RF Exposure Evaluation:
Maximum Permissible Exposure Evaluation

Prepared for:
Motorola, Inc. - NextNet Wireless

FCC ID: PHX-PCC2510

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1 RF EXPOSURE EVALUATION – MAXIMUM PERMISSIBLE EXPOSURE (MPE)

1.1 Introduction

This document is prepared on behalf of Motorola, Inc. – NextNet Wireless to show compliance with the RF Exposure requirements as required in §1.1310 of the FCC Rules and Regulations and RSS-102 of Industry Canada.

The limit for Maximum Permissible Exposure (MPE), specified in FCC §1.1210, is listed in Table 1. According to FCC §1.1310 and RSS-102: the criteria listed in the following table shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in §1.1307(b).

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)	Average Time (Minutes)
(A) Limits For Occupational / Control Exposures (f = frequency)				
30-300	61.4	0.163	1.0	6
300-1500	…	…	f/300	6
1500-100,000	…	…	5.0	6
(B) Limits For General Population / Uncontrolled Exposure (f = frequency)				
30-300	27.5	0.073	0.2	30
300-1500	…	…	f/1500	30
1500-100,000	…	…	1.0	30

Table 1. Limits for Maximum Permissible Exposure (MPE)

1.2 EUT Identification

The Motorola, Inc. – NextNet Wireless Model: PCC-2510 is a PCMCIA Card operating in the 2496 – 2690 MHz band. The device contains a permanently attached antenna and a port for an external antenna. For the MPE evaluation the device is connected to the external accessory antenna.

EUT:
Model: PCC-2510
Grantee: Motorola, Inc. – NextNet Wireless
FCC ID: PHX-PCC2510
External Accessory Antenna: P/N: 501-0512-XXXX
Antenna Gain: 7dBi

The EUT was evaluated at the low, mid, and high channel of operation with the maximum transmit duty cycle. The modulation during testing was set to 4QAM.

1.3 MPE Requirements Overview

Three different categories of transmitters are defined by the FCC in OET Bulletin 65. These categories are fixed installation, mobile, and portable and are defined as follows:

- **Fixed Installations:** fixed location means that the device, including its antenna, is physically secured at a permanent location and is not able to be easily moved to another location. Additionally, distance to humans from the antenna is maintained to at least 2 meters.
- **Mobile Devices:** a mobile device is defined as a transmitting device designed to be used in other than fixed locations and to be generally used in such a way that a separation distance of at least 20 centimeters is normally maintained between the transmitter's radiating structures and the body of the user or nearby persons. Transmitters designed to be used by consumers or workers that can be easily re-located, such as a wireless modem operating in a laptop computer, are considered mobile devices if they meet the 20 centimeter separation requirement. The FCC rules for evaluating mobile devices for RF compliance are found in 47 CFR §2.1091.
- **Portable Devices:** a portable device is defined as a transmitting device designed to be used so that the radiating structure(s) of the device is/are within 20 centimeters of the body of the user. Portable device requirements are found in Section 2.1093 of the FCC's Rules (47 CFR§2.1093).

The FCC also categorizes the use of the device as based upon the user's awareness and ability to exercise control over his or her exposure. The two categories defined are Occupational/ Controlled Exposure and General Population/Uncontrolled Exposure. These two categories are defined as follows:

- **Occupational/Controlled Exposure:** In general, occupational/controlled exposure limits are applicable to situations in which persons are exposed as a consequence of their employment, who have been made fully aware of the potential for exposure and can exercise control over their exposure. This exposure category is also applicable when the exposure is of a transient nature due to incidental passage through a location where the exposure levels may be higher than the general population/uncontrolled limits, but the exposed person is fully aware of the potential for exposure and can exercise control over his or her exposure by leaving the area or by some other appropriate means. Awareness of the potential for RF exposure in a workplace or similar environment can be provided through specific training as part of a RF safety program. If appropriate, warning signs and labels can also be used to establish such awareness by providing prominent information on the risk of potential exposure and instructions on methods to minimize such exposure risks.
- **General Population/Uncontrolled Exposure:** The general population / uncontrolled exposure limits are applicable to situations in which the general public may be exposed or in which persons who are exposed as a consequence of their employment may not be made fully aware of the potential for exposure or cannot exercise control over their exposure. Members of the general public would come under this category when exposure is not employment-related; for example, in the case of a wireless transmitter that exposes persons in its vicinity. Warning labels placed on low-power consumer devices such as cellular telephones are not considered sufficient to allow the device to be considered under the occupational/controlled category, and the general population/uncontrolled exposure limits apply to these devices.

