Appendix D - Maximum Permissible Exposure Calculation

D.1 REFERENCES

Normative Reference Standard	FCC CFR 47§1.1310 IEEE Std C95.1-1999
Procedure Reference	FCC CFR 47§2.1091

D.2 LIMITS

	Frequency	Power Density
FCC CFR 47§1.1310 Table 1(b)	300 - 1500 MHz	f/1500 mW/cm^2
	1500 - 100,000 MHz	1.0 mW/cm^2

D.3 ENVIRONMENTAL CONDITIONS

Temperature	na
Humidity	na
Barometric Pressure	na

D.4 MEASUREMENT EQUIPMENT SETUP

MEASUREMENT EQUIPMENT CONNECTIONS	The results described herein were determined by calculations, so no measurement equipment was used. The power measurements for each radio used in these calculations were made as described in Appendix A of this report.
MEASUREMENT EQUIPMENT SETTINGS	n/a

D.5 DUT OPERATING DESCRIPTION

Dual-Band GPRS	The maximum GPRS RF conducted output power in each band used for these calculations was measured on Channel 251 for Cellular and Channel 661 for PCS.
Dual-Band EDGE	The maximum EDGE RF conducted output power in each band used for these calculations was measured on Channel 190 for Cellular and Channel 661 for PCS.
Dual-Band UMTS	The maximum UMTS RF conducted output power in each band used for these calculations was measured on Channel 4233 for Cellular and Channel 9400 for PCS.

D.6 TEST RESULTS

D.6.1 Calculations:

Swivel Dipole Antenna (Max. Measured Conducted Power - Cellular GPRS Mode)

Prediction of MPE Limit
OET Bulletin 65, Edition 97-01

Equation from page 18

$$S = \frac{PG}{4\pi R^2}$$

$$R = \sqrt{\frac{PG}{4\pi S}}$$

S= power density
P= power input to the antenna
G= power gain of the antenna in the direction of interest relative to an isotropic radiator
R= distance to the center of radiation of the antenna
SL= power density limit

Ratio of Time On versus Total Transmit Time	0.25

Choose ↓ **ENTER** ↓

Occupational/Controlled	○	
General Population/Uncontrolled	◉	
Tx Frequency:	848.80	(MHz)
Maximum Peak Power at Antenna Input Terminal:	32.28	(dBm)
Source-Based Time-Average Factor:	-6.02	(dB)
Antenna gain:	2.60	(dBi)

SL=	**0.57**	(mW/cm^2)
P=	**422.6102**	(mW)
G=	**1.82**	(numeric)

R = 10.40 (cm)

S (mw/cm^2) at 20cm

0.15282675

Formulae:

$S = \frac{PG}{4\pi R^2}$ where: S = Power Density Limit
P = Power Output of the Device
G = Numeric Antenna Gain
R = Distance from Antenna

$R = \sqrt{\frac{P}{4\pi S}}$

Source-Based Time-Average Factor = 10 * log (Time On / (Time On + Time Off))
Power Output of the Device (W) = 10 * log (RF Output Power (dBm) + Source-Based Time Average Factor (dB))

D.6.2 Calculations:

Swivel Dipole Antenna (Max. Measured Conducted Power - PCS GPRS Mode)

Prediction of MPE Limit
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Equation from page 18

$$S = \frac{PG}{4\pi R^2}$$

$$R = \sqrt{\frac{PG}{4\pi S}}$$

S= power density
P= power input to the antenna
G= power gain of the antenna in the direction of interest relative to an isotropic radiator
R= distance to the center of radiation of the antenna
SL= power density limit

Ratio of Time On versus Total Transmit Time	0.25	
Choose	ENTER	
Occupational/Controlled	○	
General Population/Uncontrolled	◉	
Tx Frequency:	1880.00	(MHz)
Maximum Peak Power at Antenna Input Terminal:	28.63	(dBm)
Source-Based Time-Average Factor:	-6.02	(dB)
Antenna gain:	2.60	(dBi)

SL=	1.00	(mW/cm^2)
P=	182.3644	(mW)
G=	1.82	(numeric)

R = 5.14 (cm)

S (mw/cm^2) at 20cm

0.065947658

Formulae:

