Spectrum Engineering Services

Smart Meter RF Survey Site Report

Ashton Court

Appendix A.1

Publication Date: 19 October 2015

Version: 1.2

OFCOM_SES(15)010.A.1

Document Control

Prepared for:	Department of Energy and Climate Change
Author(s):	Dave Smith
Checked by:	Alistair Abington
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Contents

Section Page

1 Introduction

This document details the results and findings for the DECC smart meter RF survey of multiple dwelling units. The survey was to examine the path loss measurements within different types of multiple dwelling units.

Before reading this report appendix, the main report shall be read, as this contains explanations to the testing procedure, how the data was processed and a description to the results presentation.

On the 14 July 2015, Ofcom engineers conducted a radio propagation survey at the Multiple Dwelling Units (MDU) property described below. This survey is part of the drive by the Department of Energy and Climate Change (DECC) to rollout Smart Meters in every UK home.

As part of this program, DECC is keen to understand how radio frequency signals propagate through the different MDU.

Transmit and receive locations for the test equipment were typical locations where you may find the electricity and gas meters in these types of buildings. These locations were identified with the assistance of energy suppliers.

Walk testing of the high power transmitted was carried out at this location and the results are summarised in Section 7 of the main report.

Table 1 Site Details

Detail	Description
Property Identifier	Ashton Court
Property Type	Converted Building
Material of Construction	Sand Stone
Type of Exterior Wall	Stone
Property Age	1633
Gas Meter Location	Meter room
Electricity Meter Location	Meter room

Figure 1 Typical View Ashton Court

Figure 2 Front of Property

Radio frequency path loss measurements were conducted in the 868MHz short range device band, typically used for short range indoor applications.

The measurements were carried out in predefined locations within the building in consultation with the energy suppliers.

2 Path Loss Survey Methodology

A detailed description of the methodology can be found in a separate document.[1]

2.1 Number of Locations Tested

Ofcom tested a combined total of twenty six receive locations within the property and outside, using signals from four different transmitter locations. The receive antenna was tested in two orientations, vertical and horizontal. A total of 78 test files were recorded for Ashton Court.

The two transmit locations in the small MDU used:

1. Electricity Cupboard (Room 49) (100 mW).
2. Office (Room 38) (100 mW).
3. IT Room (Room 88 1st Floor) (100 mW).
4. Ranger Flat (500 mW).

2.2 Measurements Recorded

Three types of measurements were carried out during the survey:

1. An interference measurement to determine the activity in the 868MHz SRD band. This was carried out at one location, close to where one of the transmitter antennas was located.
2. Receive signal level measurements using a known transmit signal. The receive signal was measured in both the vertical and horizontal orientation, at various locations throughout the MDU and outside the MDU.

The diagram below shows the typical transmit/receive equipment set up used during the MDU testing.

[1] Ofcom – Smart Meter RF Survey Methodology, Reference: OFCOM_SES(15)_011 – 868MHz Smart_Test_Method_v2.0

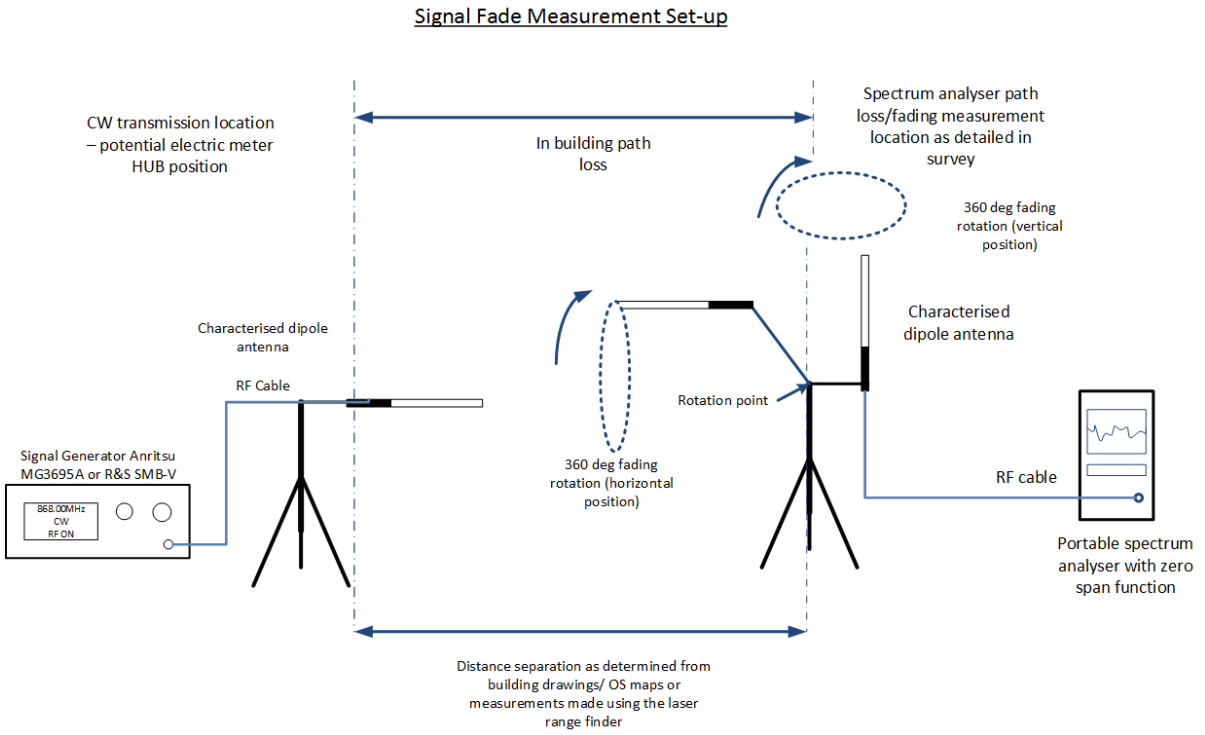


Figure 3 Test Equipment Details

For traceability the main test equipment components used in the MDU survey are listed below with appropriate tracking details.

Prior to the commencement of daily testing the RF level from the Transmit antennas was calibrated to 100mW (500mW as required).

Table 2 Test Equipment Details

Item	Make/Model	Serial / Asset Number
Signal Generator 1	R&S SMBV100B	256587 (0471)
Signal Generator 2	Anritsu MG3695A	032006
Power Amplifier	ENI 607l-01	162
Spectrum Analyser 1	R&S FSH8	115160/028
Spectrum Analyser 2	R&S ZVH8	1155159/EJ

Table 3 Test Antenna Details

Item	Make/Model	Serial Number	VSWR
Tx Antenna 1	Radio Structures ENF900	11911	1.43
Tx Antenna 2	Radio Structures ENF900	11883	1.51
Rx Antenna 1	Radio Structures ENF900	11910	1.42
Rx Antenna 2	Radio Structures ENF900	11882	1.62

3 Site Details

3.1 Building Plan and Test Locations

See Appendix A – Building Plan, which contains a plan of the property with a grid used to identify the test locations an Appendix B – Test Locations contains a table which details the test locations. The grid used in Appendix A represents a 4 meter square and is scaled to the Ordnance Survey plan drawings.

3.2 Test Heights

The test heights are provided in the table below

Table 4 Test Heights

Location	Location Name	Height
Tx 1	Electricity Cupboard (Room 49)	1.5 m
Tx 2	Office (Room 38)	1.5 m
Tx 3	Ranger Flat	1.5 m
Tx 4	IT Room (Room 88 1st Floor)	1.5 m

3.3 Photographs of Transmit Locations

Figure 4 Transmit Location 1 Electricity Cupboard (Room 49)

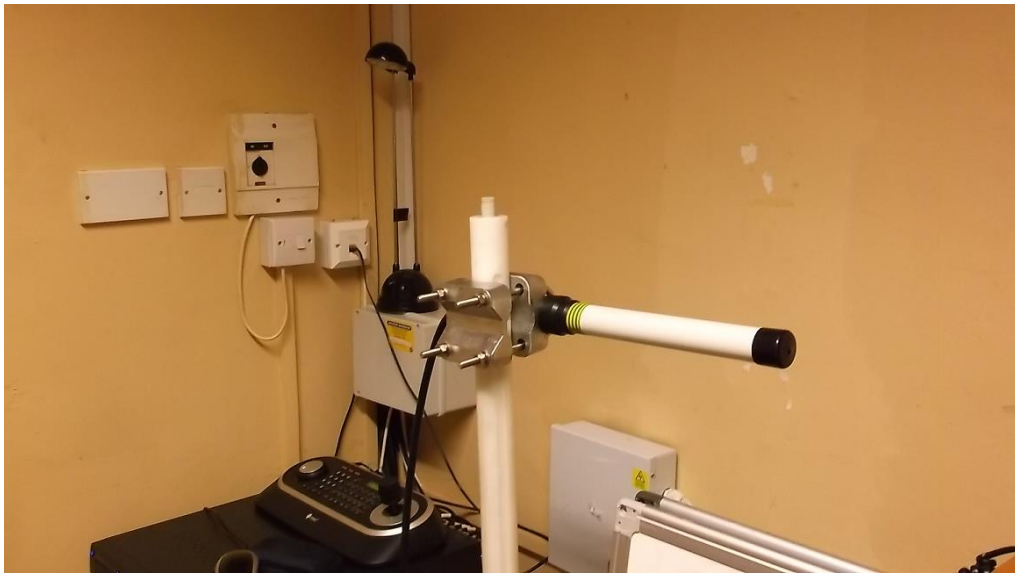


Figure 5 Transmit Location 2 Office (Room 38)

Figure 6 Transmit Location 3 IT Office (Room 88)

3.4 Photographs of Receive Test Locations

The following photographs are of typical test locations within Ashton Court. This location is a commercial premises and is used to represent an old building converted to flats.

Figure 7 Sample Test Location 1

Figure 8 Sample Test Location 2

Figure 9 Sample Test Location 3

Figure 10 Sample Test Location 4

4 Test Results

This section presents the processed results for the measurements taken at Ashton Court.

4.1 Test Frequencies and Powers

The following interference sweep was carried out to determine the frequencies that could be used for the subsequent testing. Figure 11 shows a sweep of the 868 MHz band and the activity in the band.

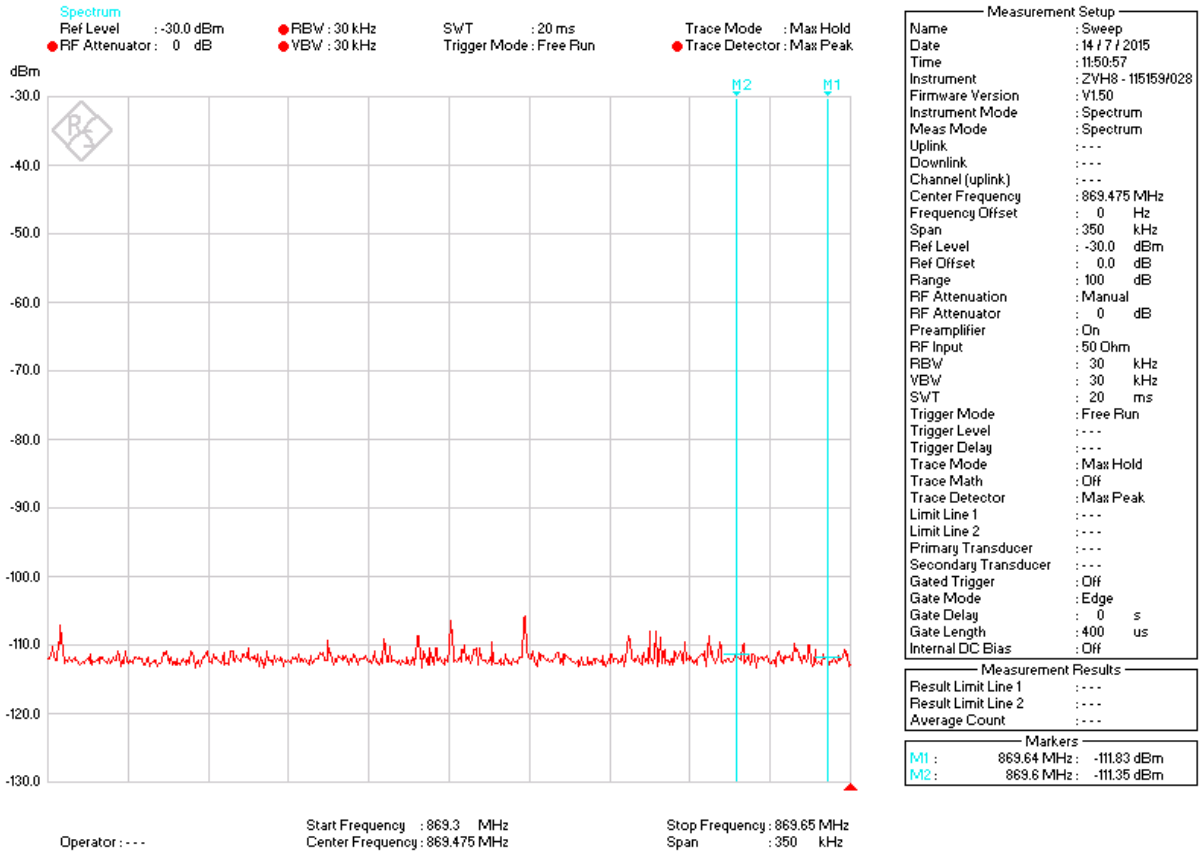


Figure 11 Scan of the 868 MHz Band

The following test frequencies and powers were used in all tests at Ashton Court.

