Relatório de Ensaio

Monitorização e Medição dos Níveis de Intensidade dos Campos Electromagnéticos

HA6027 ARRABIDA SHOPPING

Data: 29 de Junho de 2010
Ensaios Realizados por: Armando Marques
Autor: Armando Marques
Departamento: Responsabilidade Social
Aprovado por: Vitor Pena
Contacto: emf.pt@vodafone.com

Índice

Introdução

A medição dos níveis de campos electromagnéticos (CEM) em locais de acesso público e junto das antenas de estações-base permite verificar o cumprimento dos níveis de referência definidos na Portaria 1421/2004 de 23 de Novembro.

Este relatório tem como objectivo verificar a conformidade electromagnética da estação-base da Vodafone Portugal com a referência “HA6027 ARRABIDA SHOPPING”, utilizando os procedimentos de monitorização e medição dos níveis de intensidade dos CEMs com origem em estações de radiocomunicações estabelecidos pela Anacom.

Descrição do local de ensaio

Nome		**ARRABIDA SHOPPING**	
Tipologia		**Interior**	
Outros Operadores		**---**	
Código		**HA6027**	
Endereço		Praceta Henrique Moreira, 4400-346 Vila Nova de Gaia	
Latitude		N 41º 08' 35" 000	
Longitude		W 8º 38' 11" 000	
Tecnologias		GSM/UMTS	
Data		05-05-2010	
Hora Inicio	**Hora Fim**	10:07:40	12:30:53

Localização do local de ensaio

Fotografias do local de ensaio

Foto nº 1

(Vista Geral do Site)

Foto nº 2

(Ponto de Medição 1)

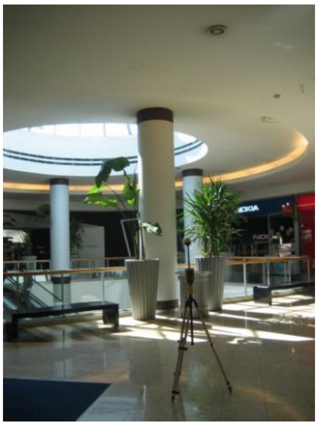


Foto nº 3

(Ponto de Medição 2)

Foto nº 4

(Ponto de Medição 3)

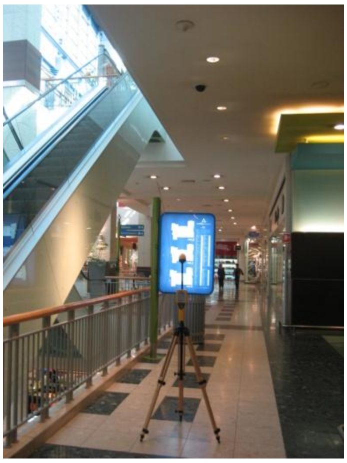


Foto nº 5

(Ponto de Medição 4)

Foto nº 6

(Ponto de Medição 5)

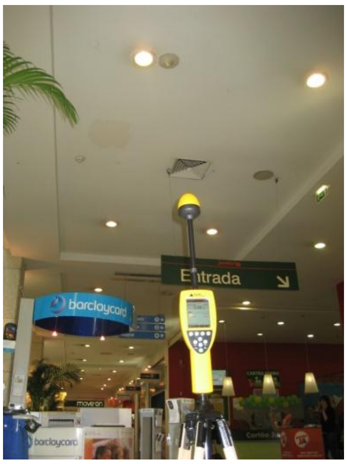


Foto nº 7

(Ponto de Medição 6)

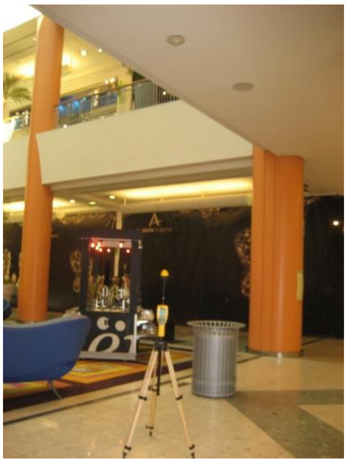


Foto nº 8

(Ponto de Medição 7)

Foto nº 9

(Ponto de Medição 8)

Foto nº 10

(Ponto de Medição 9)

Foto nº 11

(Ponto de Medição 10)

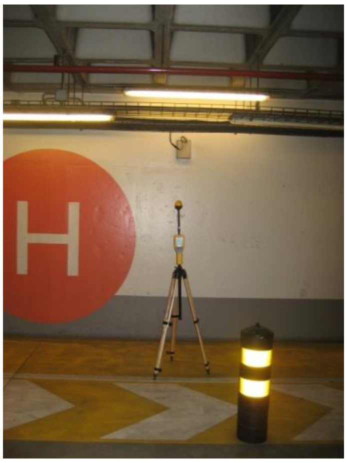
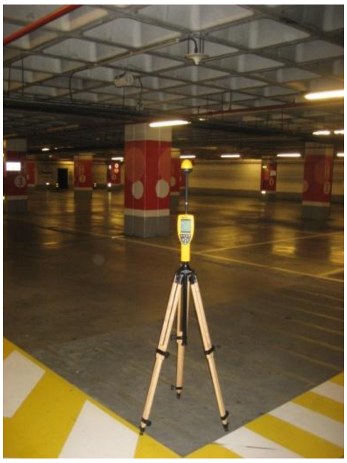


Foto nº 12

(Ponto de Medição 11)



Descrição dos equipamentos de ensaio

As medições foram efectuadas utilizando um equipamento medidor de CEMs NBM-550, com uma sonda EP0391. Este equipamento encontra-se devidamente calibrado, sendo os certificados de calibração válidos até 16/12/11 e 18/12/11, respectivamente.

Nota: Em anexo encontram-se as cópias dos certificados de calibração e respectivas especificações.

Método de ensaio

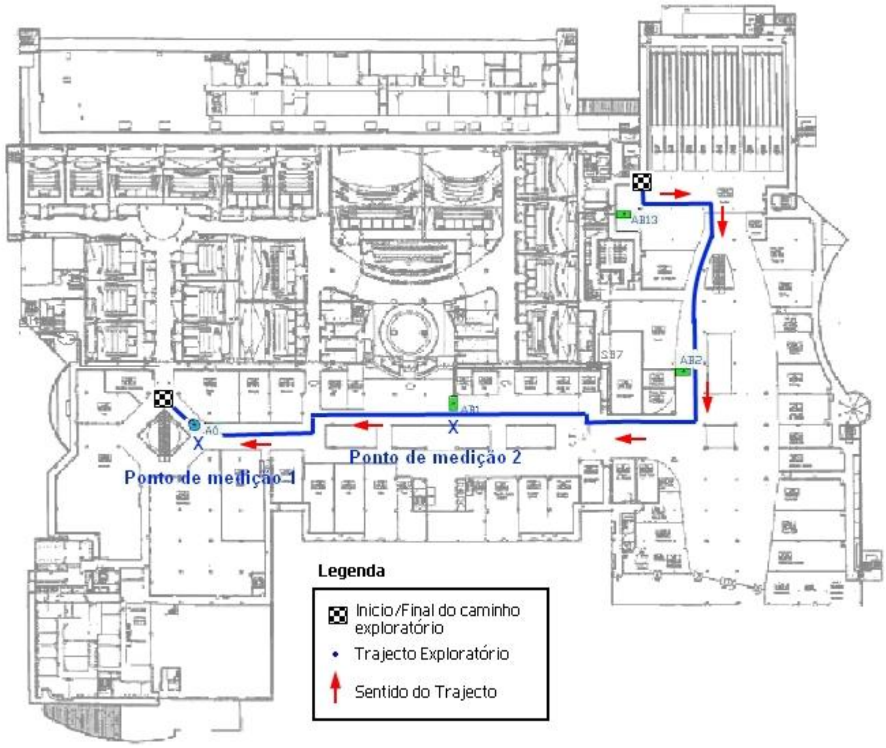
Método	Descrição	Método aplicado
Método 1	O método 1 deve ser aplicado quando apenas se pretende conhecer o nível global de campo electromagnético.	X
Método 2	O método 2 deve ser aplicado sempre que for requerido descriminar por frequência os níveis de campo electromagnético, ou quando o método 1 não é apropriado.	
Método 3	O método 3 da INVESTIGAÇÃO DETALHADA deve ser utilizado sempre que os métodos 1 e 2 não forem aplicáveis.	