The Motorola, Inc. – NextNet Wireless Model PCC-2510 with external antenna is evaluated to the Mobile Device requirements and is considered a device to be used by the General Population/Uncontrolled Exposure.

1.4 Procedure

Two procedures are available for determining compliance with the MPE requirements. One method is calculating the RF exposure level using well established formulas while the other method involves actual measurements using a RF Field probe. For the purpose of this document, both methods were performed.

The power generated by this product is initially measured by a power meter. Through use of the Friis transmission formula and the maximum gain of the antenna the MPE level is calculated at a distance of 20cm.

Friis Transmission Formula

Friis transmission formula: $P_d = (P_{out}*G) / (4\pi r^2)$

Where,

P_d = Power Density (mW/cm^2)
P_{out} = output power to antenna (mW)
G = gain of antenna in linear scale
π = 3.1416
r = distance between observation point and center of the radiator (cm)

1.4.1 Calculated MPE

The highest RF powered measured was 31.93dBm (1559.55mW) at 2499 MHz. According to the §1.1310 of the FCC rules, the power density limit for General Population/Uncontrolled Exposure at this frequency of operation is $1mW/cm^2$. The EUT has a maximum transmit duty cycle of 9.16%. Plots of the timing and pulse widths are shown in Figure 1 through Figure 5. The maximum power can therefore be reduced by this operation duty cycle limitation.

Pmax = 31.93dBm – 10*Log(Duty Cycle)(dB) = 21.55dBm

Given the above information and a 7dBi gain antenna the following power density is calculated at 20cm spacing.

Frequency	2500	MHz	
Limit	1.000	mW/cm^2	
Distance (cm), R =	20	cm	
Power (dBm), P =	21.55	dBm	142.89 mW
TX Ant Gain (dBi), G =	7	dBi	
Power Density (P_d) =	**0.142**	mW/cm^2	(at 20cm)
Minimum Distance =	**7.5**	cm	

Table 2. Calculated MPE Data

The calculated MPE of $0.142mW/cm^2$ complies with the MPE limit of 1 mW/cm^2.