Table 5 Transmit Frequencies and Powers

Transmitter	Frequency	Power
Tx 1	869.640 MHz	100mW
Tx 2	869.450 MHz	100mW
Tx 3	869.640 MHz	500mW
Tx 4	869.450 MHz	100mW

Figure 12 shows the median values for all the measurements taken at Ashton Court at both 100 and 500 mW.

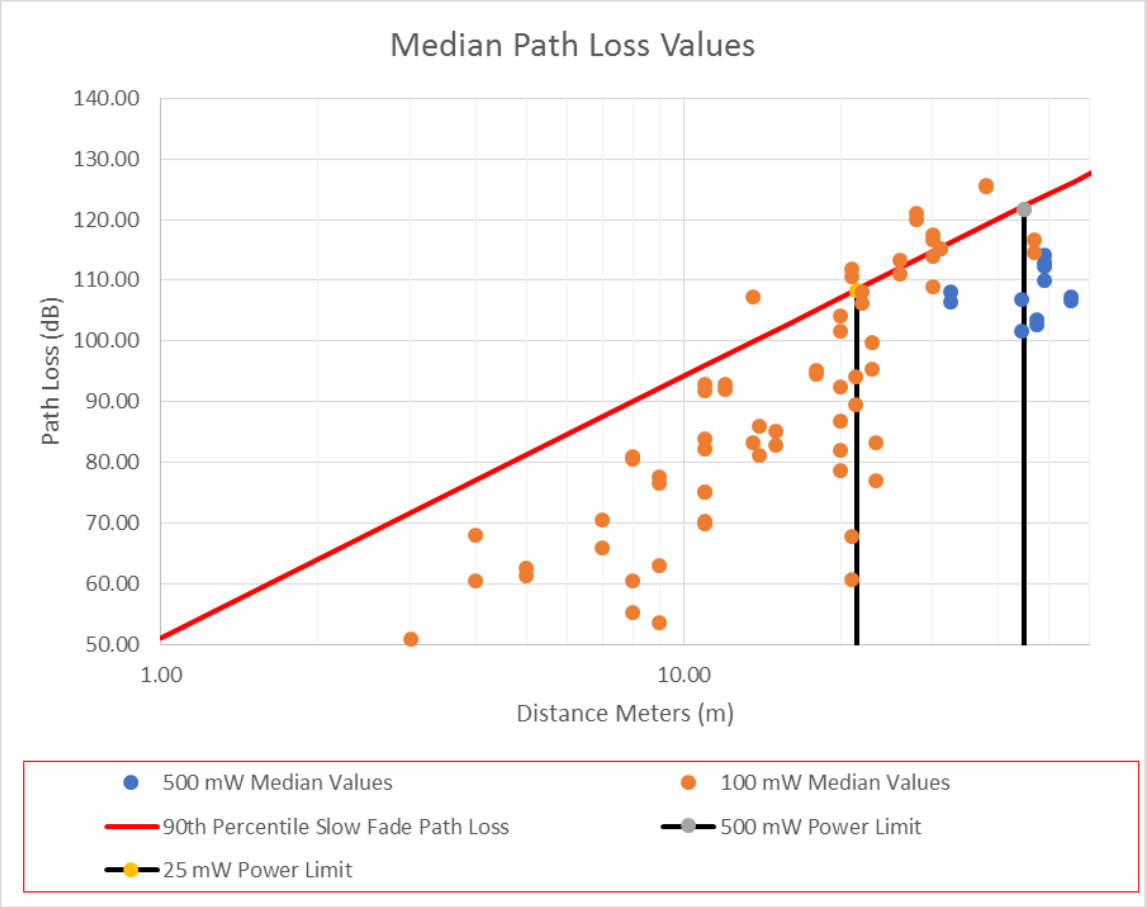


Figure 12 Median Path Loss Measurements

Path loss limit line, 25mW and 500mW power limits on the chart in Figure 12 are derived from the summary of all the data collected on all sites. Details of how these limits are derived and their formulation is contained in the final summary report, to which this document is an Appendix.

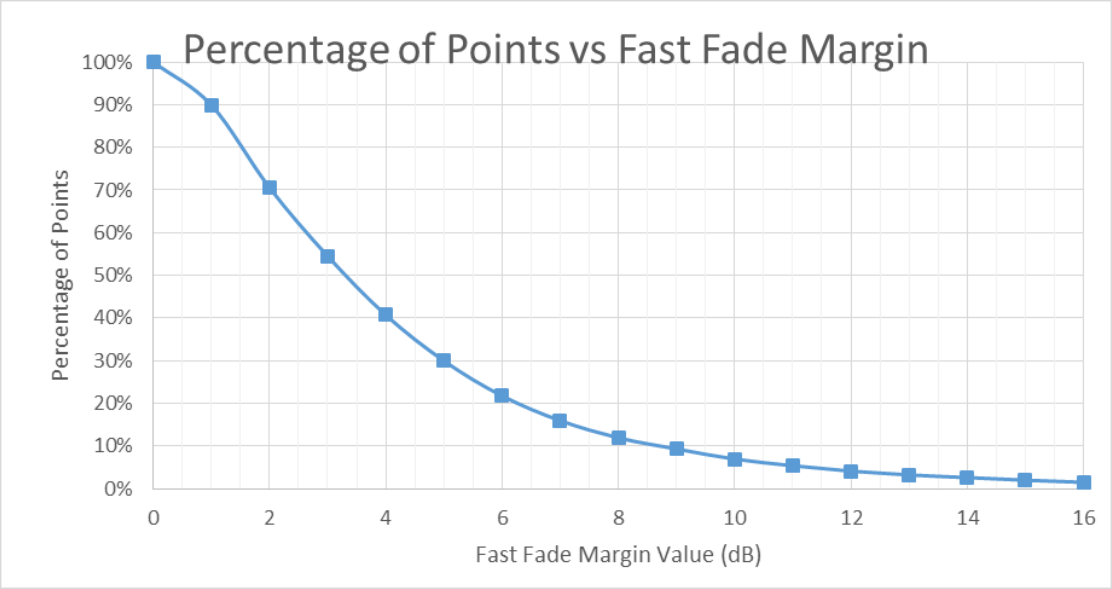
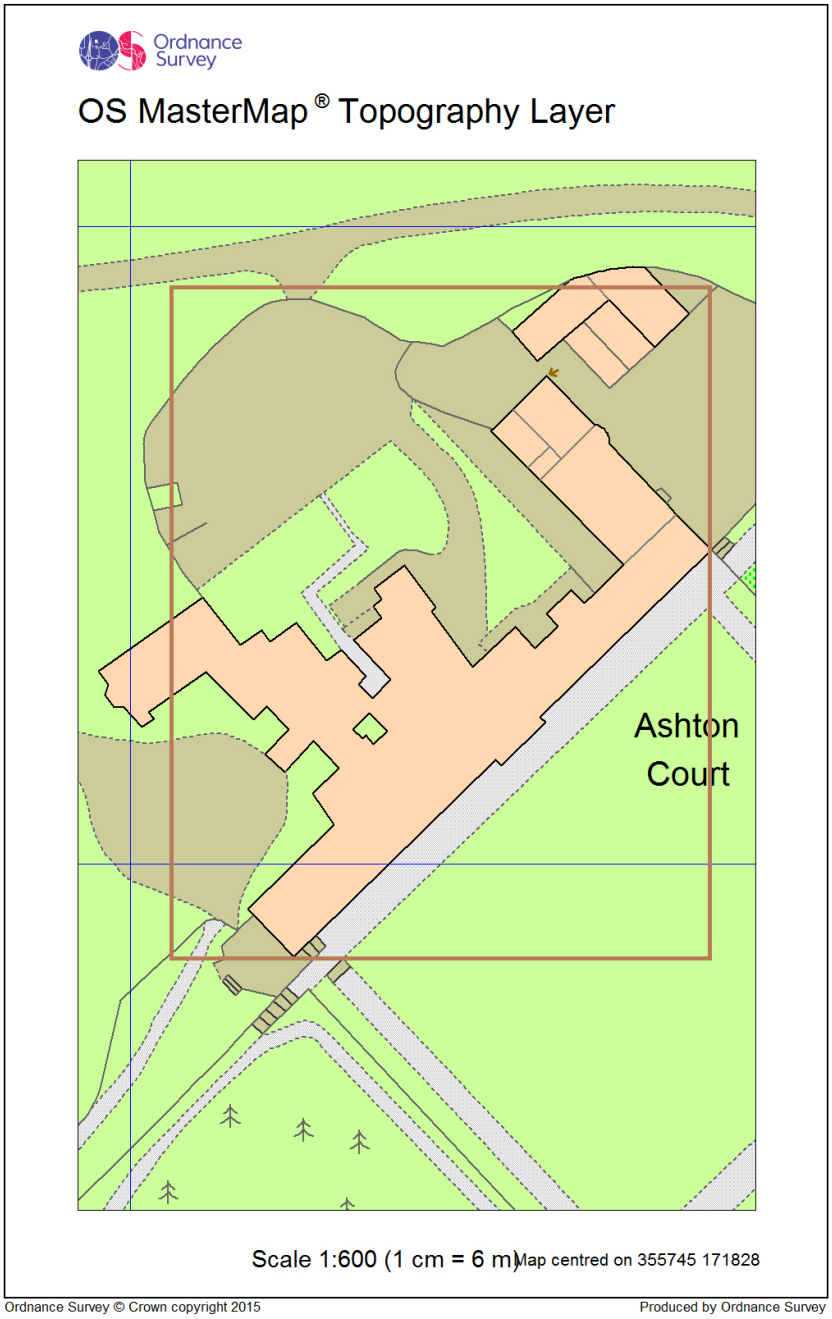
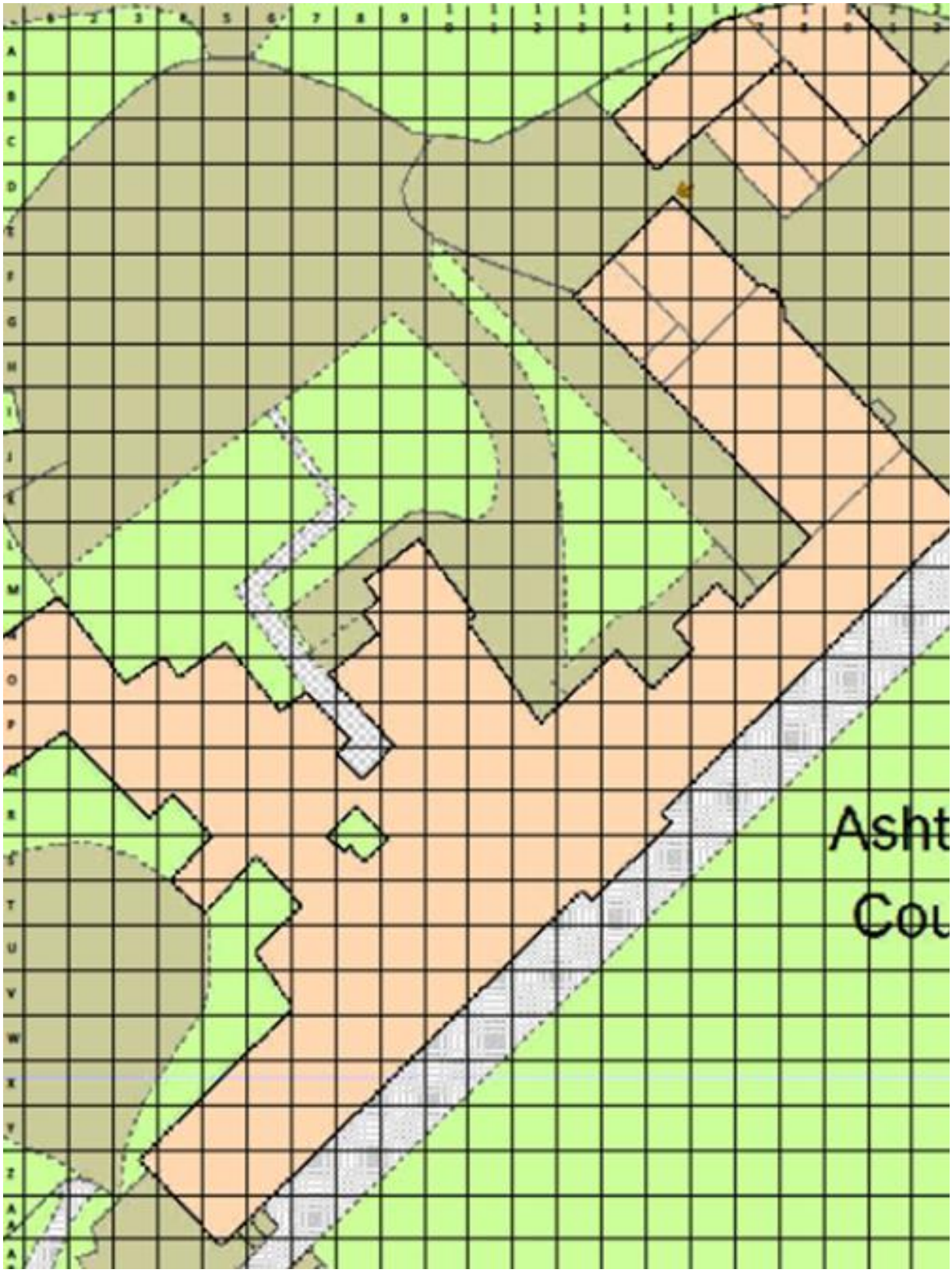