Especificações técnicas das antenas da estação-base

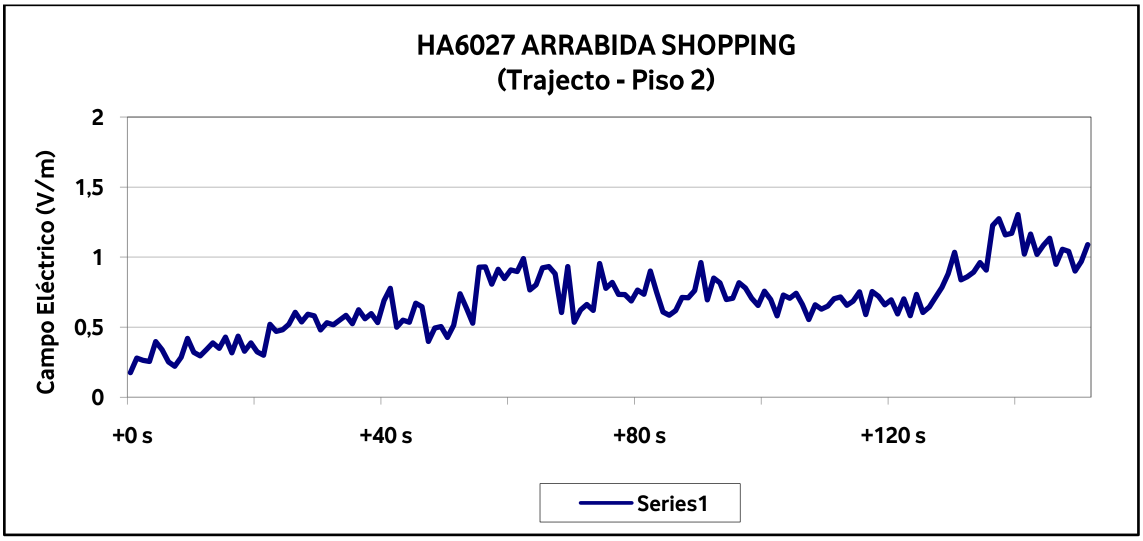
Sistema	Tipo de antena
GSM	Direccional/Omnidireccional
UMTS	Direccional/Omnidireccional

