 0.01 dB, SAR (10g): 6.64 mW/g ± 0.01 dB, (Worst-case extrapolation)
Penetration depth: 6.4 (6.2, 6.9) [mm]
Powerdrift: 0.02 dB
SAR [mW/g]
1.00E+1
9.00E+0
8.00E+0
7.00E+0
6.00E+0
5.00E+0
4.00E+0
3.00E+0
2.00E+0
1.00E+0
Schmid & Partner Engineering AG, Zurich, Switzerland

07/10/02

Validation Dipole D2450V2 SN712, d = 10 mm

Frequency: 2450 MHz; Antenna Input Power: 250 [mW]
SAM Phantom; Flat Section; Grid Spacing: Dx = 20.0, Dy = 20.0, Dz = 10.0
Probe: ET3DV6 - SN1507; ConvF(5.00,5.00,5.00) at 2450 MHz; IEEE1528 2450 MHz: σ = 1.90 mho/m ϵ_r = 38.3 ρ = 1.00 g/cm^3
Cubes (2): Peak: 27.4 mW/g ± 0.02 dB, SAR (1g): 13.7 mW/g ± 0.01 dB, SAR (10g): 6.34 mW/g ± 0.01 dB, (Advanced extrapolation)
Penetration depth: 6.7 (6.6, 7.0) [mm]
Powerdrift: 0.02 dB



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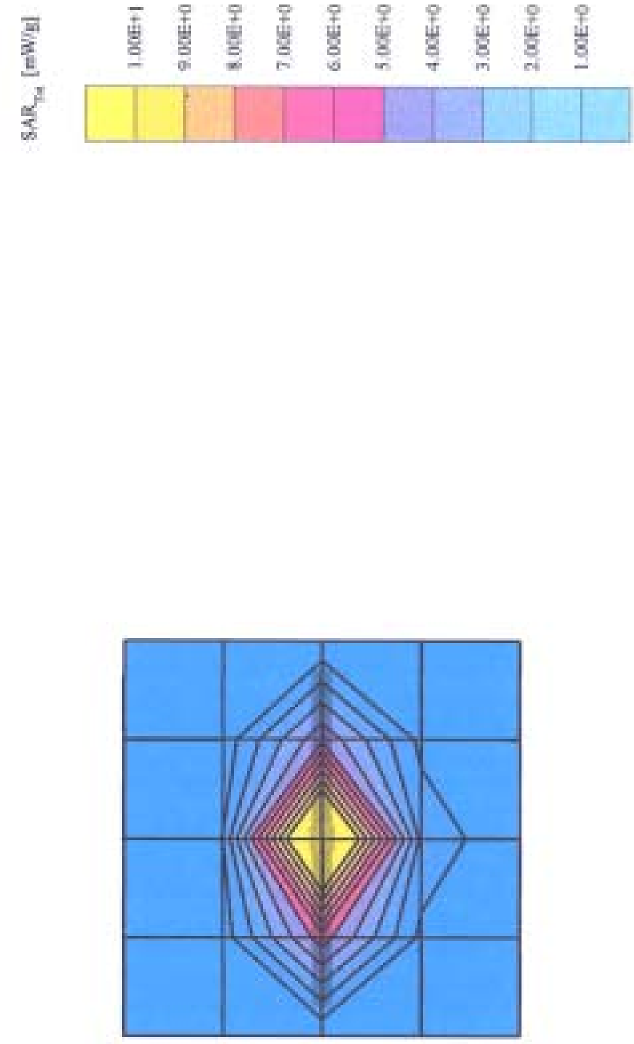
07/15/02

Validation Dipole D2450V2 SN712, d = 10 mm

Frequency: 2450 MHz; Antenna Input Power: 250 [mW]
SAM Phantom; Flat Section; Grid Spacing: Dx = 20.0, Dy = 20.0, Dz = 10.0
Probe: ET3DV6 - SN1507; ConvF(4.50,4.50,4.50) at 2450 MHz; IEEE1528 2450 MHz: σ = 2.01 mho/m ε_r = 51.7 ρ = 1.00 g/cm³
Cubes (2): Peak: 28.8 mW/g ± 0.02 dB, SAR (1g): 14.4 mW/g ± 0.02 dB, SAR (10g): 6.71 mW/g ± 0.01 dB, (Worst-case extrapolation)
Penetration depth: 7.2 (6.9, 7.9) [mm]
Powerdrift: 0.01 dB