$S = \frac{PG}{4\pi R^2}$ where: S = Power Density Limit
P = Power Output of the Device
G = Numeric Antenna Gain
R = Distance from Antenna

$R = \sqrt{\frac{PG}{4\pi S}}$

Source-Based Time-Average Factor = 10 * log (Time On / (Time On + Time Off))
Power Output of the Device (W) = 10 * log (RF Output Power (dBm) + Source-Based Time Average Factor (dB))

D.6.3 Calculations:

Swivel Dipole Antenna (Max. Measured Conducted Power - Cellular EDGE Mode)

Prediction of MPE Limit
OET Bulletin 65, Edition 97-01

Equation from page 18

$$S = \frac{PG}{4\pi R^2}$$

$$R = \sqrt{\frac{PG}{4\pi S}}$$

S= power density
P= power input to the antenna
G= power gain of the antenna in the direction of interest relative to an isotropic radiator
R= distance to the center of radiation of the antenna
SL= power density limit

Ratio of Time On versus Total Transmit Time	0.25

Choose ↓ **ENTER** ↓

Occupational/Controlled	○	
General Population/Uncontrolled	◉	
Tx Frequency:	836.60	(MHz)
Maximum Peak Power at Antenna Input Terminal:	26.89	(dBm)
Source-Based Time-Average Factor:	-6.02	(dB)
Antenna gain:	2.60	(dBi)

SL=	**0.56**	(mW/cm^2)
P=	**122.1631**	(mW)
G=	**1.82**	(numeric)

R = 5.63 (cm)

S (mw/cm^2) at 20cm

0.044177321

Formulae:

$S = \frac{PG}{4\pi R^2}$ where: S = Power Density Limit
P = Power Output of the Device
G = Numeric Antenna Gain
R = Distance from Antenna

$R = \sqrt{\frac{PG}{4\pi S}}$

Source-Based Time-Average Factor = 10 * log (Time On / (Time On + Time Off))
Power Output of the Device (W) = 10 * log (RF Output Power (dBm) + Source-Based Time Average Factor (dB))

D.6.4 Calculations:

Swivel Dipole Antenna (Max. Measured Conducted Power - PCS EDGE Mode)

Prediction of MPE Limit
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Equation from page 18

$$S = \frac{PG}{4\pi R^2}$$

$$R = \sqrt{\frac{PG}{4\pi S}}$$

S= power density
P= power input to the antenna
G= power gain of the antenna in the direction of interest relative to an isotropic radiator
R= distance to the center of radiation of the antenna
SL= power density limit

Ratio of Time On versus Total Transmit Time	0.25	
Choose / ENTER		
Occupational/Controlled	○	
General Population/Uncontrolled	◉	
Tx Frequency:	1880.00	(MHz)
Maximum Peak Power at Antenna Input Terminal:	25.73	(dBm)
Source-Based Time-Average Factor:	-6.02	(dB)
Antenna gain:	2.60	(dBi)

SL=	**1.00**	(mW/cm^2)
P=	**93.5276**	(mW)
G=	**1.82**	(numeric)

R = 3.68 (cm)

S (mw/cm^2) at 20cm

0.033822007

Formulae:

$S = \frac{PG}{4\pi R^2}$ where: S = Power Density Limit
P = Power Output of the Device
G = Numeric Antenna Gain
R = Distance from Antenna

$R = \sqrt{\frac{PG}{4\pi S}}$

Source-Based Time-Average Factor = 10 * log (Time On / (Time On + Time Off))
Power Output of the Device (W) = 10 * log (RF Output Power (dBm) + Source-Based Time Average Factor (dB))

D.6.5 Calculations:

Swivel Dipole Antenna (Max. Measured Conducted Power - Cellular UMTS Mode)

Prediction of MPE Limit
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Equation from page 18

$$S = \frac{PG}{4\pi R^2}$$

$$R = \sqrt{\frac{PG}{4\pi S}}$$

S= power density
P= power input to the antenna
G= power gain of the antenna in the direction of interest relative to an isotropic radiator
R= distance to the center of radiation of the antenna
SL= power density limit