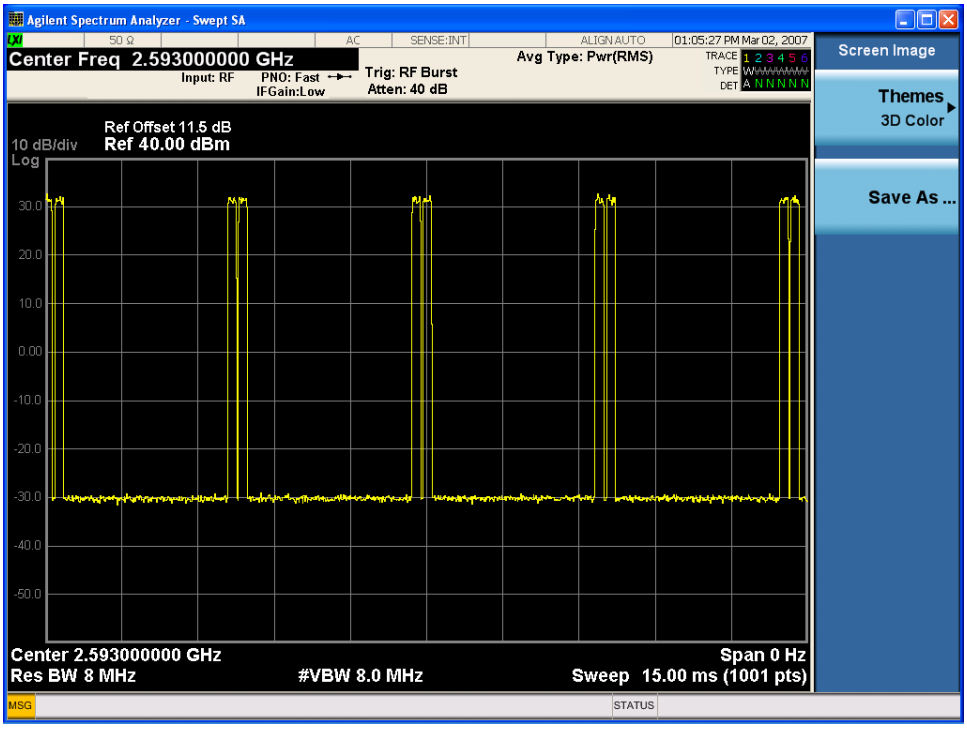

Figure 1: Transmitter at Maximum Duty Cycle Operation, (15ms sweep)

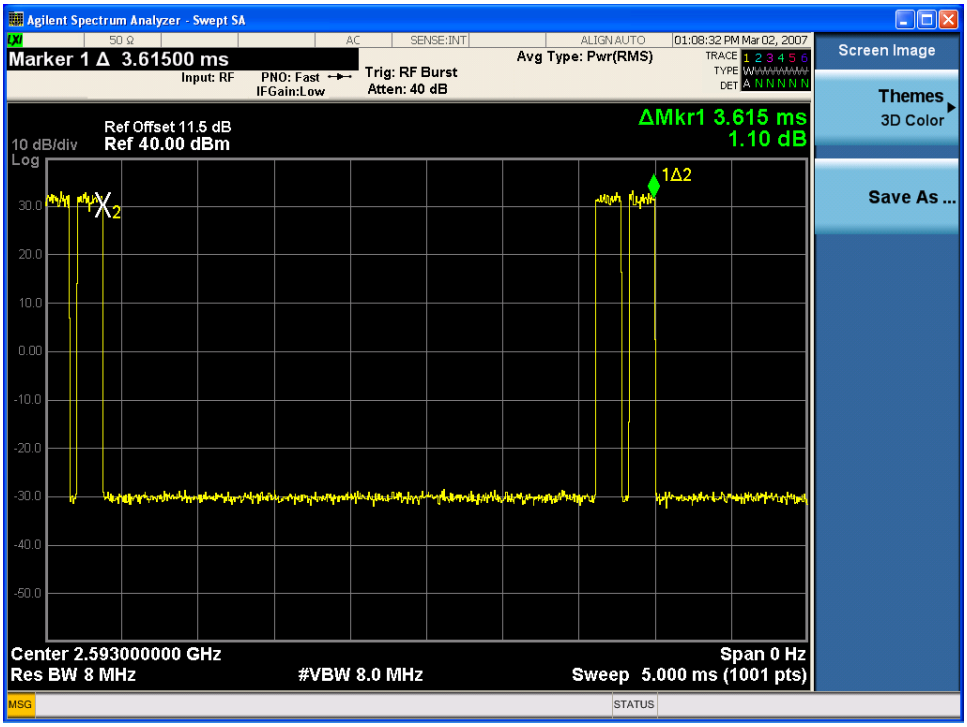

Figure 2: One Complete Transmit Cycle Time, (3.615ms)