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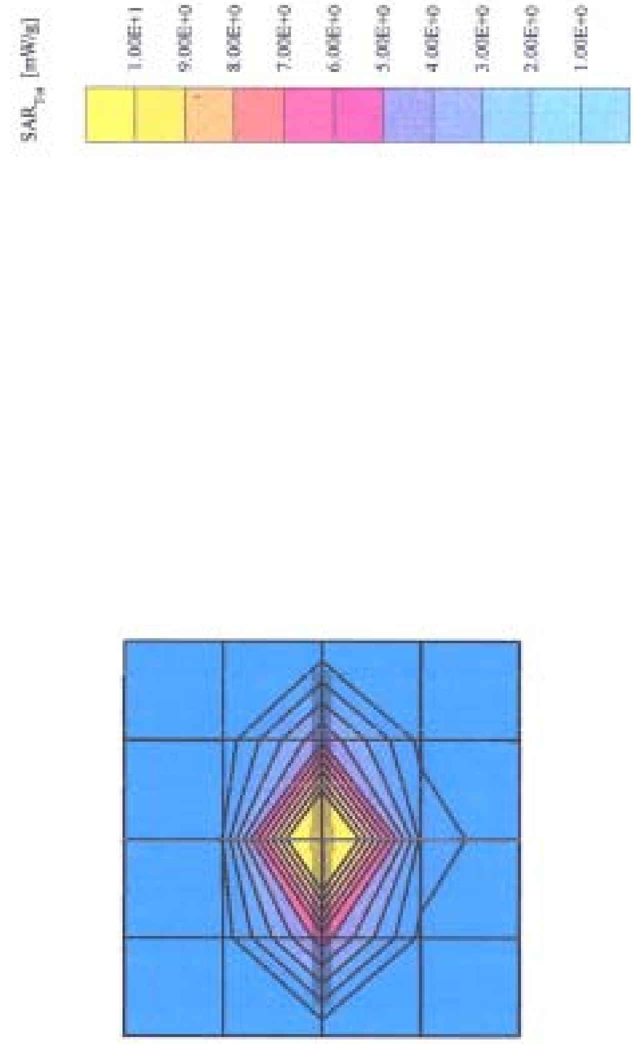
07/15/02

Validation Dipole D2450V2 SN712, d = 10 mm

Frequency: 2450 MHz; Antenna Input Power: 250 [mW]
SAM Phantom; Flat Section; Grid Spacing: Dx = 20.0, Dy = 20.0, Dz = 10.0
Probe: ET3DV6 - SN1507; ConvF(4.50,4.50,4.50) at 2450 MHz; IEEE1528 2450 MHz: σ = 2.01 mho/m ϵ_r = 51.7 ρ = 1.00 g/cm³
Cubes (2): Peak: 24.7 mW/g ± 0.02 dB, SAR (1g): 13.0 mW/g ± 0.02 dB, SAR (10g): 6.24 mW/g ± 0.01 dB, (Advanced extrapolation)
Penetration depth: 7.8 (7.7, 8.1) [mm]
Powerdrift: 0.01 dB



Schmid & Partner Engineering AG, Zurich, Switzerland

Appendix D – Probe Calibration

Schmid & Partner Engineering AG

Zeughausstrasse 43, 8004 Zurich, Switzerland, Phone +41 1 245 97 00, Fax +41 1 245 97 79

Calibration Certificate

Dosimetric E-Field Probe

Type:	**ET3DV6**
Serial Number:	**1531**
Place of Calibration:	**Zurich**
Date of Calibration:	**August 27, 2002**
Calibration Interval:	**12 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:	[signature]

Schmid & Partner
Engineering AG

Zeughausstrasse 43, 8004 Zurich, Switzerland, Telephone +41 1 245 97 00, Fax +41 1 245 97 79

Probe ET3DV6

SN:1531

Manufactured:	July 15, 2000
Last calibration:	September 24, 2001
Recalibrated:	August 27, 2002

Calibrated for System DASY3

ET3DV6 SN:1531 August 27, 2002

DASY3 - Parameters of Probe: ET3DV6 SN:1531

Sensitivity in Free Space

NormX	1.43	μV/(V/m)^2
NormY	1.47	μV/(V/m)^2
NormZ	1.51	μV/(V/m)^2

Diode Compression

DCP X	97	mV
DCP Y	97	mV
DCP Z	97	mV

Sensitivity in Tissue Simulating Liquid

Head	900 MHz	ε_r = 41.5 ± 5%	σ = 0.97 ± 5% mho/m
Head	835 MHz	ε_r = 41.5 ± 5%	σ = 0.90 ± 5% mho/m

ConvF X	6.3 ± 9.5% (k=2)		Boundary effect:	
ConvF Y	6.3 ± 9.5% (k=2)		Alpha	0.38
ConvF Z	6.3 ± 9.5% (k=2)		Depth	2.57

Head	1800 MHz	ε_r = 40.0 ± 5%	σ = 1.40 ± 5% mho/m
Head	1900 MHz	ε_r = 40.0 ± 5%	σ = 1.40 ± 5% mho/m

ConvF X	5.3 ± 9.5% (k=2)		Boundary effect:	
ConvF Y	5.3 ± 9.5% (k=2)		Alpha	0.57
ConvF Z	5.3 ± 9.5% (k=2)		Depth	2.27

Boundary Effect

Head 900 MHz Typical SAR gradient: 5 % per mm

Probe Tip to Boundary		1 mm	2 mm
SAR_{be} [%]	Without Correction Algorithm	10.4	5.9
SAR_{be} [%]	With Correction Algorithm	0.4	0.6