Resultados

Piso de Medição – Piso 2

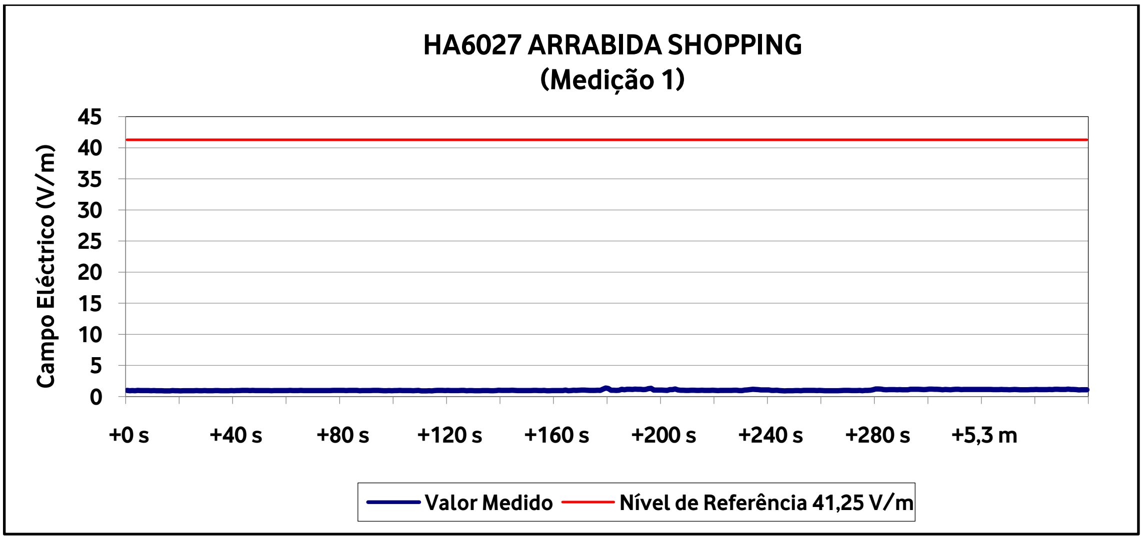


Trajecto Exploratório



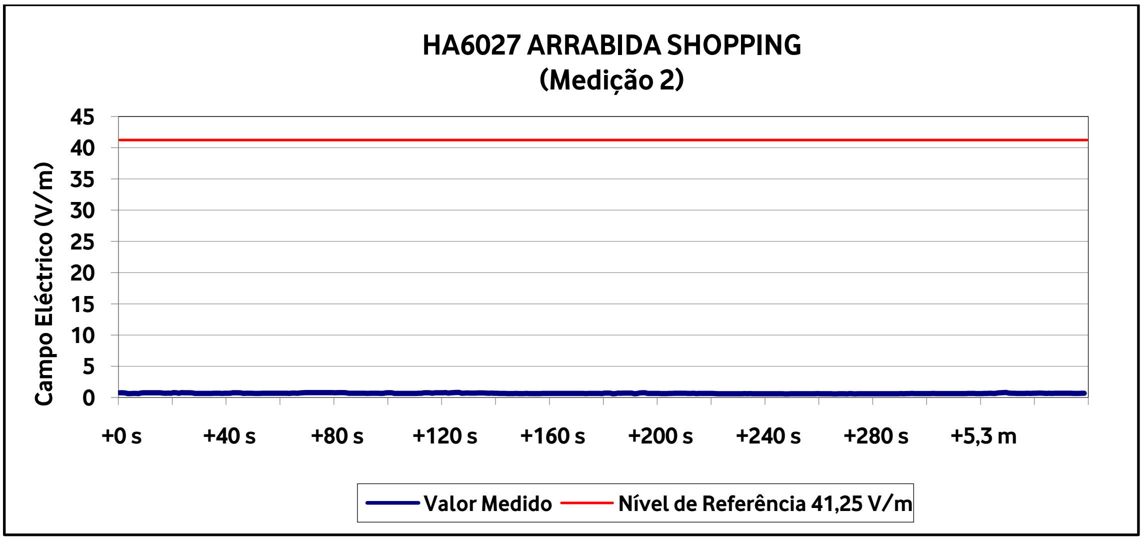
Ponto de medição nº 1

RMS (V/m)	1,02	
Max (V/m)	1,37	
Hora Início/Fim	10:12:17	10.11.47

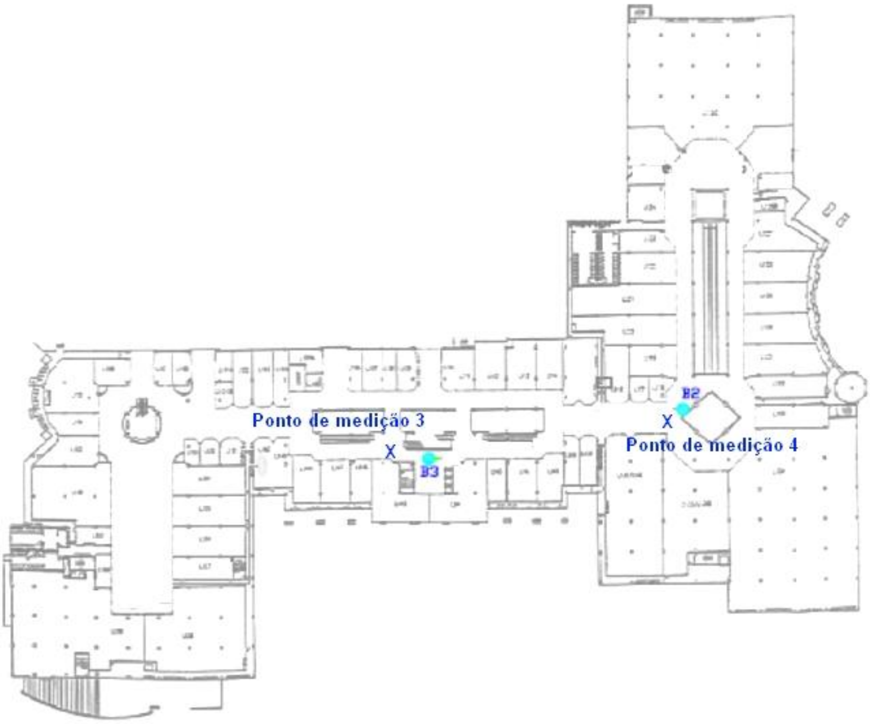


Ponto de medição nº 2

RMS (V/m)	0,67	
Max (V/m)	0,81	
Hora Início/Fim	10:19:49	10.23.56

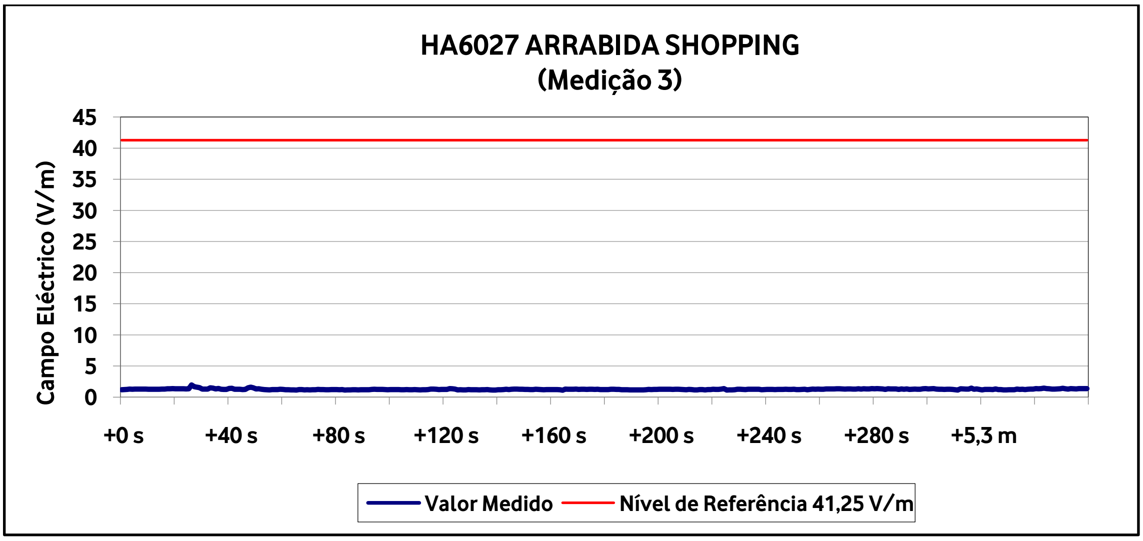


Piso de Medição – Piso 1



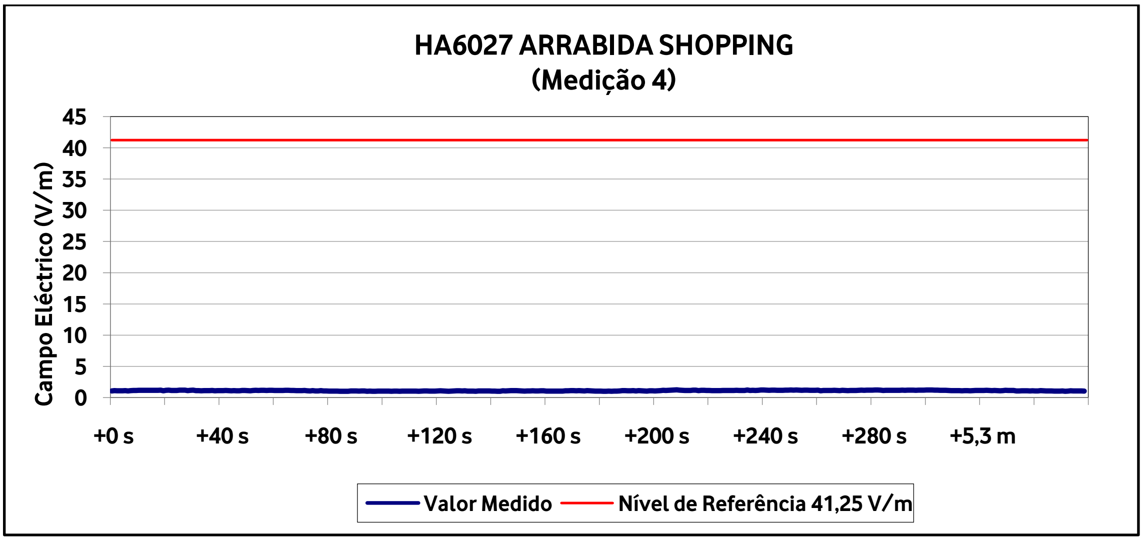
Ponto de medição nº 3

RMS (V/m)	1,27	
Max (V/m)	1,96	
Hora Início/Fim	10:27:42	10.33.42



Ponto de medição nº 4

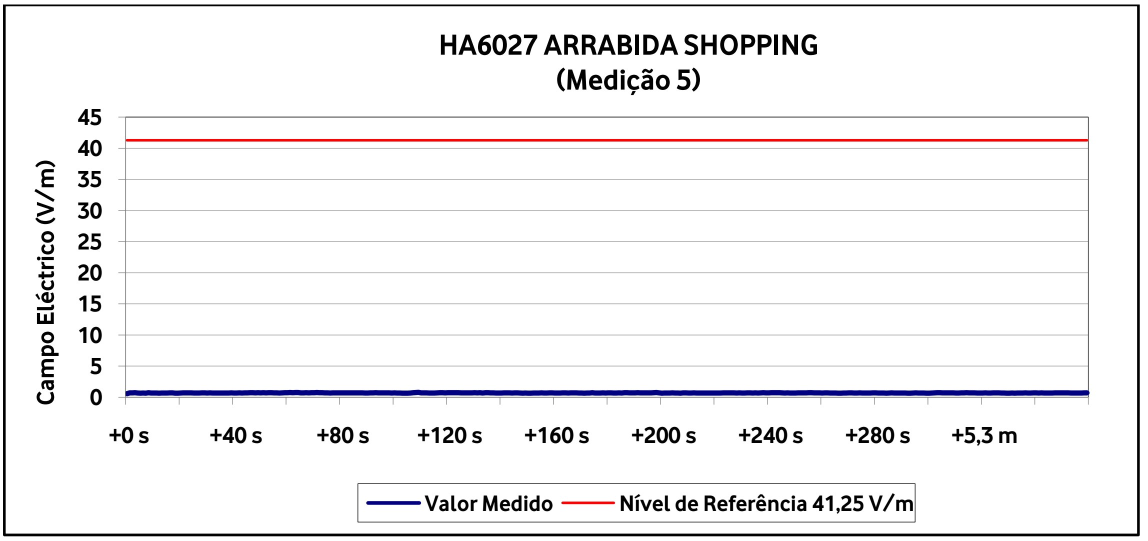
RMS (V/m)	1,13	
Max (V/m)	1,27	
Hora Início/Fim	10:35:07	10.41.07