Figure 13 Fast Fade Margin

Figure 13 Fast Fade Margin shows the average number of points recorded within increasing 1 dB steps from the median values for each multipath fast fading test. 90% of all values are less than 9 dB from the median.

5 Appendix A – Building Plan

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6 Appendix B – Test Locations

Team	Test	Floor	Inside/Outside	Grid Reference
-	Tx 1	Ground	Inside	O4
-	Tx 2	Ground	Inside	Q7
2	Rx 1	Ground	Inside	Q4
2	Rx 2	Ground	Inside	O5
2	Rx 3	Ground	Inside	O4
2	Rx 4	Ground	Outside	P6
2	Rx 5	Ground	Inside	R3
2	Rx 6	Ground	Inside	P6
1	Rx 7	Ground	Outside	V6
1	Rx 8	Ground	Outside	P1
1	Rx 9	Ground	Inside	T8
1	Rx 10	Ground	Inside	T10
1	Rx 11	Ground	Inside	P12
1	Rx 12	Ground	Inside	P13
1	Rx 13	Ground	Inside	N15

Team	Test	Floor	Inside/Outside	Grid Reference
-	Tx 3	Second	Inside	S14
-	Tx 4	First	Inside	I19
1	Rx 14	First	Inside	E15
1	Rx 15	First	Inside	G13
1	Rx 16	First	Inside	I21
1	Rx 17	First	Inside	N19
1	Rx 18	Ground	Inside	F13
1	Rx 19	Ground	Inside	F16
1	Rx 20	Ground	Outside	C16

Spectrum Engineering Services

Smart Meter RF Survey Site Report

‘B’ Bond Warehouse

Appendix A.2

Publication Date: 19 October 2015

Version: 1.2

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Document Control

Prepared for:	Department of Energy and Climate Change
Author(s):	Dave Smith
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This document details the results and findings for the DECC smart meter RF survey of multiple dwelling units. The survey was to examine the path loss measurements within different types of multiple dwelling units.

Before reading this report appendix, the main report shall be read, as this contains explanations to the testing procedure, how the data was processed and a description to the results presentation.

On the 17 July 2015, Ofcom engineers conducted a radio propagation survey at the Multiple Dwelling Units (MDU) property described below. This survey is part of the drive by the Department of Energy and Climate Change (DECC) to rollout Smart Meters in every UK home.

As part of this program, DECC is keen to understand how radio frequency signals propagate through the different MDU.

Transmit and receive locations for the test equipment were typical locations where you may find the electricity and gas meters in these types of buildings. These locations were identified with the assistance of energy suppliers.

Table 1 Site Details

Detail	Description
Property Identifier	'B' Bond Warehouse
Property Type	N/A Commercial property
Material of Construction	Brick and Concrete
Type of Exterior Wall	Brick
Property Age	Built in 1908
Gas Meter Location	N/A
Electricity Meter Location	N/A

Figure 1 Typical View 'B' Bond Warehouse

Figure 2 Front of Property

Radio frequency path loss measurements were conducted in the 868MHz short range device band, typically used for short range indoor applications.

The measurements were carried out in predefined locations within the building in consultation with the energy suppliers.

2 Path Loss Survey Methodology

A detailed description of the methodology can be found in a separate document.[1]

2.1 Number of Locations Tested

Ofcom tested a combined total of twenty nine receive locations within the property and outside, using signals from two different transmitter locations, with one transmit where the power is increased from 100 mW to 500 mW. The receive antenna was tested in two orientations, vertical and horizontal. A total of 148 test files were recorded for 'B' Bond Warehouse.

The two transmit locations in the MDU used:

1. Electrical meter room ground floor (100 mW).
2. Plant room (100 mW).
3. Electrical meter room ground floor (500 mW).

2.2 Measurements Recorded

Three types of measurements were carried out during the survey:

1. An interference measurement to determine the activity in the 868MHz SRD band. This was carried out at one location, close to where one of the transmitter antennas was located.
2. Receive signal level measurements using a known transmit signal. The receive signal was measured in both the vertical and horizontal orientation, at various locations throughout the MDU and outside the MDU.

The diagram below shows the typical transmit/receive equipment set up used during the MDU testing.

[1] Ofcom – Smart Meter RF Survey Methodology, Reference: OFCOM_SES(15)_011 – 868MHz Smart_Test_Method_v2.0

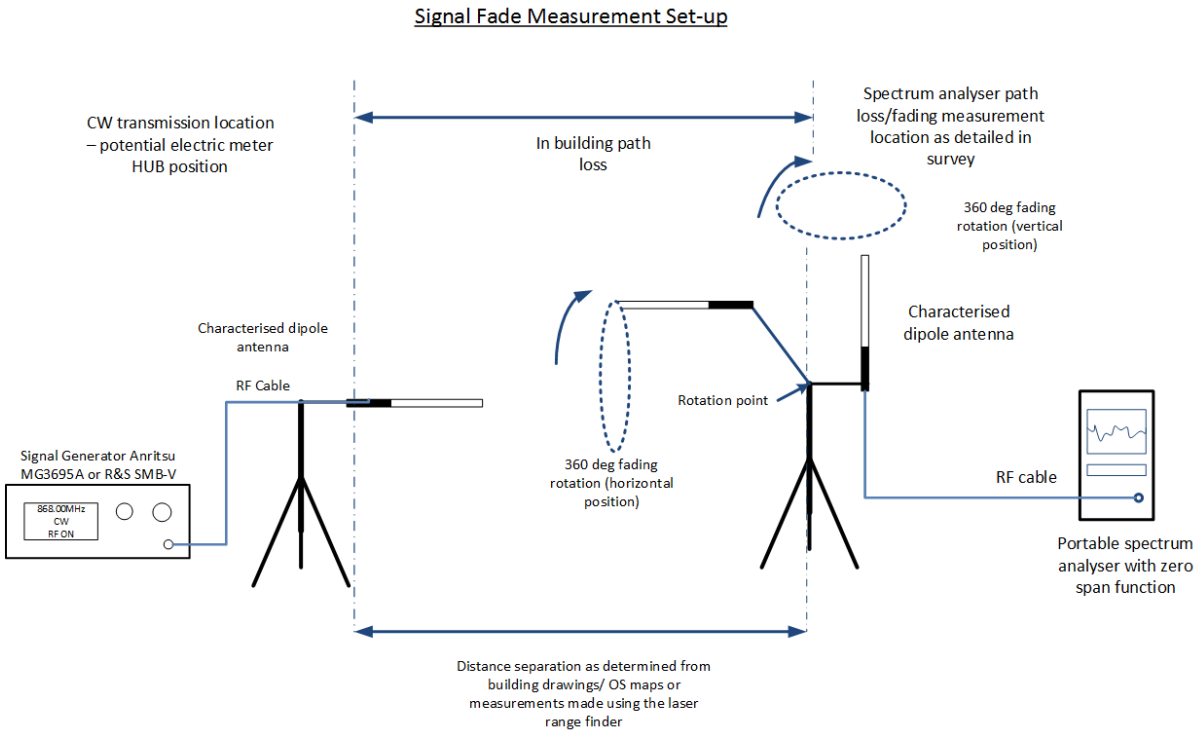

Figure 3 Equipment Set Up

2.3 Test Equipment Details

For traceability the main test equipment components used in the MDU survey are listed below with appropriate tracking details.

Table 2 Test Equipment Details

Item	Make/Model	Serial / Asset Number
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Item	Make/Model	Serial Number	VSWR
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3.1 Building Plan and Test Locations

See Appendix A – Building Plan, which contains a plan of the property with a grid used to identify the test locations and Appendix B – Test Locations contains a table which details the test locations. The grid used in Appendix A represents a 4 meter square and is scaled to the Ordnance Survey plan drawings.

3.2 Test Heights

The test heights are provided in the table below

Table 4 Test Heights

Location	Location Name	Height
Tx 1	Electrical meter room ground floor	1.5 m
Tx 2	Plant room Ground floor	1.5 m
Tx 3	Electrical meter room ground floor	1.5 m

3.3 Photographs of Transmit Locations

Figure 4 Transmit Location 1 Electricity Cupboard

3.4 Photographs of Receive Test Locations

The following photographs are of typical test locations within 'B' Bond Warehouse. This location is a commercial premises and is used to represent an old building converted to flats.

The figures below show typical test locations within the building.

Figure 5 Sample Test Location 1

Figure 6 Sample Test Location 2

Figure 7 Sample Test Location 3

Figure 8 Sample Test Location 4

4 Test Results

This section presents the processed results for the measurements taken at 'B' Bond Warehouse.

4.1 Test Frequencies and Powers

The following interference sweep was carried out to determine the frequencies that could be used for the subsequent testing. Figure 9 shows a sweep of the 868 MHz band and the activity in the band.