Head 1800 MHz Typical SAR gradient: 10 % per mm

Probe Tip to Boundary		1 mm	2 mm
SAR_{be} [%]	Without Correction Algorithm	12.4	8.0
SAR_{be} [%]	With Correction Algorithm	0.1	0.3

Sensor Offset

Probe Tip to Sensor Center	2.7	mm
Optical Surface Detection	1.3 ± 0.2	mm

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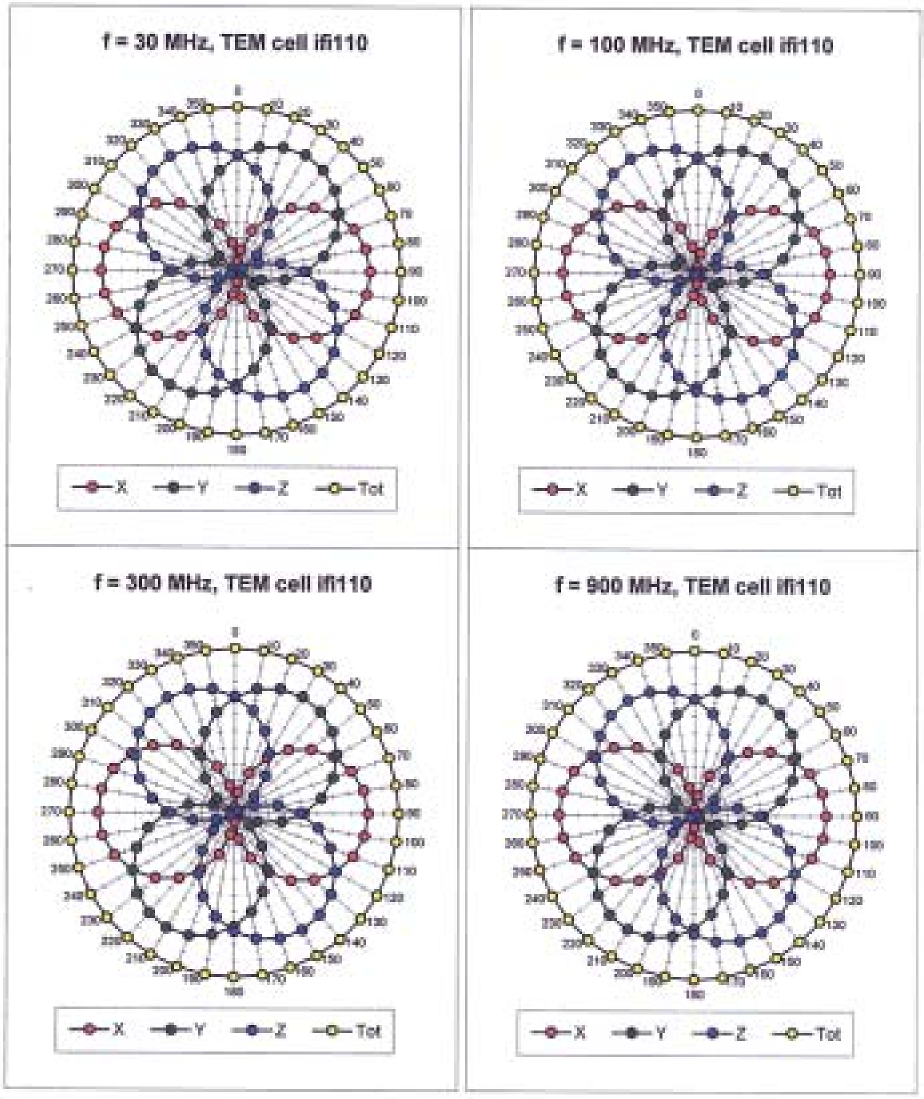
Receiving Pattern (φ), θ = 0°