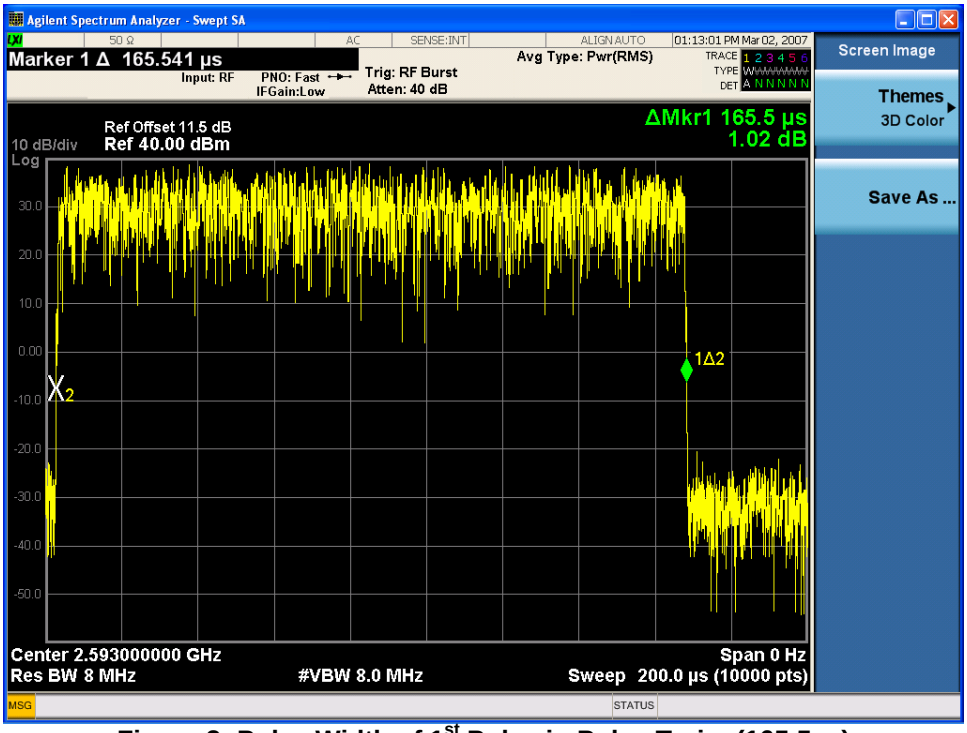

Figure 3: Pulse Width of 1st Pulse in Pulse Train, (165.5µs)

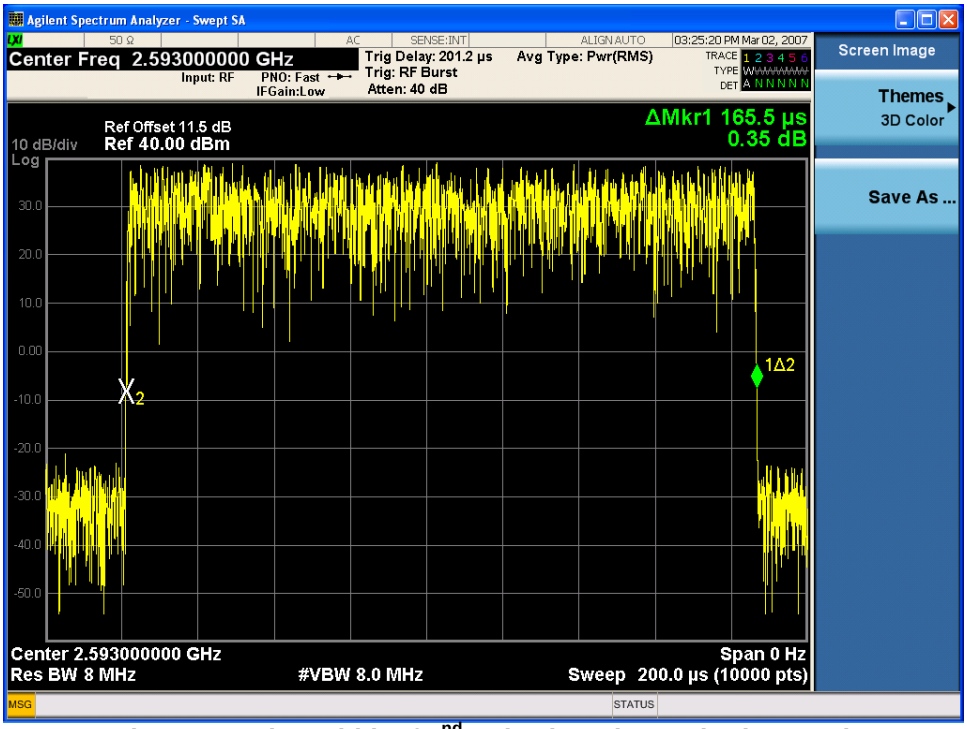

Figure 4: Pulse Width of 2nd Pulse in Pulse Train, (165.5µs)