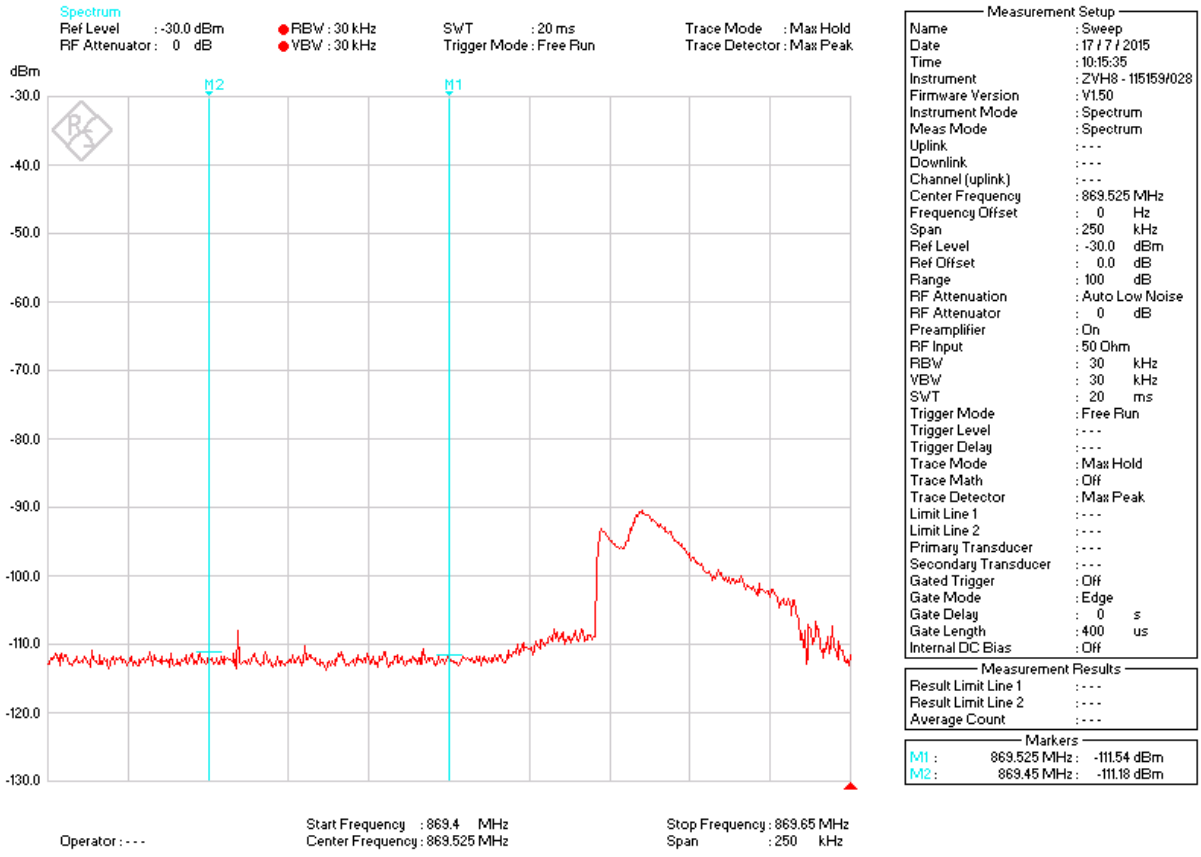

Figure 9 Scan of the 868 MHz Band

The following test frequencies and powers were used in all tests at 'B' Bond Warehouse.

It should be noted that high levels of channel occupancy was observed during the morning test period. However, the test frequencies were chosen so as not to impact upon the measurements.

Table 5 Transmit Frequencies and Powers

Transmitter	Frequency	Power
Tx 1	869.640 MHz	100mW
Tx 2	869.450 MHz	100mW
Tx 3	869.640 MHz	500mW

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Figure 10 shows the median values for all the measurements taken at 'B' Bond Warehouse at both 100 and 500 mW.

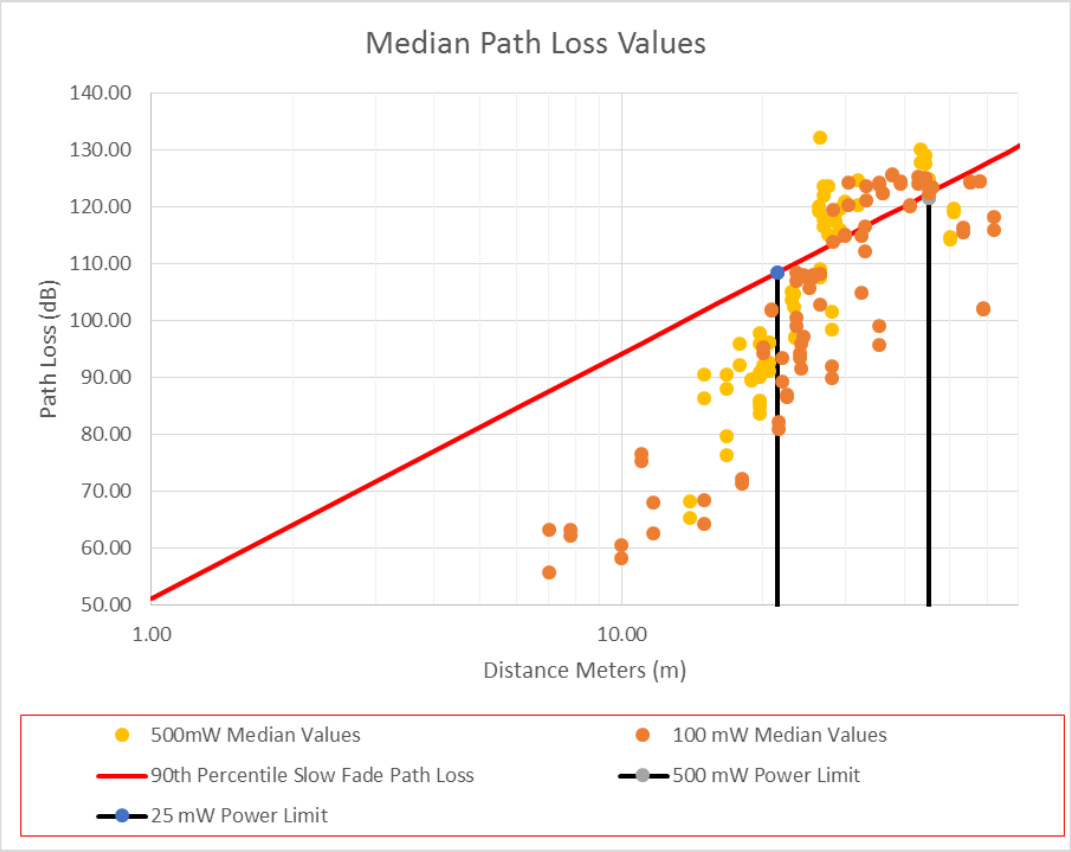


Figure 10 Median Path Loss Measurements

Path loss limit line, 25mW and 500mW power limits on the chart in Figure 10 are derived from the summary of all the data collected on all sites. Details of how these limits are derived and their formulation is contained in the final summary report, to which this document is an Appendix.

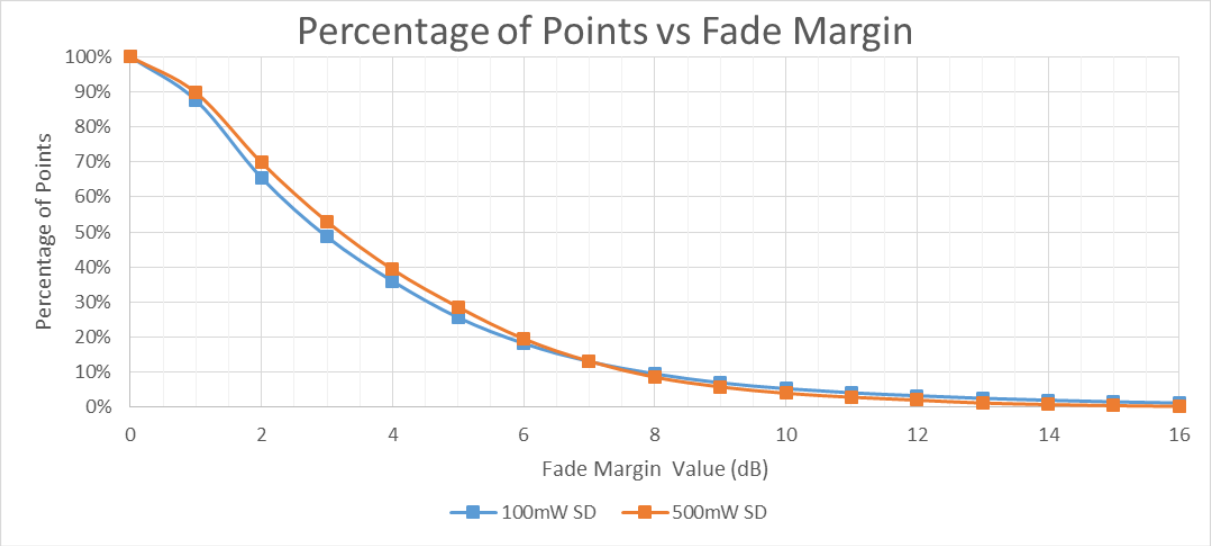


Figure 11 Median Fade Margin

Figure 11 Median Fade Margin shows the average number of points recorded within increasing 1 dB steps from the median values for each fast fading test. 90% of all values are below 7.5 dB from the median. Fading measurements were taken for 100mW and 500mW signals and the fast fading levels can be seen to be similar for both signals.