Ratio of Time On versus Total Transmit Time	1.00

Choose ↓ **ENTER** ↓

Occupational/Controlled	○		
General Population/Uncontrolled	◉		
Tx Frequency:		846.60	(MHz)
Maximum Peak Power at Antenna Input Terminal:		24.00	(dBm)
Source-Based Time-Average Factor:		0.00	(dB)
Antenna gain:		2.60	(dBi)

SL=	**0.56**	(mW/cm^2)
P=	**251.1886**	(mW)
G=	**1.82**	(numeric)

R = 8.03 (cm)

S (mw/cm^2) at 20cm

0.090836286

Formulae:

$S = \frac{PG}{4\pi R^2}$ where: S = Power Density Limit
P = Power Output of the Device
G = Numeric Antenna Gain
R = Distance from Antenna

$R = \sqrt{\frac{PG}{4\pi S}}$

Source-Based Time-Average Factor = 10 * log (Time On / (Time On + Time Off))
Power Output of the Device (W) = 10 * log (RF Output Power (dBm) + Source-Based Time Average Factor (dB))

D.6.6 Calculations:

Swivel Dipole Antenna (Max. Measured Conducted Power - PCS UMTS Mode)

Prediction of MPE Limit
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Equation from page 18

$$S = \frac{PG}{4\pi R^2}$$

$$R = \sqrt{\frac{PG}{4\pi S}}$$

S= power density
P= power input to the antenna
G= power gain of the antenna in the direction of interest relative to an isotropic radiator
R= distance to the center of radiation of the antenna
SL= power density limit

Ratio of Time On versus Total Transmit Time	1.00	
Choose / ENTER		
Occupational/Controlled	○	
General Population/Uncontrolled	◉	
Tx Frequency:	1880.00	(MHz)
Maximum Peak Power at Antenna Input Terminal:	23.00	(dBm)
Source-Based Time-Average Factor:	0.00	(dB)
Antenna gain:	2.60	(dBi)

SL=	1.00	(mW/cm^2)
P=	199.5262	(mW)
G=	1.82	(numeric)

R = 5.38 (cm)

S (mw/cm^2) at 20cm

0.072153826

Formulae:

$S = \frac{PG}{4\pi R^2}$ where: S = Power Density Limit
P = Power Output of the Device
G = Numeric Antenna Gain
R = Distance from Antenna

$R = \sqrt{\frac{PG}{4\pi S}}$

Source-Based Time-Average Factor = 10 * log (Time On / (Time On + Time Off))
Power Output of the Device (W) = 10 * log (RF Output Power (dBm) + Source-Based Time Average Factor (dB))

D.6.7 Calculations:

Vehicle-Mount Antenna (Max. Measured Conducted Power - Cellular GPRS Mode)

Prediction of MPE Limit
OET Bulletin 65, Edition 97-01

Equation from page 18

$$S = \frac{PG}{4\pi R^2}$$

$$R = \sqrt{\frac{PG}{4\pi S}}$$

S= power density
P= power input to the antenna
G= power gain of the antenna in the direction of interest relative to an isotropic radiator
R= distance to the center of radiation of the antenna
SL= power density limit

Ratio of Time On versus Total Transmit Time	0.25	
Choose / ENTER		
Occupational/Controlled	○	
General Population/Uncontrolled	◉	
Tx Frequency:	848.80	(MHz)
Maximum Peak Power at Antenna Input Terminal:	32.28	(dBm)
Source-Based Time-Average Factor:	-6.02	(dB)
Antenna gain and Cable Loss:	1.11	(dBi)

SL=	**0.57**	(mW/cm^2)
P=	**422.6102**	(mW)
G=	**1.29**	(numeric)

R = 8.76 (cm)

S (mw/cm^2) at 20cm

0.108442464

Formulae:

$S = \frac{PG}{4\pi R^2}$ where: S = Power Density Limit
P = Power Output of the Device
G = Numeric Antenna Gain
R = Distance from Antenna

$R = \sqrt{\frac{PG}{4\pi S}}$

Source-Based Time-Average Factor = 10 * log (Time On / (Time On + Time Off))
Power Output of the Device (W) = 10 * log (RF Output Power (dBm) + Source-Based Time Average Factor (dB))

D.6.8 Calculations:

Vehicle-Mount Antenna (Max. Measured Conducted Power - PCS GPRS Mode)