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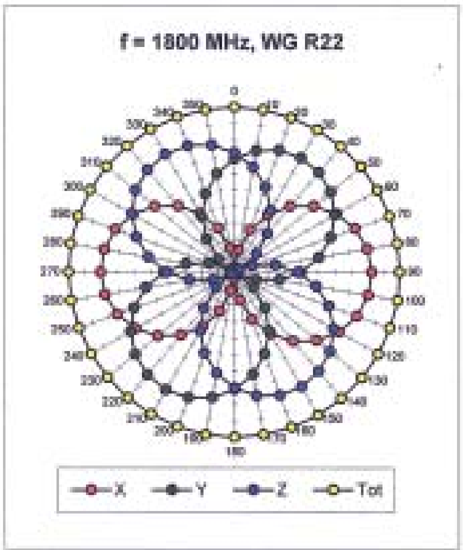
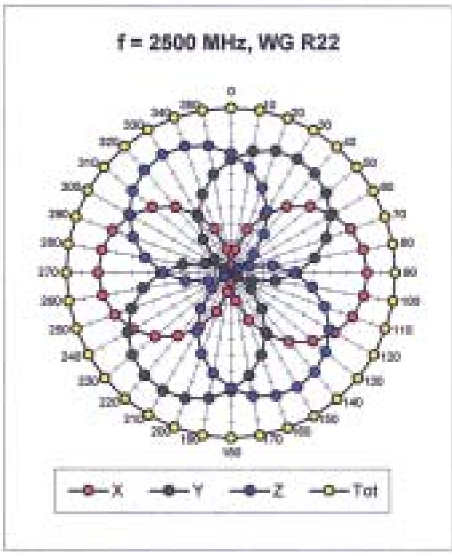
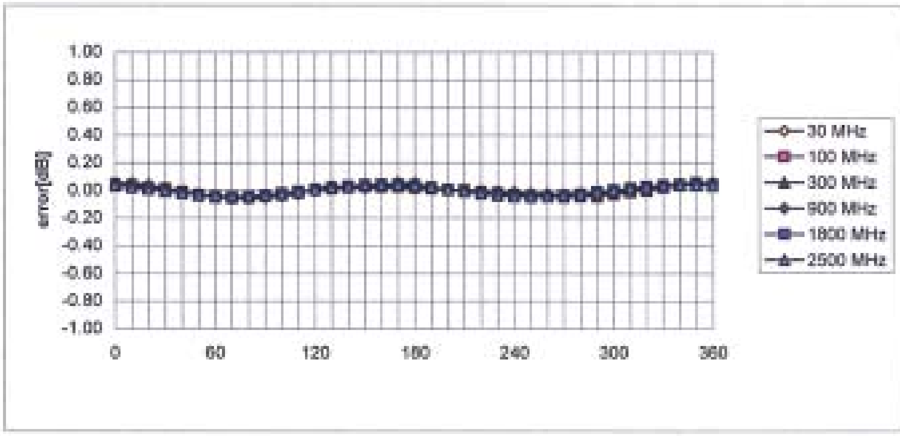




Isotropy Error (φ), θ = 0°



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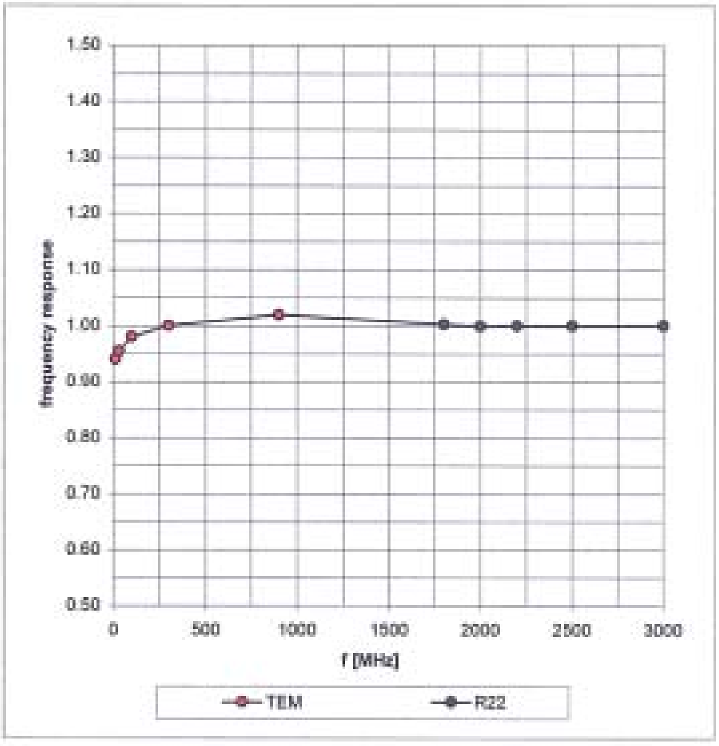
Frequency Response of E-Field

(TEM-Cell:ifi110, Waveguide R22)