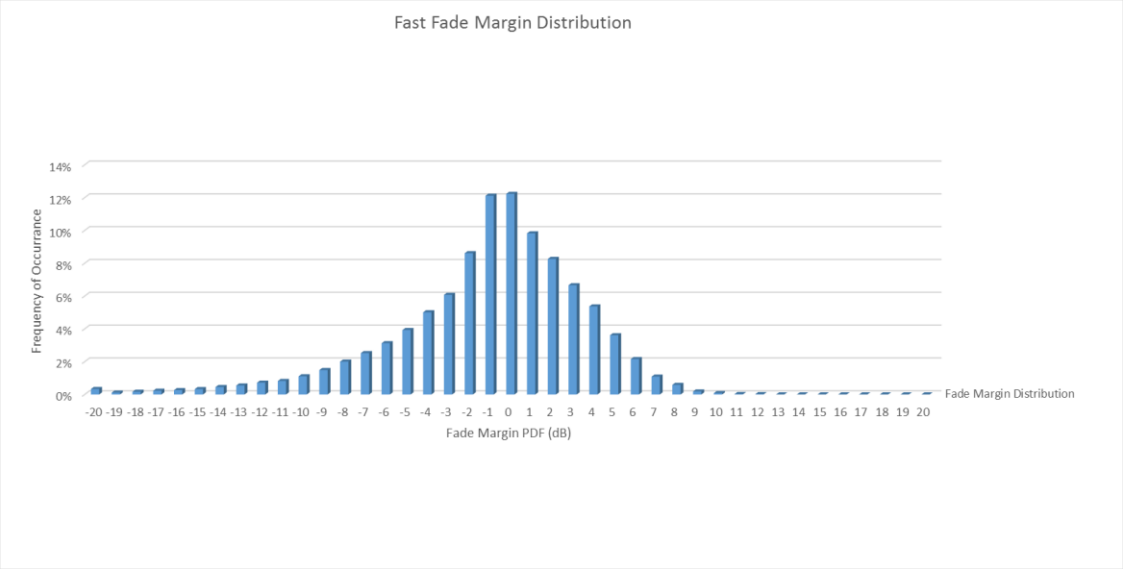


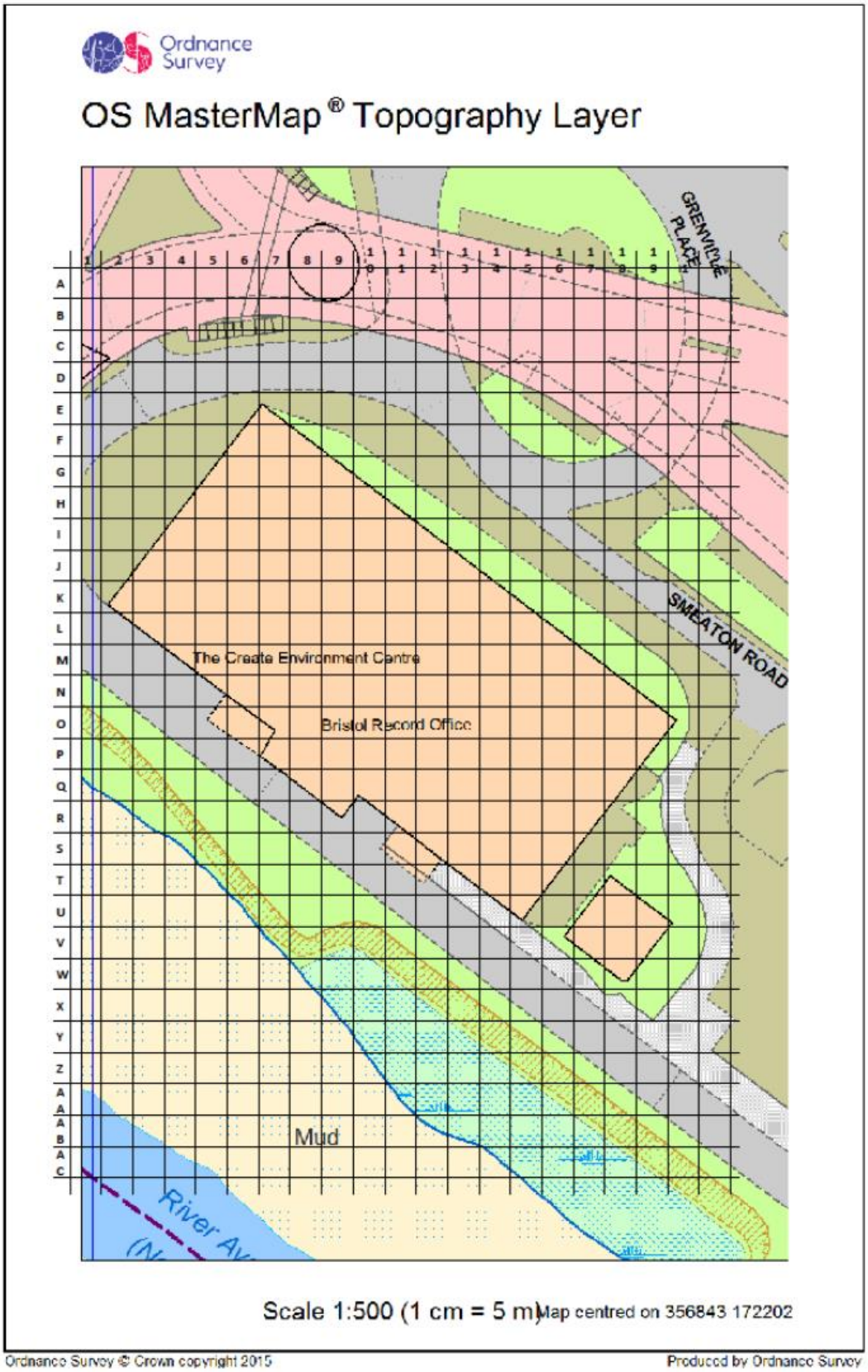
Figure 12 Fast Fading Rayleigh PDF

The fast fade margin PDF in Figure 12 shows that the building has a Rayleigh fast fading characteristic. This is explained in more detail in the main report.

Many of the measurements for the 'B' Bond warehouse lie outside the limit derived from the overall summary of all the data in Figure 10 Median Path Loss Measurements. The 'B' Bond was not a typical MDU, and parts of the building was used to house large amounts of paper archives on metal racking, which potentially could artificially increasing the path loss for the building and hence skew the results. The records office occupies the building area defined with the four corner grid location: K2 – E7 – J13 – P8. Level 0 was an office area broken up

into individual offices where as all levels above (1-7) were dedicated to document storage containing shelving units holding archive material.

5 Appendix A – Building Plan



6 Appendix B – Test Locations

Team	Test	Floor	Inside/Outside	Grid Reference
-	Tx 1/3	Ground		Q16
-	Tx 2	Ground		P18
1	Rx 1	Ground		O19
1	Rx 2	Ground		P7
1	Rx 3	Ground		L2
1	Rx 4	First	Inside	U14
1	Rx 5	First	Inside	O21
1	Rx 6	First	Inside	K14
1	Rx 7	First	Inside	Q10
1	Rx 8	Second	Inside	U15
1	Rx 9	Second	Inside	O21
1	Rx 10	Second	Inside	K14
1	Rx 11	Second	Inside	Q9
1	Rx 12	Third	Inside	U15
1	Rx 13	Third	Inside	O21
1	Rx 14	Third	Inside	K14
1	Rx 15	Third	Inside	Q9
1	Rx 16	Forth	Inside	U15
1	Rx 17	Forth	Inside	O19
1	Rx 18	Forth	Inside	K14
1	Rx 19	Forth	Inside	Q8

Team	Test	Floor	Inside/Outside	Grid Reference
2	Rx 1	First	Inside	F7
2	Rx 2	First	Inside	K3
2	Rx 3	First	Inside	N6
2	Rx 4	First	Inside	I11
2	Rx 5	Ground		U15
2	Rx 6	Ground		N19
2	Rx 7	Ground		J14
2	Rx 8	Ground		E7
2	Rx 9	Ground		K2
2	Rx 10	Ground		Q7

Spectrum Engineering Services

Smart Meter RF Survey Site Report

Brunel Estate

Appendix A.3

Publication Date: 19 October 2015

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Document Control

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As part of this program, DECC is keen to understand how radio frequency signals propagate through the different MDU.

Transmit and receive locations for the test equipment were typical locations where you may find the electricity and gas meters in these types of buildings. These locations were identified with the assistance of energy suppliers.

Walk testing of the high power transmitted was carried out at this location and the results are summarised in Section 7 of the main report.

Table 1 Site Details

Detail	Description
Property Identifier	Brunel Estate
Property Type	Block of flats with external walkways
Material of Construction	Brick and concrete
Type of Exterior Wall	Brick and concrete
Property Age	Built 1960 to 1974
Gas Meter Location	Assumed in flats
Electricity Meter Location	Assumed in flats

Figure 1 Typical Property View

Radio frequency path loss measurements were conducted in the 868MHz short range device band, typically used for short range indoor applications.

The measurements were carried out in predefined locations within the building in consultation with the energy suppliers.

2 Path Loss Survey Methodology

A detailed description of the methodology can be found in a separate document.[1]

2.1 Number of Locations Tested

Ofcom tested a combined total of twenty receive locations within the property and outside, using signals from two transmitter locations. The receive antenna was tested in two orientations, vertical and horizontal. A total of 68 test files were recorded for Brunel estate.

The three transmit locations used:

1. Outside garages at rear of flats (100 mW).
2. In a shed on the ground floor of flats (100 mW).
3. On the top floor of Culham House (500 mW).

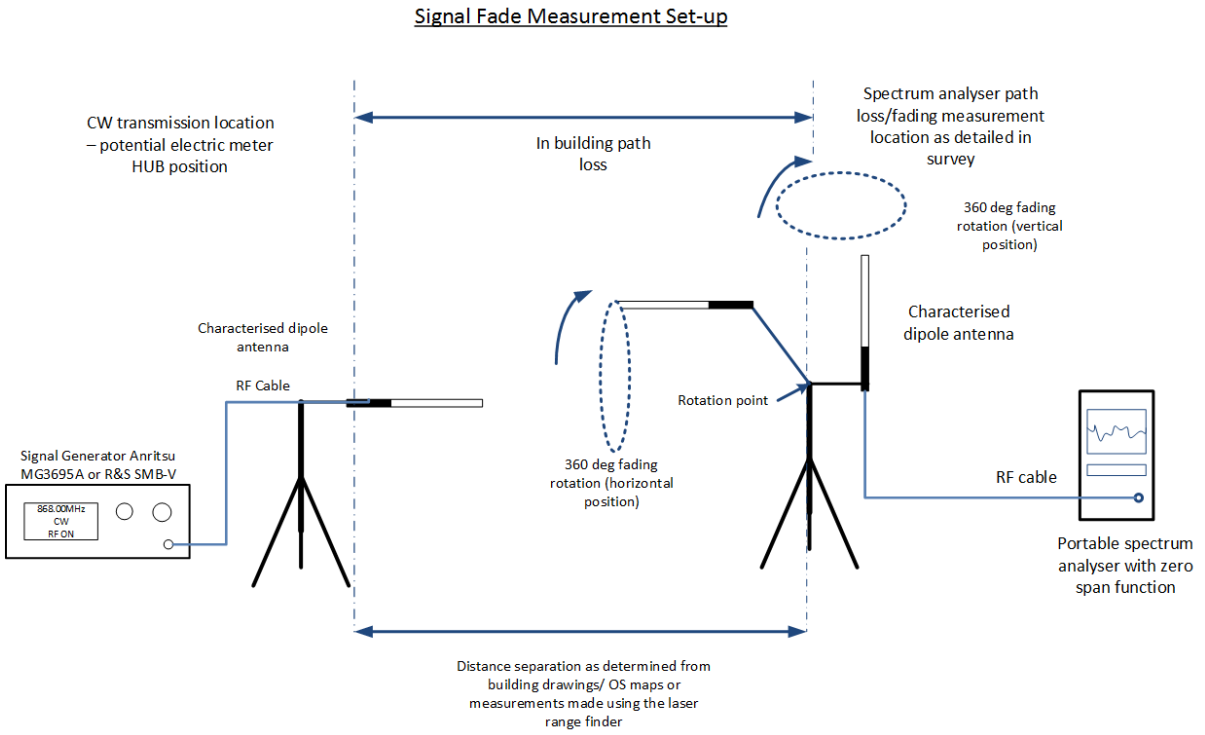
2.2 Measurements Recorded

Three types of measurements were carried out during the survey:

1. An interference measurement to determine the activity in the 868MHz SRD band. This was carried out at one location, close to where one of the transmitter antennas was located.
2. Receive signal level measurements using a known transmit signal. The receive signal was measured in both the vertical and horizontal orientation, at various locations throughout the MDU and outside the MDU.

The diagram below shows the typical transmit/receive equipment set up used during the MDU testing.

[1] Ofcom – Smart Meter RF Survey Methodology, Reference: OFCOM_SES(15)_011 – 868MHz Smart_Test_Method_v2.0



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See Appendix A – Building Plan, which contains a plan of the property with a grid used to identify the test locations and Appendix B – Test Locations contains a table which details the test locations. The grid used in Appendix A represents a 4 meter square and is scaled to the Ordnance Survey plan drawings.

3.2 Test Heights

The test heights are provided in the table below

Table 4 Test Heights

Location	Location Name	Height
Tx 1	Outside rear of flats	1 m
Tx 2	Shed on ground floor of flats	1 m
Tx 3	Top floor of Culham flats	1 m

3.3 Photographs of Transmit Locations

Figure 3 Transmit Location 1

Figure 4 Transmit Location 2

Figure 5 Top floor of Culham House Tx 3

3.4 Photographs of Receive Test Locations

The following photographs are of typical test locations within Brunel estate. All flats are entered from a central stair case in each block and the blocks are repeated along the terrace.

Figure 6 Sample Test Location 1

Figure 7 Sample Test Location 2

Figure 8 Sample Test Location 3

Figure 9 Sample Test Location 4

4 Test Results

This section presents the processed results for the measurements taken at Brunel estate.

4.1 Test Frequencies and Powers

The following interference sweep was carried out to determine the frequencies that could be used for the subsequent testing. Figure 10 shows a sweep of the 868 MHz band and the activity in the band.