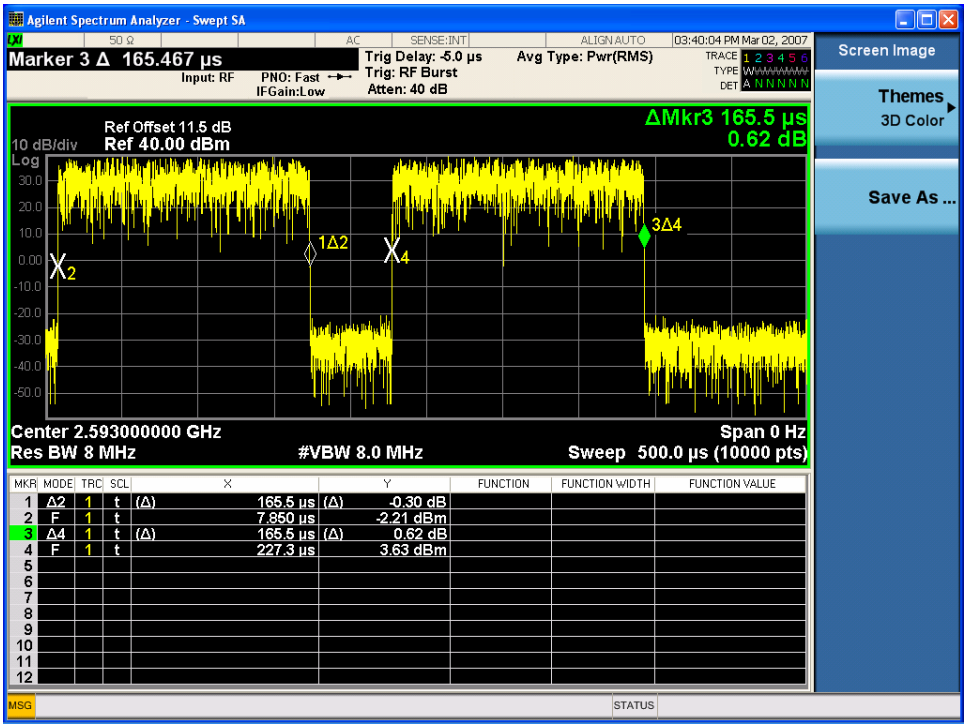

Figure 5: Transmit Pulse Widths, Pulse 1 and 2

Duty Cycle Calculation:

Duty Cycle = Total Tx Time / Tx Cycle Time

Based on the above plots the duty cycle is calculated as follows:

Duty Cycle = (165.5µs + 165.5µs) / 3.615ms = 0.0916 (9.16%)

1.4.2 Measured MPE

The measurement of the power density was also performed on the PCC-2510. The unit was setup inside a shielded anechoic chamber and set to transmit at the maximum power and duty cycle. Measurements were made with a 6MHz transmit bandwidth and a 5.5MHz transmit bandwidth. A near field probe was placed 20cm from the antenna and the maximum power density was measured and recorded. The probe was moved completely around the antenna in order to capture the maximum level.

The following table lists the results of the power density measurements.

Channel Frequency (MHz)	Channel Bandwidth (MHz)	Max P_d (mW/cm^2)
2499	6	0.1538
2687	6	0.1729
2593	6	0.1682
2499	5.5	0.1564
2687	5.5	0.1743
2593	5.5	0.1684

Table 3. MPE Measurement Data

Test Equipment:

Device	Manufacturer	Model	Calibration Due Date
Near field probe meter	Wandel & Goltermann	EMR-300	6/22/2007
Electric field probe	Wandel & Goltermann	Type 9.2	7/27/2007

Table 4. Test Equipment List

The first page of the calibration certificates for the E-field probe and meter are located at the end of this document.