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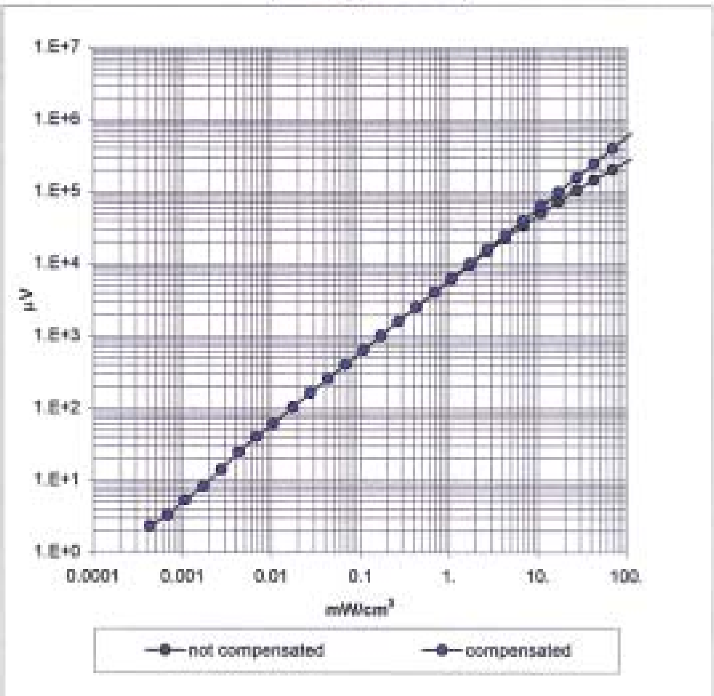
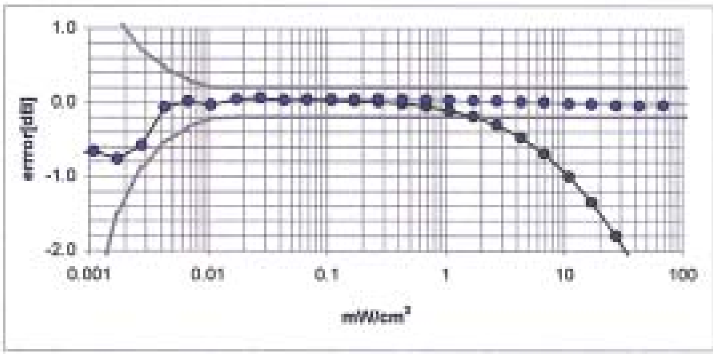
Dynamic Range f(SAR_{brain})

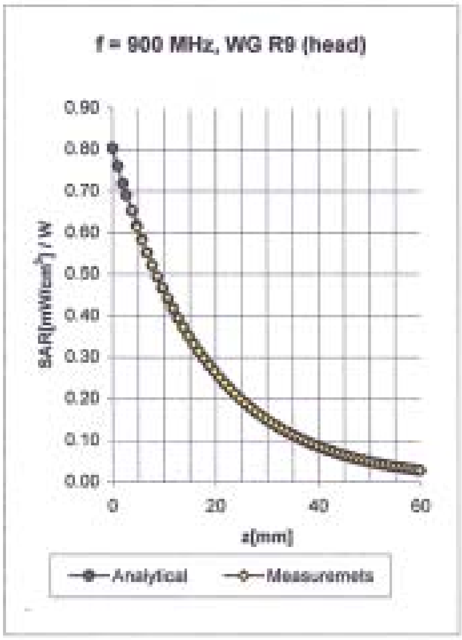
(Waveguide R22)

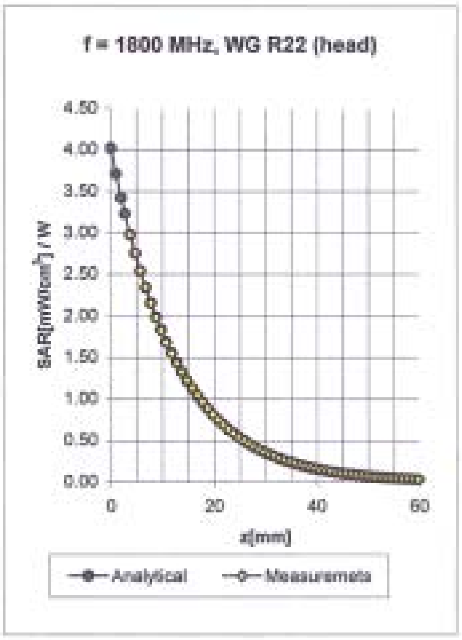




ET3DV6 SN:1531 August 27, 2002

Conversion Factor Assessment





Head **900 MHz** ε_r = **41.5 ± 5%** σ = **0.97 ± 5% mho/m**

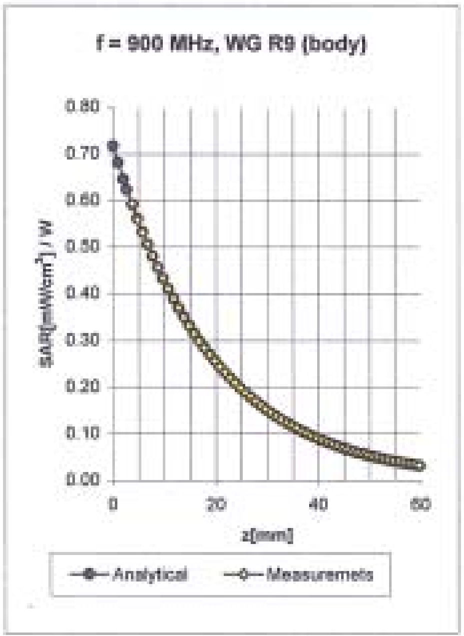
ConvF X	**6.3** ± 9.5% (k=2)		Boundary effect:	
ConvF Y	**6.3** ± 9.5% (k=2)		Alpha	**0.38**
ConvF Z	**6.3** ± 9.5% (k=2)		Depth	**2.57**