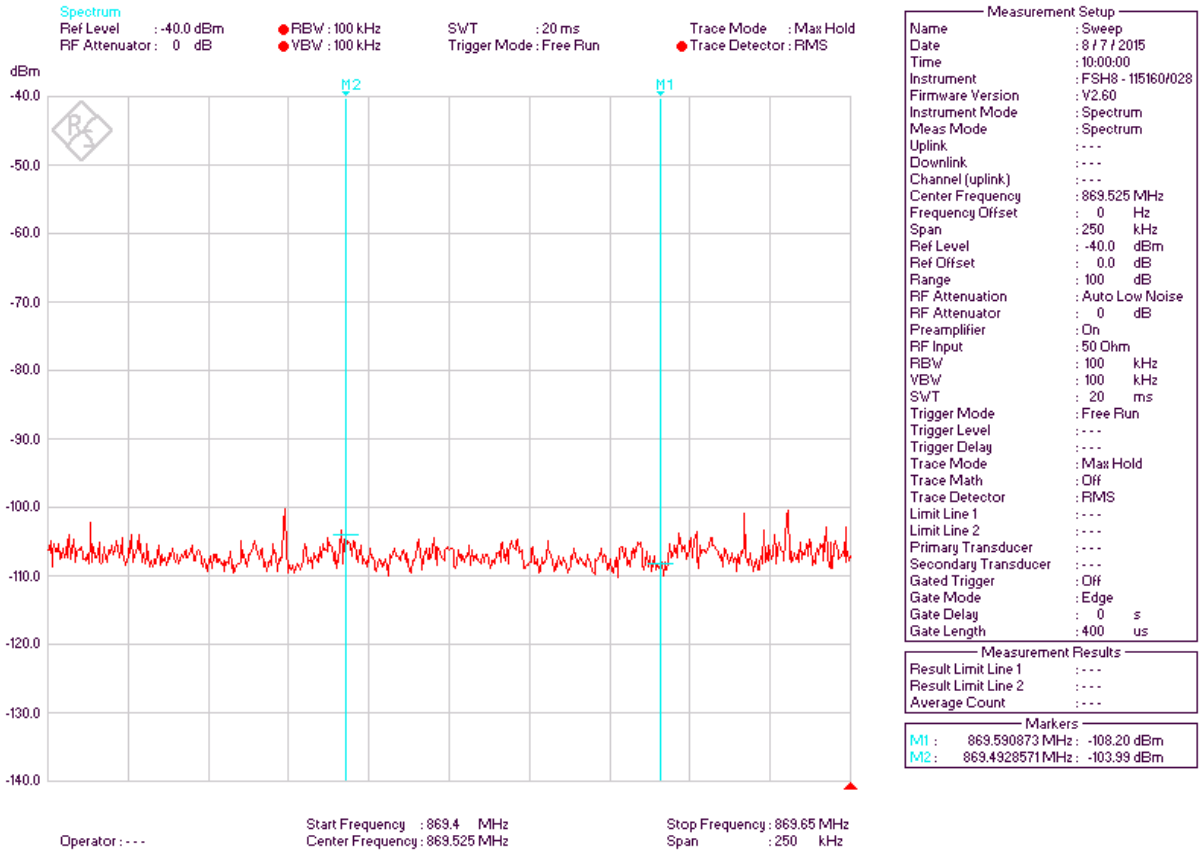


Figure 10 Scan of the 868 MHz Band

The following test frequencies and powers were used in all tests on the Brunel estate.

Table 5 Transmit Frequencies and Powers

Transmitter	Frequency	Power
Tx 1	869.590 MHz	100mW
Tx 2	869.492 MHz	100mW
Tx 3	869.492 MHz	500mW

Figure 11 shows the median values for all the measurements taken on the Brunel estate at both 100 and 500mW.

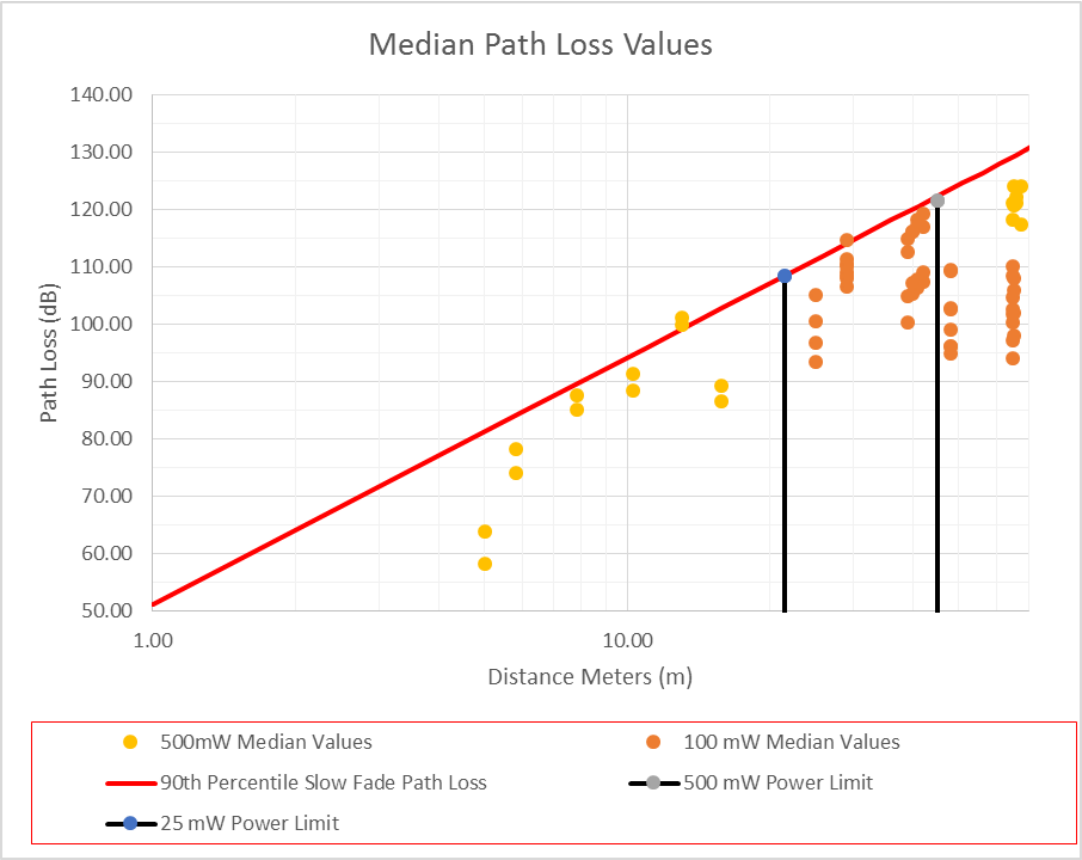


Figure 11 Median Path Loss Measurements

Path loss limit line, 25mW and 500mW power limits on the chart in Figure 11 are derived from the summary of all the data collected on all sites. Details of how these limits are derived and their formulation is contained in the final summary report, to which this document is an Appendix.

The vast majority of measurements taken at Brunel lie within the limit set from the summary of all the data.

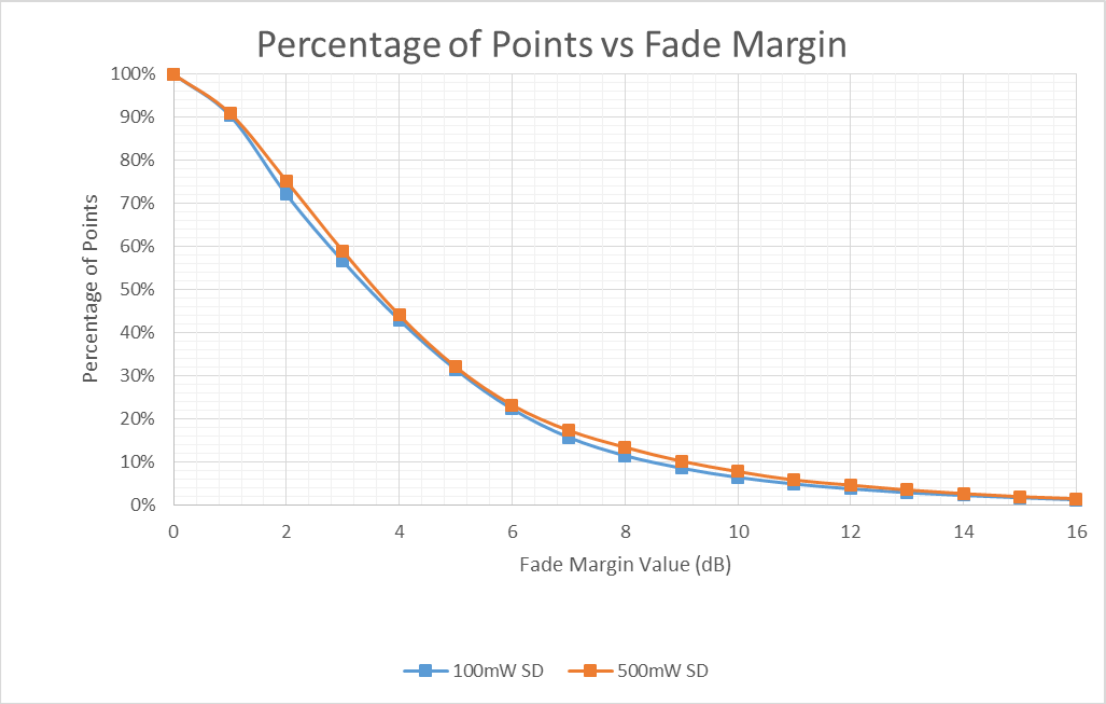


Figure 12 Fast Fade Margin

Figure 12 Fast Fade Margin shows the average number of points recorded within increasing 1 dB steps from the median values for each fast fading test. 90% of all values are less than 8.8 dB from the median. Fast fading tests were carried out at both 100mW and 500mW and from Figure 12 the levels of fading are similar.