Piso de Medição – Piso 0

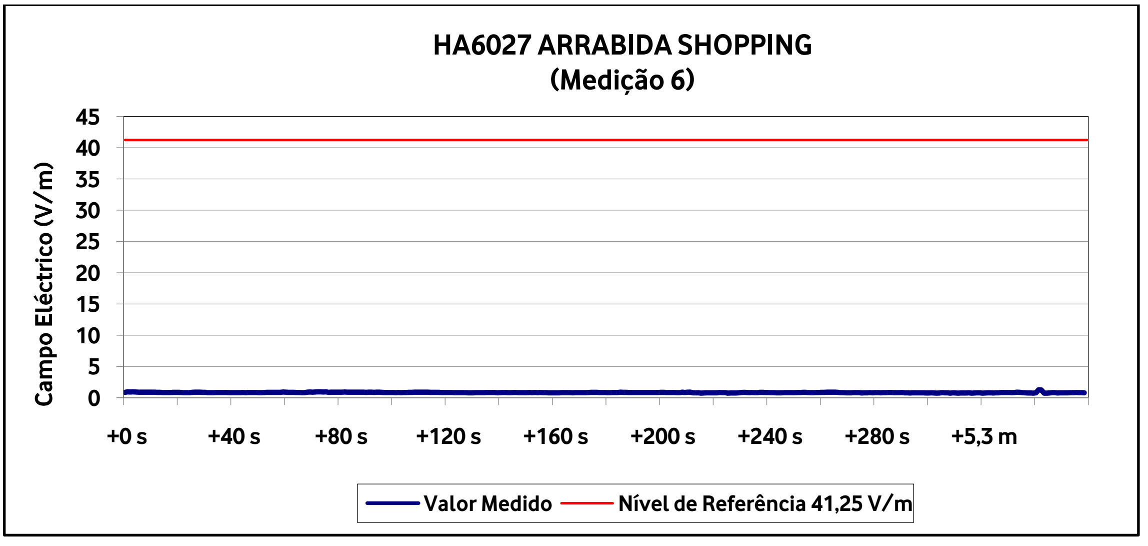
Ponto de medição nº 5

RMS (V/m)	0,69	
Max (V/m)	0,77	
Hora Início/Fim	11:00:58	11.06.58



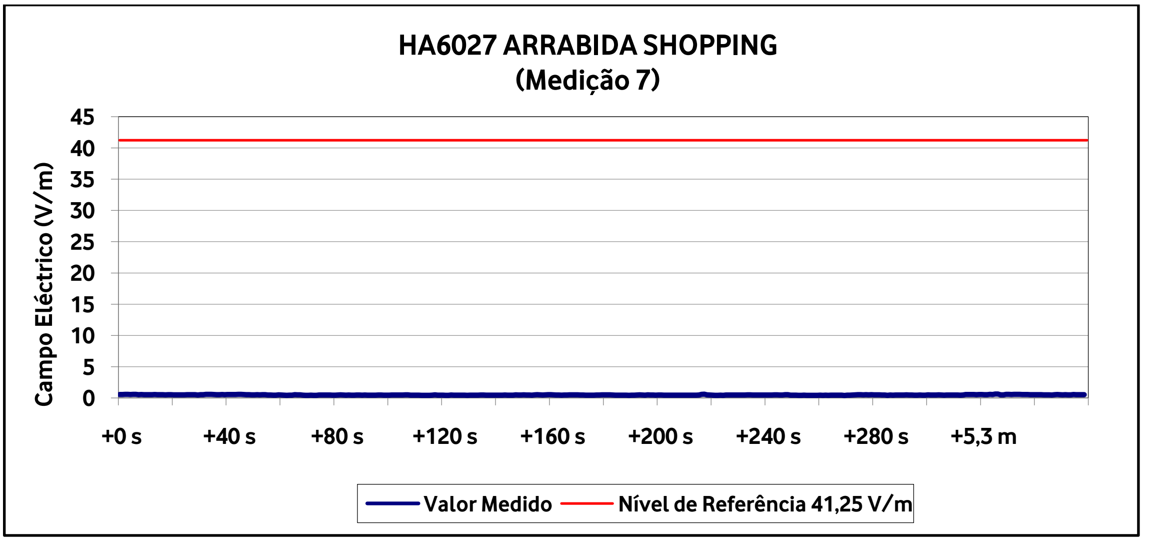
Ponto de medição nº 6

RMS (V/m)	0,84	
Max (V/m)	1,27	
Hora Início/Fim	11:08:22	11.14.22



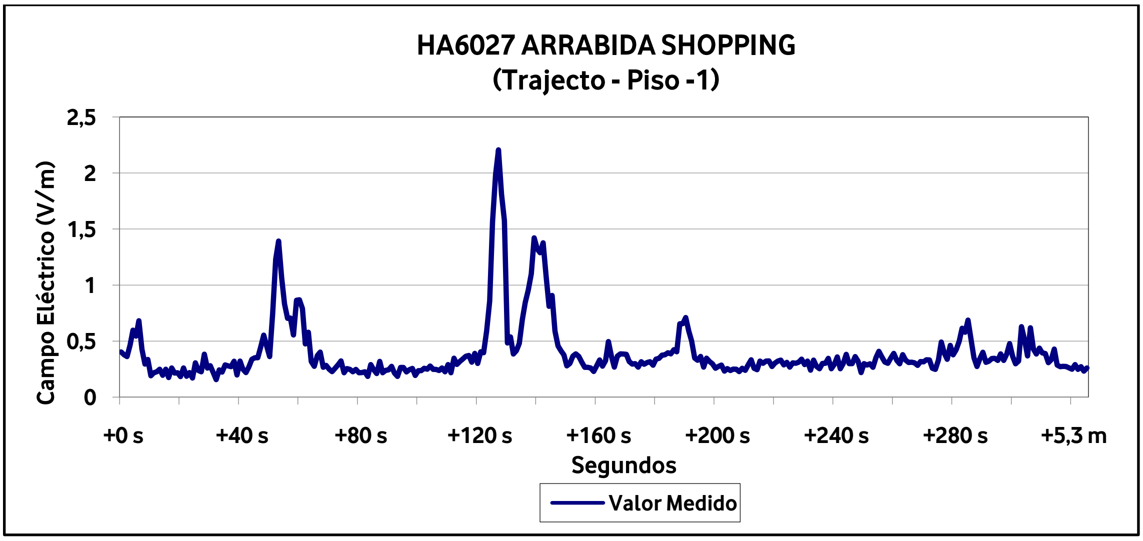
Ponto de medição nº 7

RMS (V/m)	0,51	
Max (V/m)	0,64	
Hora Início/Fim	11:16:48	11.22.48