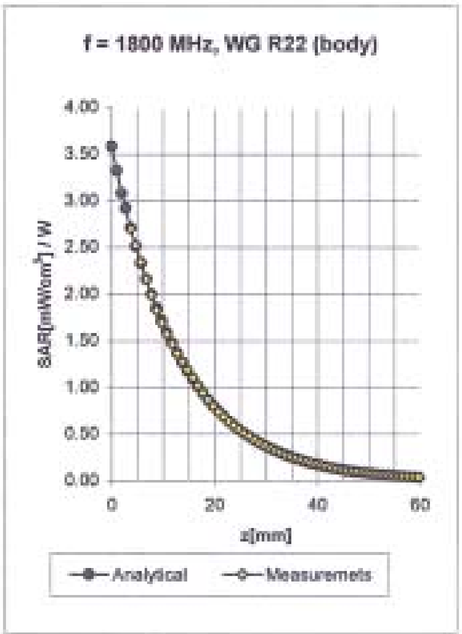
Head **1800 MHz** ε_r = **40.0 ± 5%** σ = **1.40 ± 5% mho/m**

ConvF X	**5.3** ± 9.5% (k=2)		Boundary effect:	
ConvF Y	**5.3** ± 9.5% (k=2)		Alpha	**0.57**
ConvF Z	**5.3** ± 9.5% (k=2)		Depth	**2.27**

ET3DV6 SN:1531 August 27, 2002

Conversion Factor Assessment





Body 900 MHz ε_r = 55.0 ± 5% σ = 1.05 ± 5% mho/m

ConvF X	6.1	± 9.5% (k=2)	Boundary effect:	
ConvF Y	6.1	± 9.5% (k=2)	Alpha	0.42
ConvF Z	6.1	± 9.5% (k=2)	Depth	2.46

Body 1800 MHz ε_r = 53.3 ± 5% σ = 1.52 ± 5% mho/m

ConvF X	5.1	± 9.5% (k=2)	Boundary effect:	
ConvF Y	5.1	± 9.5% (k=2)	Alpha	0.68
ConvF Z	5.1	± 9.5% (k=2)	Depth	2.18

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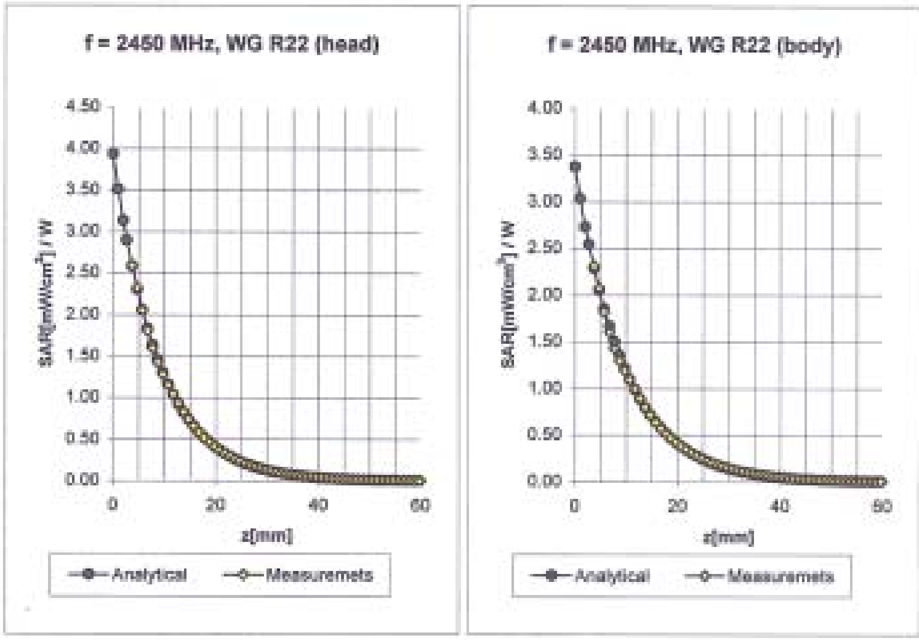
Conversion Factor Assessment



2450	Head	MHz	ε_r = 39.2 ± 5%	σ = 1.80 ± 5% mho/m
	ConvF X	4.9 ± 8.9% (k=2)		Boundary effect:
	ConvF Y	4.9 ± 8.9% (k=2)		Alpha 1.00
	ConvF Z	4.9 ± 8.9% (k=2)		Depth 1.70
2450	Body	MHz	ε_r = 52.7 ± 5%	σ = 1.95 ± 5% mho/m
	ConvF X	4.5 ± 8.9% (k=2)		Boundary effect:
	ConvF Y	4.5 ± 8.9% (k=2)		Alpha 1.00
	ConvF Z	4.5 ± 8.9% (k=2)		Depth 1.66