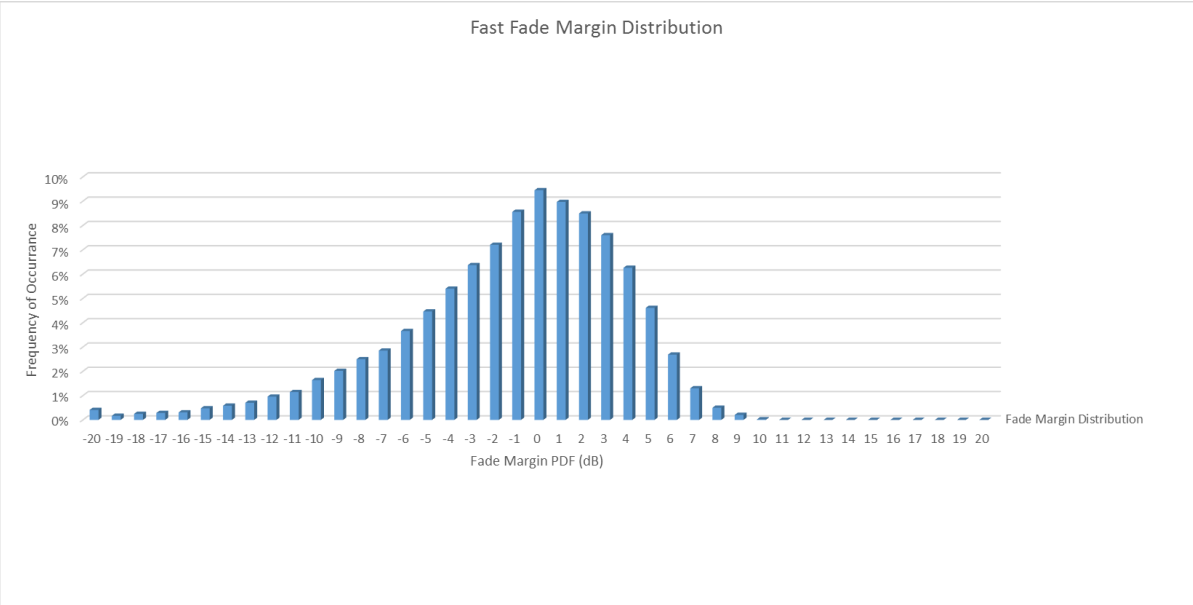
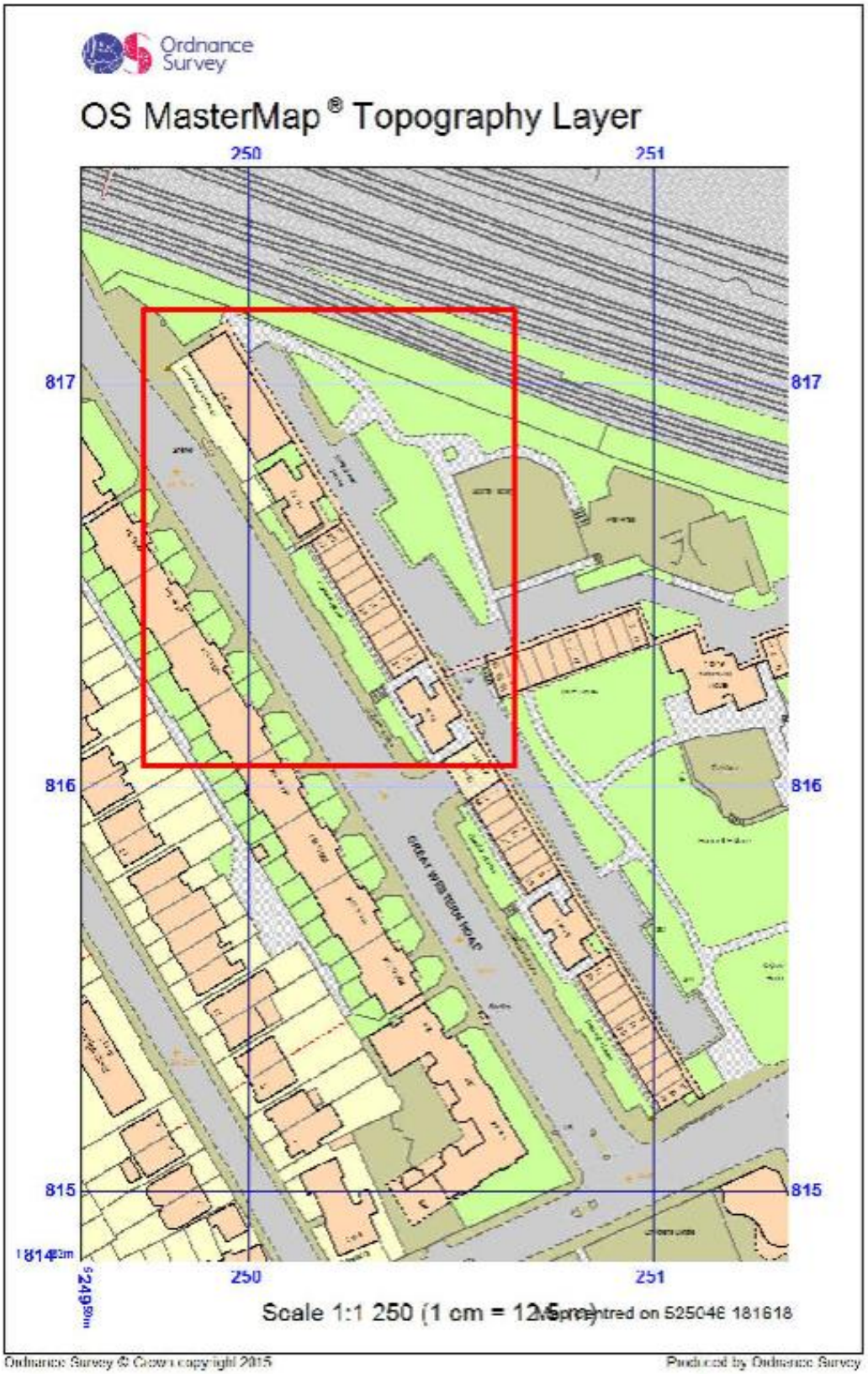
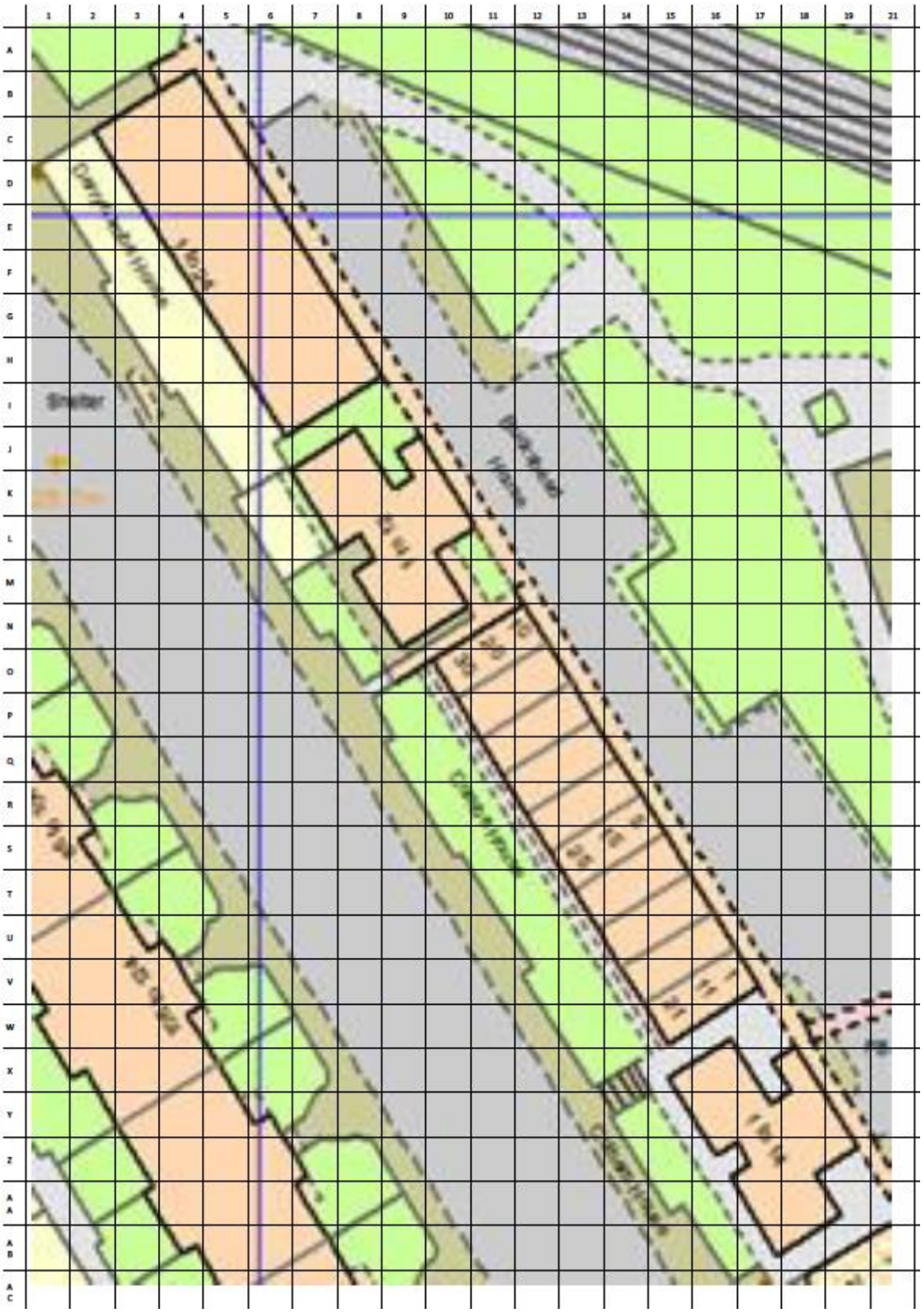


Figure 13 Fast Fading Rayleigh PDF

The fast fade margin PDF in Figure 13 shows that the building has a Rayleigh fast fading characteristic. This is explained in more detail in the main report.

5 Appendix A – Building Plan




Shelter

6 Appendix B – Test Locations

Team	Test	Floor	Inside/Outside	Grid Reference
-	Tx 1	Ground	Inside	D6
-	Tx 2	Ground	Outside	D6
-	Tx 3	Sixth	Inside	Y18
1	Rx 1	Sixth	Inside	L8
1	Rx 2	Fifth	Inside	L8
1	Rx 3	Fourth	Inside	L8
1	Rx 4	Third	Inside	L8
1	Rx 5	Second	Inside	L8
1	Rx 6	First	Inside	L8
1	Rx 7	Ground	Inside	L8
2	Rx 1	Ground	Outside	I8
2	Rx 2	Ground	Outside	K7
2	Rx 3	Ground	Outside	O8
1	Rx 1	Ground	Outside	K10
1	Rx 2	Second	Outside	K10
1	Rx 3	Fourth	Outside	K10
1	Rx 4	Sixth	Outside	K10
1	Rx 5	Ground	Inside	Z17
1	Rx 6	First	Inside	Z17
1	Rx 7	Second	Inside	Z17
1	Rx 8	Third	Inside	Z17
1	Rx 9	Fourth	Inside	Z17

Spectrum Engineering Services

Smart Meter RF Survey Site Report

Butterworth Court

Appendix A.4

Publication Date: 19 October 2015

Version: 1.2

OFCOM_SES(15)010.A.4

Document Control

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Author(s):	Dave Smith
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0.1	10/08/15	DS	Internal Draft
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1.2	30/09/15	DS	Changed Figures

Contents

Section Page

1 Introduction

This document details the results and findings for the DECC smart meter RF survey of multiple dwelling units. The survey was to examine the path loss measurements within different types of multiple dwelling units.

Before reading this report appendix, the main report shall be read, as this contains explanations to the testing procedure, how the data was processed and a description to the results presentation.

On the 17 July 2015, Ofcom engineers conducted a radio propagation survey at the Multiple Dwelling Units (MDU) property described below. This survey is part of the drive by the Department of Energy and Climate Change (DECC) to rollout Smart Meters in every UK home.

As part of this program, DECC is keen to understand how radio frequency signals propagate through the different MDU.

Transmit and receive locations for the test equipment were typical locations where you may find the electricity and gas meters in these types of buildings. These locations were identified with the assistance of energy suppliers.

Walk testing of the high power transmitted was carried out at this location and the results are summarised in Section 7 of the main report.

Table 1 Site Details

Detail	Description
Property Identifier	Butterworth Court
Property Type	Sheltered Housing
Material of Construction	Concrete
Type of Exterior Wall	Rendered Concrete
Property Age	Built in 1977
Gas Meter Location	Assumed in flats
Electricity Meter Location	Assumed in flats

Figure 1 Typical View Butterworth Court

Figure 2 Front of Property

Radio frequency path loss measurements were conducted in the 868MHz short range device band, typically used for short range indoor applications.

The measurements were carried out in predefined locations within the building in consultation with the energy suppliers.

2 Path Loss Survey Methodology

A detailed description of the methodology can be found in a separate document.[1]

2.1 Number of Locations Tested

Ofcom tested a combined total of twenty two receive locations within the property and outside, using signals from two different transmitter locations, with one transmit where the power is increased from 100 mW to 500 mW. The receive antenna was tested in two orientations, vertical and horizontal. A total of 80 test files were recorded for Butterworth Court.

The two transmit locations in the MDU used:

1. Electrical meter room ground floor (100 mW).
2. Outside next to wall (100 mW).
3. Electrical meter room ground floor (500 mW).

2.2 Measurements Recorded

Three types of measurements were carried out during the survey:

1. An interference measurement to determine the activity in the 868MHz SRD band. This was carried out at one location, close to where one of the transmitter antennas was located.
2. Receive signal level measurements using a known transmit signal. The receive signal was measured in both the vertical and horizontal orientation, at various locations throughout the MDU and outside the MDU.

The diagram below shows the typical transmit/receive equipment set up used during the MDU testing.