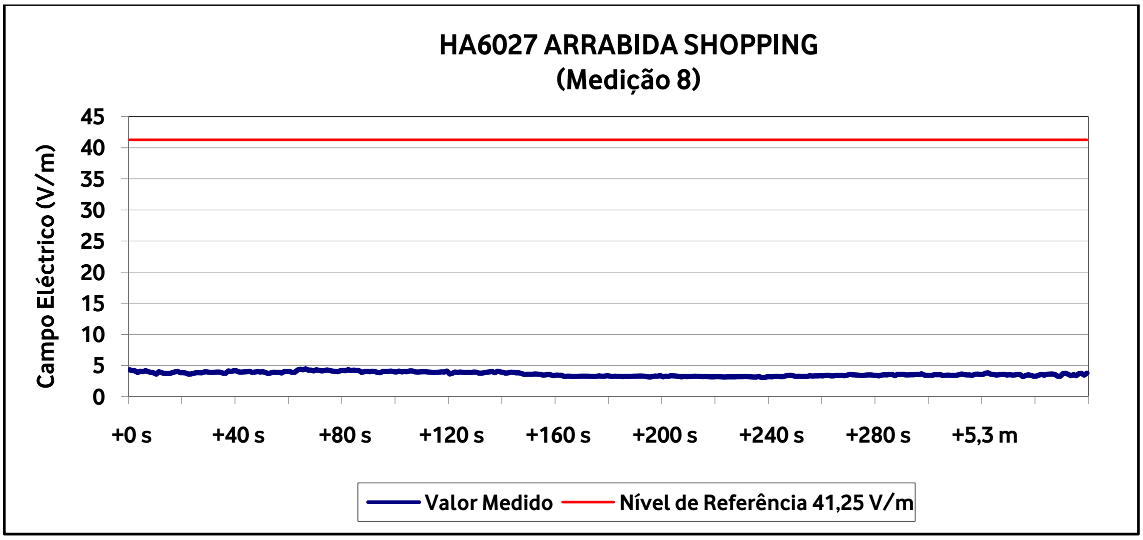
Piso de Medição – Piso -1

Trajecto Exploratório



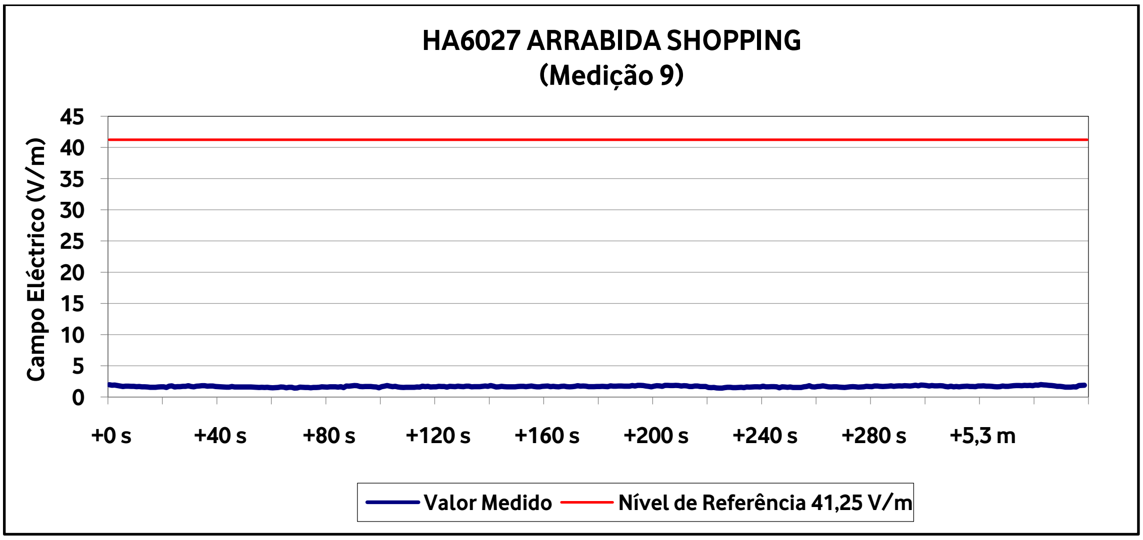
Ponto de medição nº 8

RMS (V/m)	3,64	
Max (V/m)	4,46	
Hora Início/Fim	11:47:10	11.51.10

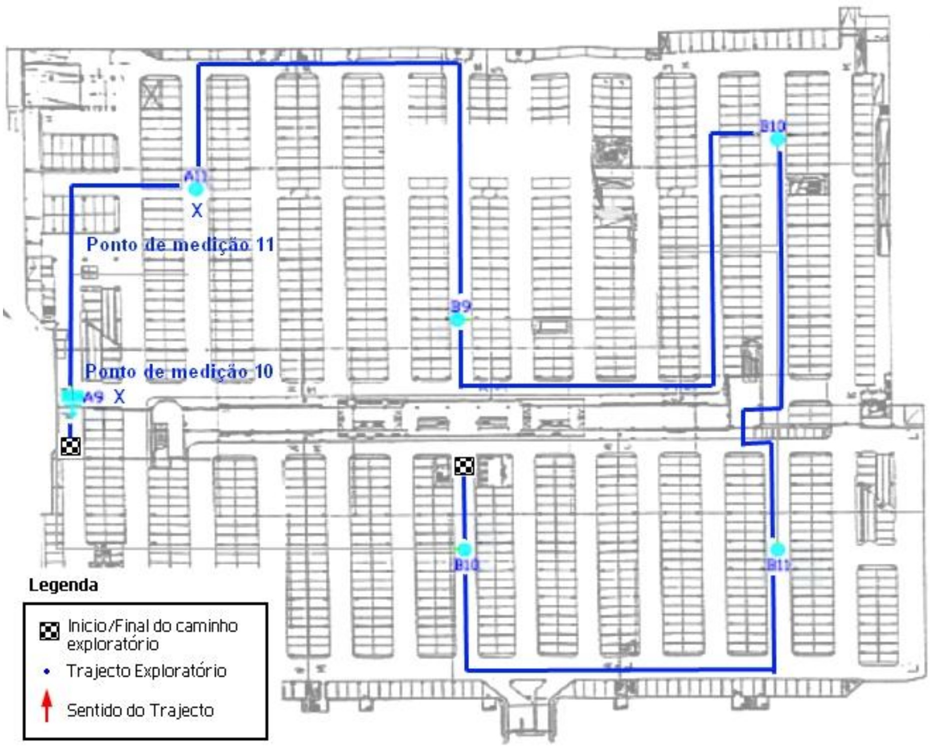


Ponto de medição nº 9

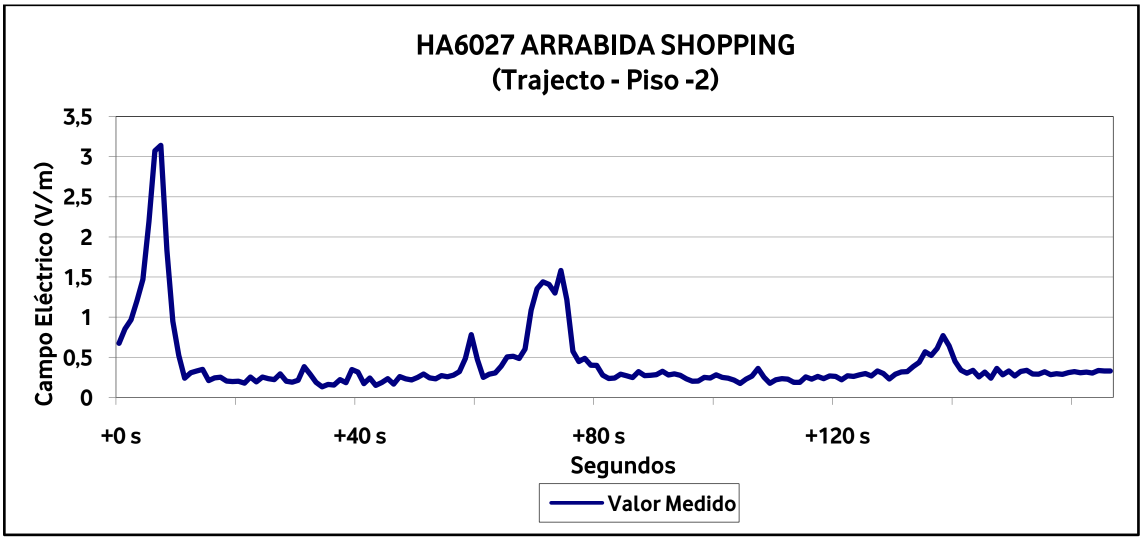
RMS (V/m)	1,70	
Max (V/m)	2,01	
Hora Início/Fim	11:55:44	12.01.44