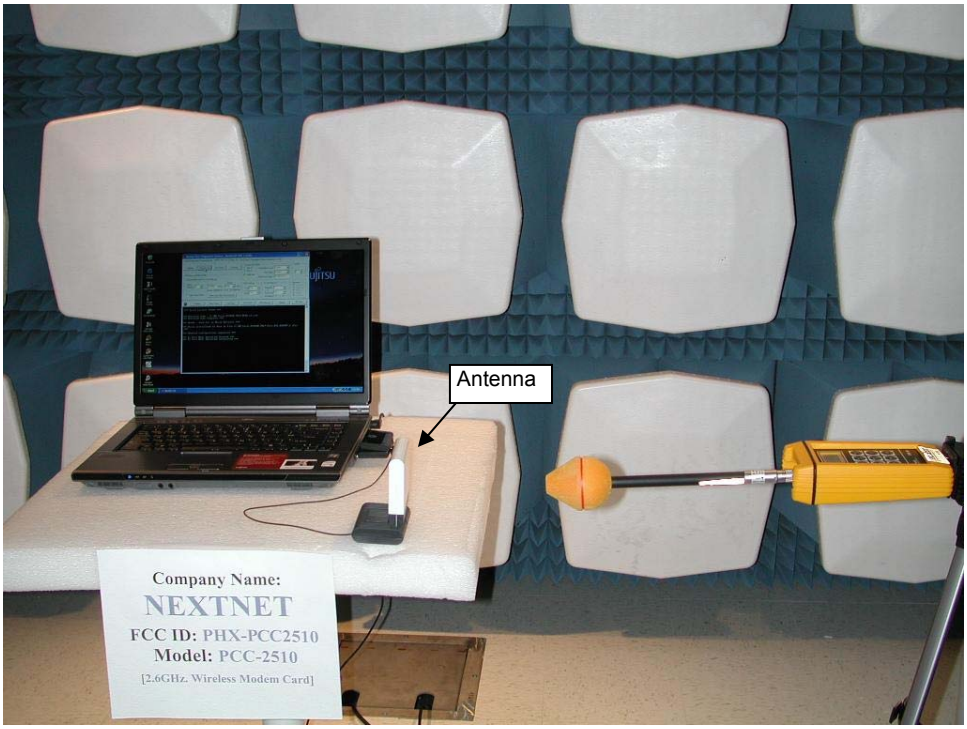

Figure 6: MPE Measurement Test Setup Photograph

1.5 Conclusion

The device meets the mobile 20cm separation distance as specified in §2.1091 of the FCC Rules and Regulations and RSS-102 of Industry Canada. An appropriate RF exposure compliance statement will be placed in the user's manual.

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narda Safety Test Solutions
an ETC Communications Company

Calibration Certificate

Narda Safety Test Solutions 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	**Electromagnetic Radiation Meter EMR-300**
Type	**2244/31**
Serial Number	**BC-0054**
Manufacturer	Narda Safety Test Solutions
Customer	
Date of Calibration	22-Jun-2006
Confirmation interval (recommended)	24 months
Ambient conditions	23 °C ± 3 °C (20 ... 60) % rel. humidity
Calibration procedure	2244-8703.002

Pfullingen, 22-Jun-2006

Person in charge
Rilling

Quality management representative
W. Kumbier

MANAGEMENT SYSTEM

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. 22443100-BC0054-060622 Date of issue: 22-Jun-06 Page 1 of 3

Figure 7. Calibration Certificate, EMR-300

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narda Safety Test Solutions
an L3 Communications Company

Certificate of Calibration

Narda Safety Test Solutions hereby certifies that the referenced equipment has been calibrated by qualified personnel to Narda's approved procedures.

This calibration certificate confirms that all measurements lie within the limit values stated in the product specific calibration procedure and that the equipment meets, or exceeds, all published technical and functional specifications.

Description	**Electric Field Probe Type 9.2**
Model	**2244/90.23**
Serial No.	**AL-0007**
Manufacturer	Narda Safety Test Solutions
Customer	
Date of Calibration	27-Juli-2006
Confirmation interval recommended	24 Months
Ambient conditions	23°C +/-3K (40...60)% rel. humidity
Results filed under Certificate No.	22449023-AL0007-060727
Test procedure	2244-8705.000

The calibration was carried out within a certified quality management system conforming to **ISO 9001**.
The metrological confirmation system for test equipment complies with **ISO 10012-1**.

Pfullingen, 27-Juli-2006

MANAGEMENT SYSTEM

Person in charge

Quality Management

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

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Certificate No. 22449023-AL0007-060727 Date of issue: 27-Juli-2006 Page 1 of 6

Figure 8. Calibration Certificate, E-Field Probe