Prediction of MPE Limit
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Equation from page 18

$$S = \frac{PG}{4\pi R^2}$$

$$R = \sqrt{\frac{PG}{4\pi S}}$$

S= power density
P= power input to the antenna
G= power gain of the antenna in the direction of interest relative to an isotropic radiator
R= distance to the center of radiation of the antenna
SL= power density limit

Ratio of Time On versus Total Transmit Time	0.25

Choose ↓ **ENTER** ↓

Occupational/Controlled	○	
General Population/Uncontrolled	◉	
Tx Frequency:	1880.00	(MHz)
Maximum Peak Power at Antenna Input Terminal:	28.63	(dBm)
Source-Based Time-Average Factor:	-6.02	(dB)
Antenna gain and Cable Loss:	0.20	(dBi)

SL=	**1.00**	(mW/cm^2)
P=	**182.3644**	(mW)
G=	**1.05**	(numeric)

R = 3.90 (cm)

S (mw/cm^2) at 20cm

0.037948916

Formulae:

$S = \frac{PG}{4\pi R^2}$ where: S = Power Density Limit
P = Power Output of the Device
G = Numeric Antenna Gain
R = Distance from Antenna

$R = \sqrt{\frac{PG}{4\pi S}}$

Source-Based Time-Average Factor = 10 * log (Time On / (Time On + Time Off))
Power Output of the Device (W) = 10 * log (RF Output Power (dBm) + Source-Based Time Average Factor (dB))

D.6.9 Calculations:

Vehicle-Mount Antenna (Max. Measured Conducted Power - Cellular EDGE Mode)

Prediction of MPE Limit
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Equation from page 18

$$S = \frac{PG}{4\pi R^2}$$

$$R = \sqrt{\frac{PG}{4\pi S}}$$

S= power density
P= power input to the antenna
G= power gain of the antenna in the direction of interest relative to an isotropic radiator
R= distance to the center of radiation of the antenna
SL= power density limit

Ratio of Time On versus Total Transmit Time	0.25

Choose ↓ **ENTER** ↓

Occupational/Controlled	○	
General Population/Uncontrolled	◉	
Tx Frequency:	836.60	(MHz)
Maximum Peak Power at Antenna Input Terminal:	26.89	(dBm)
Source-Based Time-Average Factor:	-6.02	(dB)
Antenna gain and Cable Loss:	1.11	(dBi)

SL=	**0.56**	(mW/cm^2)
P=	**122.1631**	(mW)
G=	**1.29**	(numeric)

R = 4.74 (cm)

S (mw/cm^2) at 20cm

0.031347245

Formulae:

$S = \frac{PG}{4\pi R^2}$ where: S = Power Density Limit
P = Power Output of the Device
G = Numeric Antenna Gain
R = Distance from Antenna

$R = \sqrt{\frac{PG}{4\pi S}}$

Source-Based Time-Average Factor = 10 * log (Time On / (Time On + Time Off))
Power Output of the Device (W) = 10 * log (RF Output Power (dBm) + Source-Based Time Average Factor (dB))

D.6.10 Calculations:

Vehicle-Mount Antenna (Max. Measured Conducted Power - PCS EDGE Mode)

Prediction of MPE Limit
OET Bulletin 65, Edition 97-01

Equation from page 18

$$S = \frac{PG}{4\pi R^2}$$

$$R = \sqrt{\frac{PG}{4\pi S}}$$

S= power density
P= power input to the antenna
G= power gain of the antenna in the direction of interest relative to an isotropic radiator
R= distance to the center of radiation of the antenna
SL= power density limit

Ratio of Time On versus Total Transmit Time	0.25

Choose **ENTER**

Occupational/Controlled	○	
General Population/Uncontrolled	◉	
Tx Frequency:	1880.00	(MHz)
Maximum Peak Power at Antenna Input Terminal:	25.73	(dBm)
Source-Based Time-Average Factor:	-6.02	(dB)
Antenna gain and Cable Loss:	0.20	(dBi)

SL=	1.00	(mW/cm^2)
P=	93.5276	(mW)
G=	1.05	(numeric)

R = 2.79 (cm)