Piso de Medição – Piso -2

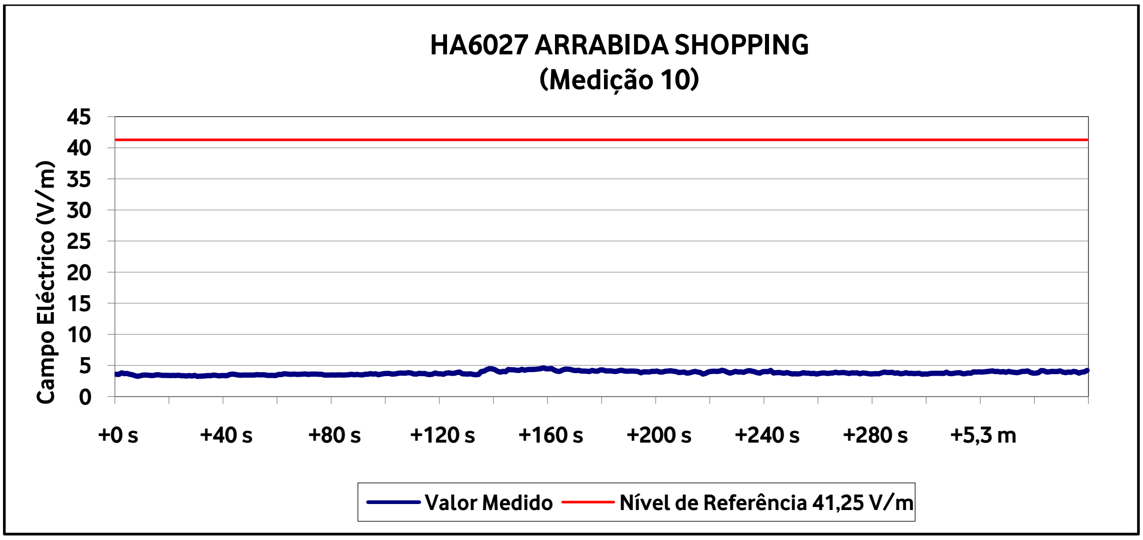


Trajecto Exploratório



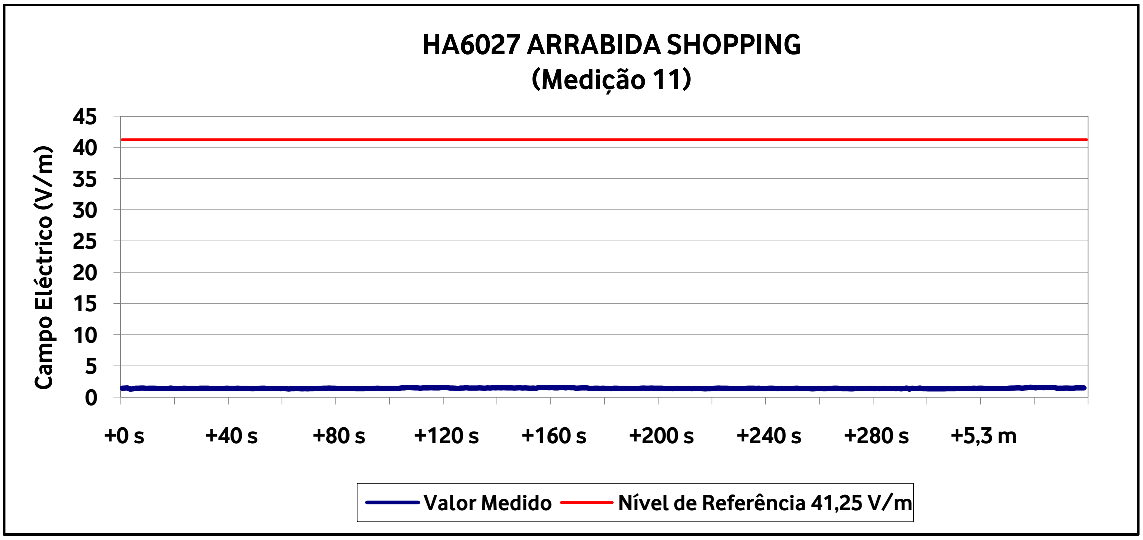
Ponto de medição nº 10

RMS (V/m)	3,81	
Max (V/m)	4,61	
Hora Início/Fim	12:16:48	12.22.48



Ponto de medição nº 11

RMS (V/m)	1,42	
Max (V/m)	1,58	
Hora Início/Fim	12:24:54	12.30.54



Resumo dos níveis CEM medidos

Medição	Amp. Campo Eléctrico			Amp. Campo Magnético			Densidade de Potência		
	E_i [V/m]	E_{lim} [V/m]	(E_i/E_{lim}) [dB]	H_i [A/m]	H_{lim} [A/m]	(H_i/H_{lim}) [dB]	S_i [W/m^2]	S_{lim} [W/m^2]	(S_i/S_{lim}) [dB]
1	0,72	41,25	-35,13	0,00	0,11	-35,17	0,00	4,50	-35,11
2	1,02	41,25	-32,14	0,00	0,11	-32,19	0,00	4,50	-32,13
3	0,67	41,25	-35,76	0,00	0,11	-35,81	0,00	4,50	-35,75
4	1,27	41,25	-30,26	0,00	0,11	-30,30	0,00	4,50	-30,25
5	1,13	41,25	-31,23	0,00	0,11	-31,27	0,00	4,50	-31,21
6	0,69	41,25	-35,56	0,00	0,11	-35,60	0,00	4,50	-35,54
7	0,84	41,25	-33,78	0,00	0,11	-33,83	0,00	4,50	-33,77
8	0,51	41,25	-38,21	0,00	0,11	-38,26	0,00	4,50	-38,20
9	0,52	41,25	-37,94	0,00	0,11	-37,99	0,00	4,50	-37,93
10	0,34	41,25	-41,59	0,00	0,11	-41,63	0,00	4,50	-41,57
11	3,64	41,25	-21,08	0,01	0,11	-21,13	0,04	4,50	-21,07
12	1,70	41,25	-27,69	0,00	0,11	-27,73	0,01	4,50	-27,67
13	0,71	41,25	-35,26	0,00	0,11	-35,31	0,00	4,50	-35,25
14	3,81	41,25	-20,69	0,01	0,11	-20,74	0,04	4,50	-20,68
15	1,42	41,25	-29,29	0,00	0,11	-29,33	0,01	4,50	-29,27

Conclusões

Analisando o resultado das medições obtidas, verifica-se que os valores máximo e médio de intensidade do campo eléctrico, detectados no local descrito, se encontram muito abaixo dos valores limite de referência recomendados pela Organização Mundial da Saúde e definidos pela Portaria 1421/2004 de 23 de Novembro, cumprindo-se as suas recomendações na íntegra.

vodafone

Anexo A: Certificados de calibração dos equipamentos de medida

Equipamento de Medida NBM-550

Narda Safety Test Solutions GmbH
Sandwiesenstrasse 7 · D-72793 Pfullingen · Germany
Phone: +49-7121-9732-0 · Fax: +49-7121-9732-790

narda Safety Test Solutions
an L3 Communications Company

Calibration Certificate

Narda Safety Test Solutions GmbH hereby certifies that the referenced equipment has been calibrated by qualified personnel to Narda's approved procedures. The calibration was carried out within a certified quality management system conforming to DIN EN ISO 9001:2000.

The metrological confirmation system for test equipment complies with ISO 10012-1.

Object	**Broadband Field Meter NBM-550**
Part Number (P/N)	**2401/01**
Serial Number (S/N)	**B-0940**
Manufacturer	Narda Safety Test Solutions GmbH
Customer	
Date of Calibration	2009-12-16
Results of Calibration	Test results within specifications
Confirmation interval (recommended)	24 months
Ambient conditions	(23 ± 3)°C (20 ... 60)% rel. humidity
Calibration procedure	2401-8700-00A

Pfullingen, 2009-12-16

Person in charge
R. Martin

Head of Laboratory
N. Moll

MANAGEMENT SYSTEM
DQS
Certified by DQS against DIN EN ISO 9001:2000 (Reg.-No. 99379-QM)

This certificate may only be published in full, unless permission for the publication of an approved extract has been obtained in writing from the Managing Director.