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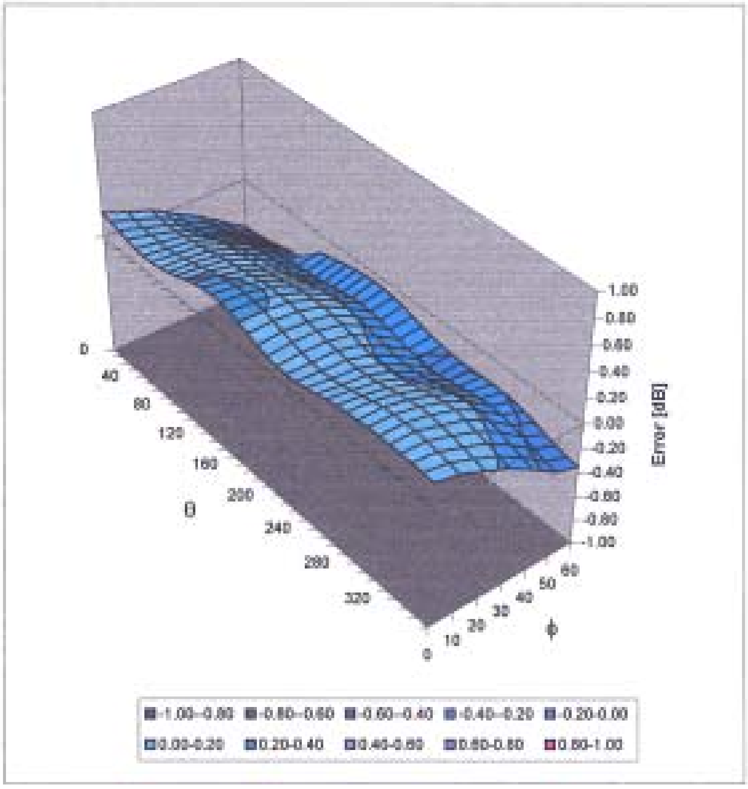
Deviation from Isotropy in HSL

Error (θ,ϕ), f = 900 MHz



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IMPORTANT NOTICE

USAGE OF PROBES IN ORGANIC SOLVENTS

Diethylene Gycol Monobuthy Ether (the basis for HSL1800 and M1800 liquids), as many other organic solvents, is a very effective softener for synthetic materials. These solvents can cause irreparable damage to certain SPEAG products, except those which are explicitly declared as compliant with organic solvents.

Compatible Probes:
- ET3DV6
- ET3DV6R
- ES3DV2
- ER3DV6
- H3DV6

Important Note for ET3DV6 Probes:
The ET3DV6 probes shall not be exposed to solvents longer than necessary for the measurements and shall be cleaned daily after use with warm water and stored dry.

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Schmid & Partner Engineering AG

合格

Technical Note 01.06.15-1

June 2002

Appendix E – Data Acquisition Electronic (DAE) Calibration

Schmid & Partner
Engineering AG

DASY - DOSIMETRIC ASSESSMENT SYSTEM

CALIBRATION REPORT

DATA ACQUISITION ELECTRONICS

MODEL: DAE3 V1

SERIAL NUMBER: 393

This Data Acquisition Unit was calibrated and tested using a FLUKE 702 Process Calibrator. Calibration and verification were performed at an ambient temperature of 23 ± 5 °C and a relative humidity of < 70%.

Measurements were performed using the standard DASY software for converting binary values, offset compensation and noise filtering. Software settings are indicated in the reports.

Results from this calibration relate only to the unit calibrated.

Calibrated by: Storchenegger

Calibration Date: 18.12, 2002

DASY Software Version: DASY3 V3.1c

Dae393c

1. DC Voltage Measurement

DA - Converter Values from DAE

High Range:	1LSB =	6.1μV ,	full range =	400 mV
Low Range:	1LSB =	61nV ,	full range =	4 mV

Software Set-up: Calibration time: 3 sec   Measuring time: 3 sec

Setup	X	Y	Z
High Range	404.0746844	404.3390978	404.1879964
Low Range	3.97137	3.94142	3.95498
Connector Position	19 °		

High Range	Input	Reading in μV	% Error
Channel X + Input	200mV	199999.6	0.00
	20mV	19995.32	-0.02
Channel X - Input	20mV	-19993.79	-0.03
Channel Y + Input	200mV	199999.5	0.00
	20mV	19993.39	-0.03
Channel Y - Input	20mV	-19994.02	-0.03
Channel Z + Input	200mV	200000	0.00
	20mV	19994.5	-0.03
Channel Z - Input	20mV	-20003.01	0.02

Low Range	Input	Reading in μV	% Error
Channel X + Input	2mV	2000.05	0.00
	0.2mV	200.366	0.18
Channel X - Input	0.2mV	-200.379	0.19
Channel Y + Input	2mV	2000.02	0.00
	0.2mV	199.114	-0.44
Channel Y - Input	0.2mV	-200.753	0.38
Channel Z + Input	2mV	2000.02	0.00
	0.2mV	199.202	-0.40
Channel Z - Input	0.2mV	-201.2	0.60

Dae393c

2. Common mode sensitivity

Software Set-up
Calibration time: 3 sec, Measuring time: 3 sec
High/Low Range

in µV	Common mode Input Voltage	High Range Reading	Low Range Reading
Channel X	200mV	11.5195	10.6443
	- 200mV	-9.45899	-10.7877
Channel Y	200mV	8.8208	9.04838
	- 200mV	-10.7208	-10.4891
Channel Z	200mV	2.57815	2.58048
	- 200mV	-3.83723	-5.33249