S (mw/cm^2) at 20cm

0.019462534

Formulae:

$$S = \frac{PG}{4\pi R^2}$$

$$R = \sqrt{\frac{PG}{4\pi S}}$$

where: S = Power Density Limit
P = Power Output of the Device
G = Numeric Antenna Gain
R = Distance from Antenna

Source-Based Time-Average Factor = 10 * log (Time On / (Time On + Time Off))
Power Output of the Device (W) = 10 * log (RF Output Power (dBm) + Source-Based Time Average Factor (dB))

D.6.11 Calculations:

Vehicle-Mount Antenna (Max. Measured Conducted Power - Cellular UMTS Mode)

Prediction of MPE Limit
OET Bulletin 65, Edition 97-01

Equation from page 18

$$S = \frac{PG}{4\pi R^2}$$

$$R = \sqrt{\frac{PG}{4\pi S}}$$

S= power density
P= power input to the antenna
G= power gain of the antenna in the direction of interest relative to an isotropic radiator
R= distance to the center of radiation of the antenna
SL= power density limit

Ratio of Time On versus Total Transmit Time	1.00

Choose ↓ **ENTER** ↓

Occupational/Controlled	○	
General Population/Uncontrolled	◉	
Tx Frequency:	846.60	(MHz)
Maximum Peak Power at Antenna Input Terminal:	24.00	(dBm)
Source-Based Time-Average Factor:	0.00	(dB)
Antenna gain and Cable Loss:	1.11	(dBi)

SL=	**0.56**	(mW/cm^2)
P=	**251.1886**	(mW)
G=	**1.29**	(numeric)

R = 6.76 (cm)

S (mw/cm^2) at 20cm

0.064455409

Formulae:

$S = \frac{PG}{4\pi R^2}$ where: S = Power Density Limit
P = Power Output of the Device
G = Numeric Antenna Gain
R = Distance from Antenna

$R = \sqrt{\frac{PG}{4\pi S}}$

Source-Based Time-Average Factor = 10 * log (Time On / (Time On + Time Off))
Power Output of the Device (W) = 10 * log (RF Output Power (dBm) + Source-Based Time Average Factor (dB))

D.6.12 Calculations:

Vehicle-Mount Antenna (Max. Measured Conducted Power - PCS UMTS Mode)

Prediction of MPE Limit
OET Bulletin 65, Edition 97-01

Equation from page 18

$$S = \frac{PG}{4\pi R^2}$$

$$R = \sqrt{\frac{PG}{4\pi S}}$$

S= power density
P= power input to the antenna
G= power gain of the antenna in the direction of interest relative to an isotropic radiator
R= distance to the center of radiation of the antenna
SL= power density limit

Ratio of Time On versus Total Transmit Time	1.00

Choose ↓ **ENTER** ↓

Occupational/Controlled	○	
General Population/Uncontrolled	◉	
Tx Frequency:	1880.00	(MHz)
Maximum Peak Power at Antenna Input Terminal:	23.00	(dBm)
Source-Based Time-Average Factor:	0.00	(dB)
Antenna gain and Cable Loss:	0.20	(dBi)

SL=	**1.00**	(mW/cm^2)
P=	**199.5262**	(mW)
G=	**1.05**	(numeric)

R = 4.08 (cm)

S (mw/cm^2) at 20cm

0.041520193

Formulae:

$S = \frac{PG}{4\pi R^2}$ where: S = Power Density Limit
P = Power Output of the Device
G = Numeric Antenna Gain
R = Distance from Antenna

$R = \sqrt{\frac{PG}{4\pi S}}$

Source-Based Time-Average Factor = 10 * log (Time On / (Time On + Time Off))
Power Output of the Device (W) = 10 * log (RF Output Power (dBm) + Source-Based Time Average Factor (dB))

D.7 PASS/FAIL

In reference to the results outlined in D6 the DUT passes the requirements as stated in the reference standards as follows:
1) The DUT must comply with the minimum spacing requirement of 20 cm to ensure an exposure of not more than f/1500 mW/cm^2 for frequencies between 300 and 1500 MHz and 1 mW/cm^2 for frequencies between 1500 and 100,000 MHz.

D.8 SIGN-OFF

I attest to the accuracy of the data. All measurements reported herein were performed by me and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements.

Spencer Watson
EMC Manager
Celltech Labs Inc.

June 27, 2006
Date