Certificate No. NBM-550-B-0940-091216-1327 Date of issue: 2009-12-16 Page 1 of 3

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Method of Measurement

The device under test (DUT) represents a three-channel voltage meter offering high accuracy and high resolution. The DUT is calibrated by applying a known DC voltage to each of the inputs.

Uncertainty of Measurement

The measurement uncertainty stated in this document is the expanded uncertainty with a coverage factor of 2 (corresponding, in the case of normal distribution, to a confidence probability of 95 %).

The uncertainty analysis for this calibration was done in accordance with the ISO/TAG-Guide (Guide to the expression of uncertainty in measurement). The measurement uncertainties are derived from contributions from the measurement of power, reflection, attenuation and frequency, mismatch, stability of instrumentation and repeatability of handling.

This statement of uncertainty applies to the measured values only and does not include effects like temperature response and long term stability of the calibrated device.

Traceability of Measuring Equipment

The calibration results are traceable to SI-units according to ISO/IEC 17025:1999. Physical units, which are not included in the list of accredited measured quantities such as field strength or power density, are traced to the basic units via approved measurement and computational methods.

The equipment used for this calibration is traceable to the reference listed below and the traceability is guaranteed by ISO 9001 Narda internal procedure.

Reference- / Working-Standard	Manufacturer	Model	Serial Number	Certificate Number	Cal. Due Date	Trace (*)
Digital Multimeter	Agilent	34410A	MY47000646	1-1997407260-1	2011-02	UKAS

Note (*): For details on accredited laboratories please refer to the corresponding homepage: http://www.dkd.info/

Certificate No. NBM-550-B-0940-091216-1327 Date of issue: 2009-12-16 Page 2 of 3

Narda Safety Test Solutions GmbH
Sandwiesenstrasse 7 · D-72793 Pfullingen · Germany
Phone: +49-7121-9732-0 · Fax: +49-7121-9732-790

Results

Voltage display uncertainty

Channel	Input voltage applied	Specified voltage display	Meas. Uncertainty	Meas. voltage display
X	2.400 V	(2.376+/-0.024) V	+/-0.007 V	2.373 V
Y	2.400 V	(2.376+/-0.024) V	+/-0.007 V	2.373 V
Z	2.400 V	(2.376+/-0.024) V	+/-0.007 V	2.373 V

Note: Because of an internal divider the nominal value of the voltage display is 2.376 V.

Sonda EF0391

Narda Safety Test Solutions GmbH
Sandwiesenstrasse 7 · D-72793 Pfullingen · Germany
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narda
Safety Test Solutions
an L3 Communications Company

Calibration Certificate

Narda Safety Test Solutions GmbH hereby certifies that the referenced equipment has been calibrated by qualified personnel to Narda's approved procedures. The calibration was carried out within a certified quality management system conforming to ISO 9001:2000.

The metrological confirmation system for test equipment complies with ISO 10012-1.

Object	**Probe EF0391, E-Field**
Part Number (P/N)	**2402/01**
Serial Number (S/N)	**A-1022**
Manufacturer	Narda Safety Test Solutions GmbH
Customer	
Date of Calibration	2009-12-18
Results of Calibration	
Confirmation interval (recommended)	24 months
Ambient Conditions	Temperature: (23 ± 3) °C Rel. humidity: (20 to 60) %
Calibration procedure	2402-8701-00A

Pfullingen, 2009-12-18

MANAGEMENT SYSTEM

Person in Charge
Rilling

Head of Laboratory
N. Moll

This certificate may only be published in full, unless permission for the publication of an approved extract has been obtained in writing from the Managing Director.

Certified by DQS according to DIN EN ISO 9001:2000 (Reg.-No. 99379-QM)

Certificate No. 240201-A1022-091218-02858 Date of issue: 2009-12-18 Page 1 of 5

Narda Safety Test Solutions GmbH
Sandwiesenstrasse 7 · D-72793 Pfullingen · Germany
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Method of Measurement

The calibration of RF field strength probes involves the generation of a calculable linearly polarized electromagnetic field - approximating to a plane wave - into which the device under test is placed. The probe is calibrated separately from the base meter.

The probe is aligned for maximum interception of the field, i.e. probe's pole is orientated in the analytic angle (54.74 degrees to vertical E-field vector). At each test frequency the probe is rotated by 360 deg while taking readings continously. The results are calculated from the minimum and maximum response during rotation.

$$E_{mean} = \sqrt{E_{min} * E_{max}} \qquad EllipseRatio = 10 * \log\left(\frac{E_{max}}{E_{min}}\right)$$

Frequency Response:

A correction factor K is a numerical factor to compensate the systematic error due to frequency response.

$$K = E_{actual} / E_{mean}$$

The correction factor K is stored in the probe memory. When combined with the NBM-5xx Field Meter the frequency response correction may be enabled.

Field Generation

Set Up "A" (1600 MHz ...):

Calibration using calculated field strength. The probe is positioned with the boresight of a linearly polarized horn antenna. The field strength is derived from the horn's gain g, the transmitted power of the antenna and the distance d. The power measurement includes the power meter's response $P_m * F_{th}$ and a fixed attentuation D.

$$E = \sqrt{\eta * \frac{P_m * F_{th} * D * g}{4 * \pi * d^2}}$$

with η : intrinsic impedance of propagation medium in Ohms.

Reference: IEEE Std. 1309-1996

Set Up "B" (300 MHz ... 1600 MHz):

Calibration using a transfer standard. The probe is mounted in front of a double balanced ridge horn antenna. The field strength is set to a known value based on the power meter reading P_m in referece to a calibrated sensor (E_{ref}, P_{ref}).

$$E = E_{ref} * \sqrt{P_m / P_{ref}}$$

Set Up "C" (... 300 MHz):

Calibration using calculated field strength. A Crawford TEM cell is used to generate the known field strength E. The field strength is derived from TEM cell's septum height b, impedance Z_0 and from the output power Pnet of the cell. The output power measurement includes the power meter's response $P_m * F_{th}$ and a fixed attentuation D.

$$E = \frac{\sqrt{P_m * F_{th} * D * Z_0}}{b}$$

Certificate No. 240201-A1022-091218-02858 Date of issue: 2009-12-18 Page 2 of 5

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Uncertainties

The measurement uncertainty stated in this document is the expanded uncertainty with a coverage factor of 1.96 (corresponding, in the case of normal distribution, to a confidence probability of 95 %).

The uncertainty analysis for this calibration was done in accordance with the ISO-Guide (Guide to the expression of Uncertainty in Measurement). The measurement uncertainties are derived from contributions from the measurement of power, impedance, attenuation, mismatch, length, frequency, stability of instrumentation, repeatability of handling and field uniformity in the field generators (TEM cell and anechoic chamber).

This statement of uncertainty applies to the measured values only and does not make any implementation or include any estimation as to the long-term stability of the calibrated device.

Test Equipment and Traceability

The calibration results are traceable to SI-units according to ISO/IEC 17025:1999. Physical units, which are not included in the list of accredited measured quantities such as field strength or power density, are traced to the basic units via approved measurement and computational methods.

The equipment used for this calibration is traceable to the reference listed below and the traceability is guaranteed by ISO 9001 Narda internal procedure.