3. Channel separation

Software Set-up
Calibration time: 3 sec, Measuring time: 3 sec
High Range

in µV	Input Voltage	Channel X	Channel Y	Channel Z
Channel X	200mV	-	3.87894	-0.249448
Channel Y	200mV	0.754446	-	5.51548
Channel Z	200mV	-1.16639	0.548042	-

4. AD-Converter Values with inputs shorted

in LSB	Low Range	High Range
Channel X	15563	16112
Channel Y	15059	15995
Channel Z	17960	16464

Dae393c

5. Input Offset Measurement

Measured after 15 min warm-up time of the Data Acquisition Electronic.
Every Measurement is preceded by a calibration cycle.

Software set-up:
Calibration time: 3 sec
Measuring time: 3 sec
Number of measurements: 100, Low Range

Input 10MΩ

in µV	Average	min. Offset	max. Offset	Std. Deviation
Channel X	0.83	-0.63	2.29	0.31
Channel Y	-1.70	-3.57	-0.50	0.32
Channel Z	-0.63	-2.32	0.23	0.30

Input shorted

in µV	Average	min. Offset	max. Offset	Std. Deviation
Channel X	0.13	-0.34	0.56	0.16
Channel Y	-0.75	-1.29	-0.24	0.18
Channel Z	-1.06	-1.66	-0.49	0.18

6. Input Offset Current

in fA	Input Offset Current
Channel X	< 25
Channel Y	< 25
Channel Z	< 25

7. Input Resistance

	Calibrating	Measuring
Channel X	200 kΩ	200 MΩ
Channel Y	200 kΩ	200 MΩ
Channel Z	200 kΩ	200 MΩ

Dae393c

8. Low Battery Alarm Voltage

in V	Alarm Level
Supply (+ Vcc)	7.36 V
Supply (- Vcc)	-7.32 V

9. Power Consumption

in mA	Switched off	Stand by	Transmitting
Supply (+ Vcc)	0.000	5.29	13.8
Supply (- Vcc)	-0.011	-7.58	-8.8

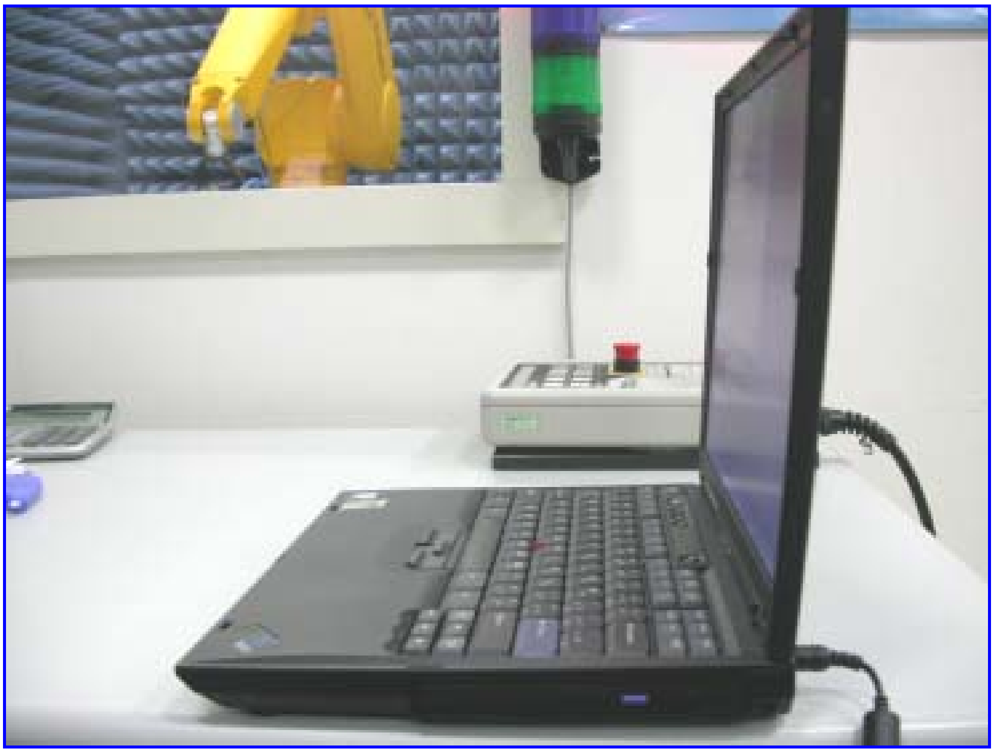
10. Functional test

Touch async pulse 1	ok
Touch async pulse 2	ok
Touch status bit 1	ok
Touch status bit 2	ok
Remote power off	ok
Remote analog Power control	ok
Modification Status	B – C

Date: 11.12.02 Signature: P-Akl...

Dae383c

Appendix F – Photographs of Auxiliary Equipment

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