Reference- / Working- Standard	Manufacturer	Model	Serial Number	Certificate Number	Cal Due Date	Trace (*)
Digital Multimeter	agilent	34410A	MY47000646	1-1997407260-1	2011-02	UKAS
Set-Up "A" (1800 MHz to 3 GHz)						
Power Sensor 18GHz	agilent	8481A	US37299951	1-2217165994-1	2011-08	UKAS
Power Sensor 18GHz	agilent	8481A	US37299952	1-2217214152-1	2011-09	UKAS
Power Meter, Two Channel	agilent	E4419A	MY40330449	1-2217141092-1A	2011-09	UKAS
Calliper	Preisser	0-800mm	310121016	649724 DKD-K-12001 06-05	(#)	DKD
Set-Up "B" (200 MHz to 1600 MHz)						
E-Field Reference Probe	Narda	Type 9.2	V-0017	601C1734 & 51200637E	(#)	SIT
Power Sensor 18GHz	agilent	8481A	US37299870	1-2217214643-1	2011-09	UKAS
Power Meter, Two Channel	agilent	E4419B	GB43311917	1-2295928041-1A	2011-11	UKAS
Set-Up "C" (100 kHz to 300 MHz)						
Depth Calliper	Preisser	0-300mm	220721020	649723 DKD-K-12001 06-05	(#)	DKD
Vector Network Analyzer	R&S	ZVC	100032	0063 DKD-K-16101 06-04	(#)	DKD
Calibration Kit, 50Ohm N	R&S	ZV–Z21	100072	86553 DKD-K-19401 06-04	(#)	DKD
Power Sensor 50Ohm DC…18GHz	R&S	NRV-Z51	100909	0133 DKD-K-16101 2009-06	2011-06	DKD
RF-Millivoltmeter	R&S	URV55	100305	0129 DKD-K-16101 2009-06	2011-06	DKD
Attenuator	Weinschel	49-20-33 & 44-10	KH966/BS5534	3235 DKD-K-00501 2008-05	2011-05	DKD

(*) For details on accredited laboratories please refer to the corresponding homepage:
http://www.dkd.info/ DKD
http://sit.imgc.to.cnr.it/ SIT
http://www.ukas.com/ UKAS

(#) Cal Due Date is irrelevant as equipment is a reference standard but not a working standard

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Results

Frequency Response and Ellipticity

The frequency response is measured with instrument setting: Apply Correction Frequency = OFF.

Frequency in MHz	E_{actual} in V/m	Meas. Uncertainty in dB	E_{mean} in V/m	Correction Factor K (*)	Ellipse Ratio in dB
0.1	6.15	0.5	4.25	1.445	0.23
0.2	6.15	0.5	4.98	1.236	0.17
0.3	6.14	0.5	5.22	1.176	0.15
1	6.11	0.5	5.62	1.088	0.15
3	6.08	0.5	5.85	1.040	0.13
10	6.14	0.5	6.13	1.002	0.12
27.12	6.14	0.5	6.25	0.981	0.11
100	6.17	0.5	6.62	0.931	0.10
200	6.11	0.8	6.36	0.960	0.12
300	6.08	0.8	6.13	0.992	0.10
500	6.21	1.5	6.40	0.970	0.13
750	6.15	1.5	6.14	1.002	0.06
1000	6.12	1.5	6.66	0.918	0.16
1800	6.16	0.7	6.83	0.902	0.17
2450	6.14	0.7	5.87	1.047	0.26
2700	6.11	0.7	5.08	1.202	0.37
3000	6.15	0.7	4.70	1.309	0.58

Flatness (1 - 1000 MHz): +/-0.74 dB
Flatness (100 kHz – 3000 MHz): +/-2.05 dB
Max. Ellipse Ratio (1 - 3000 MHz): +/-0.58 dB

(*) The frequency response correction data is stored in the probe memory. When the probe is connected to a NBM-5xx Field Meter the implemented frequency response correction may be enabled. This is done by selecting the desired frequency and the setting: Apply Correction Frequency = ON.

Adjustment (informative):

Gain multiplier = K_g = 1.0040

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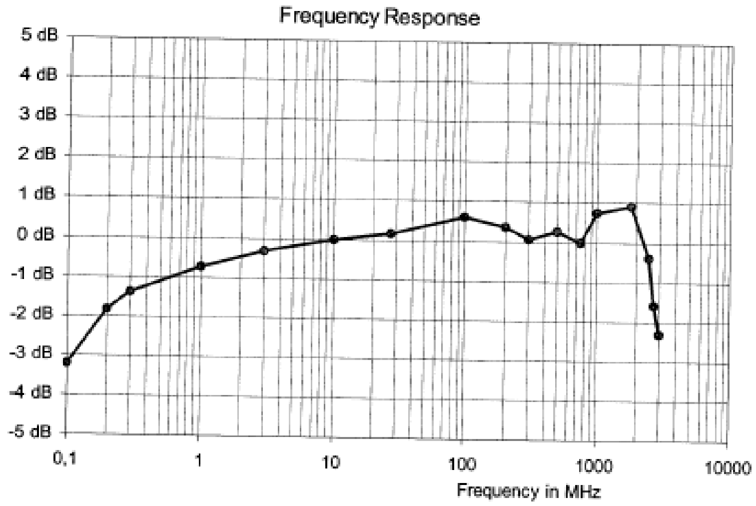
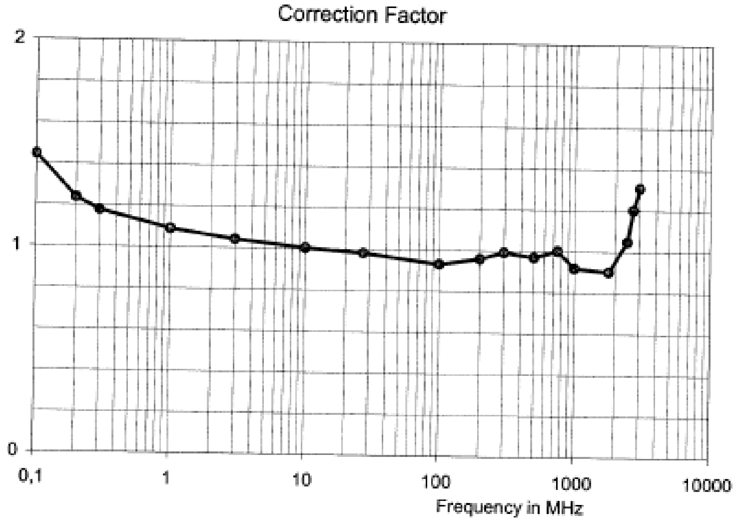
Frequency Response

Frequency response data with setting: Apply Correction Frequency = OFF.





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Anexo B: Especificações técnicas dos equipamentos de medida

Marca	Narda			
Modelo	NBM-550 com Sonda de Campo Eléctrico EF0391			
Data da última calibração	NBM-550	16/12/09		
	Sonda EF0391	18/12/09		
Banda de Frequências	100 kHz – 3 GHz			
Gama de Amplitudes	0.2 – 320 V/m			
Gama Dinâmica	64 dB			
Resolução	0.01 V/m			
Tipo de Sensor	Sistema baseado em Diodo			
Dimensões	**Medidor de campo**	46x98x276 mm	**Sonda**	Comprimento – 318 mm Diâmetro – 66 mm
Peso	**Medidor de campo**	550 g	**Sonda**	90 g

Grandeza	**Incerteza de x_i**		**$u(x_i)$**	**c_i**	**$(c_i\, u(x_i))^2$ [%]**	**$(c_i\, u(x_i))^2$ [dB]**
	Valor [%]	**Pr. Dist.; k**				
Flatness	±26.62	Uniforme; $\sqrt{3}$	±15.37	1	±236.20	10.53
Incerteza na medida	±18.85	Normal; 1.96	±9.62	1	±92.50	5.69
Linearidade	±8.39	Uniforme; $\sqrt{3}$	±4.85	1	±23.48	1.83
Isotropia	±12.20	Uniforme; $\sqrt{3}$	±7.04	1	±49.63	3.50
Temperatura	±2.33	Uniforme; $\sqrt{3}$	±1.34	1	±1.81	0.16

Incerteza Padrão Combinada	$u_c(y)=\sqrt{\sum_{i=1}^{n}\left(c_i \cdot (x_i)\right)^2}$	±20.09 %	1.59 dB
Incerteza Expandida (95%)	$u_e = 1{,}96 \cdot u_c$	±39.38 %	2.88 dB