[1] Ofcom – Smart Meter RF Survey Methodology, Reference: OFCOM_SES(15)_011 – 868MHz Smart_Test_Method_v2.0

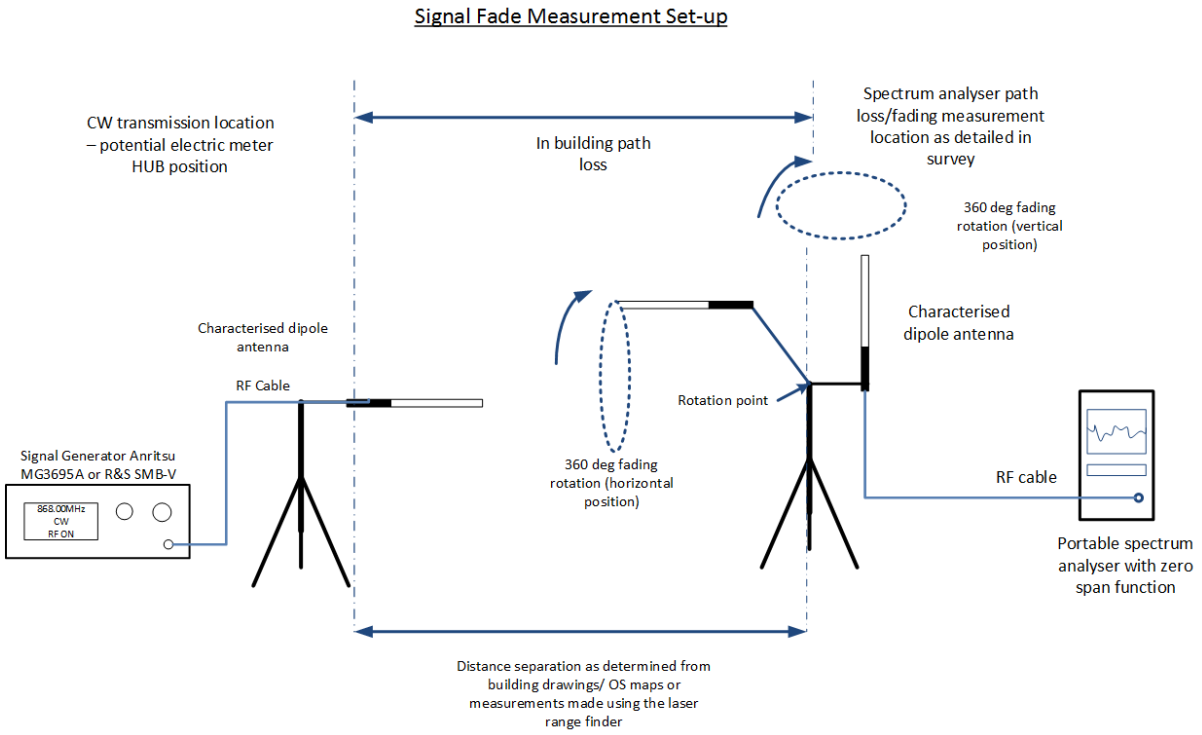

Figure 3 Equipment Set Up

2.3 Test Equipment Details

For traceability the main test equipment components used in the MDU survey are listed below with appropriate tracking details.

Table 2 Test Equipment Details

Item	Make/Model	Serial / Asset Number
Signal Generator 1	R&S SMBV100B	256587 (0471)
Signal Generator 2	Anritsu MG3695A	032006
Power Amplifier	ENI 607l-01	162
Spectrum Analyser 1	R&S FSH8	115160/028
Spectrum Analyser 2	R&S ZVH8	1155159/EJ

Table 3 Test Antenna Details

Item	Make/Model	Serial Number	VSWR
Tx Antenna 1	Radio Structures ENF900	11911	1.43
Tx Antenna 2	Radio Structures ENF900	11883	1.51
Rx Antenna 1	Radio Structures ENF900	11910	1.42
Rx Antenna 2	Radio Structures ENF900	11882	1.62

3 Site Details

3.1 Building Plan and Test Locations

See Appendix A – Building Plan which contains a plan of the property with a grid used to identify the test locations and Appendix B – Test Locations contains a table which details the test locations. The grid used in Appendix A represents a 4 meter square and is scaled to the Ordnance Survey plan drawings.

3.2 Test Heights

The test heights are provided in the table below

Table 4 Test Heights

Location	Location Name	Height
Tx 1	Electrical meter room ground floor	1.5 m
Tx 2	Outside next to wall	1.5 m
Tx 3	Electrical meter room ground floor	1.5 m

3.3 Photographs of Transmit Locations

Figure 4 Transmit Location 1 Electricity Cupboard

3.4 Photographs of Receive Test Locations

The following photographs are of typical test locations within Butterworth Court. This is a ground and first floor sheltered housing complex built circa 1977 in brick and rendered concrete. It comprises of self-contained flats, communal rest room areas and shared laundry facilities.

The figures below show typical test locations within the public areas of the flats.

Figure 5 Sample Test Location 1

Figure 6 Sample Test Location 2

Figure 7 Sample Test Location 3

4 Test Results

This section presents the processed results for the measurements taken at Butterworth Court.

4.1 Test Frequencies and Powers

The following interference sweep was carried out to determine the frequencies that could be used for the subsequent testing. Figure 8 shows a sweep of the 868 MHz band and the activity in the band.

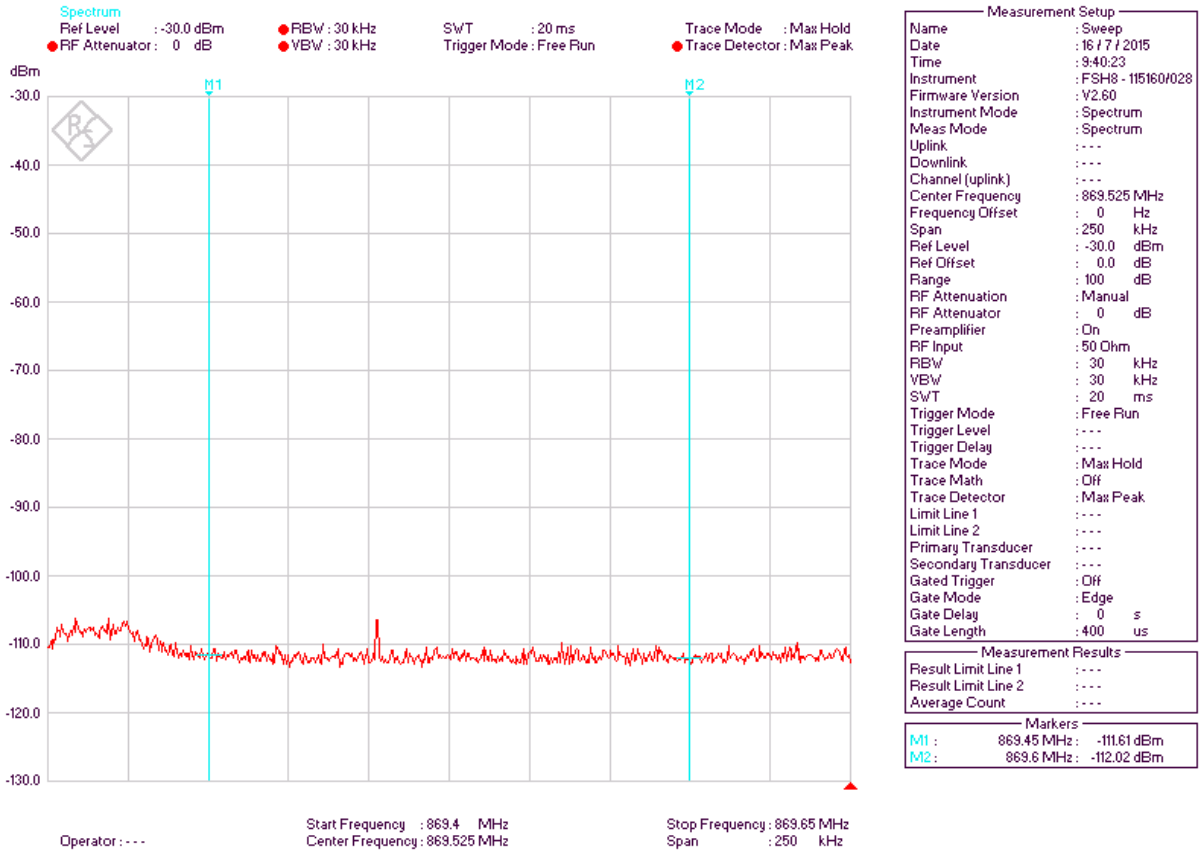

Figure 8 Scan of the 868 MHz Band

The following test frequencies and powers were used in all tests at Butterworth Court.

Table 5 Transmit Frequencies and Powers

Transmitter	Frequency	Power
Tx 1	869.550 MHz	100mW
Tx 2	869.650 MHz	100mW
Tx 3	869.550 MHz	500mW

Figure 9 shows the median values for all the measurements taken at Butterworth Court at both 100 and 500 mW.

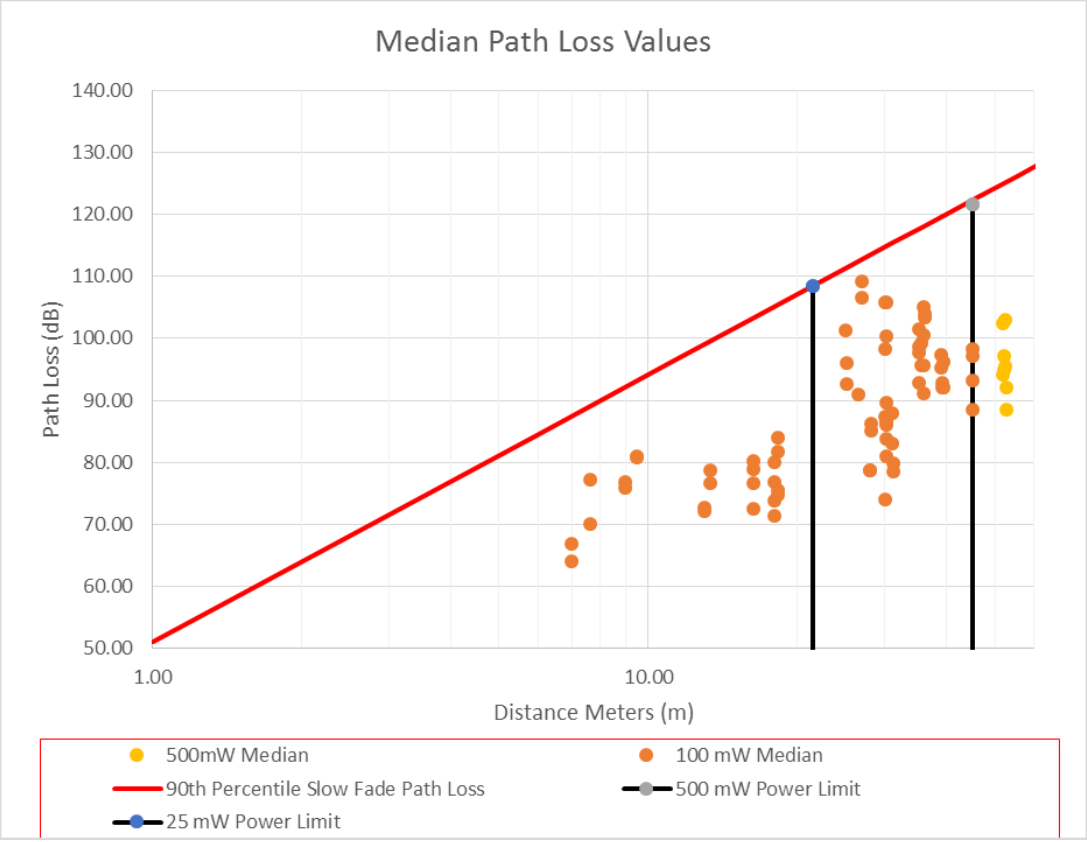

Figure 9 Median Path Loss Measurements

Path loss limit line, 25mW and 500mW power limits on the chart in Figure 9 are derived from the summary of all the data collected on all sites. Details of how these limits are derived and their formulation is contained in the final summary report, to which this document is an Appendix.

It can be seen that all values fall within the limits of collated data for all sites. All measured median values are within the 25 mW path loss value of 111dB.

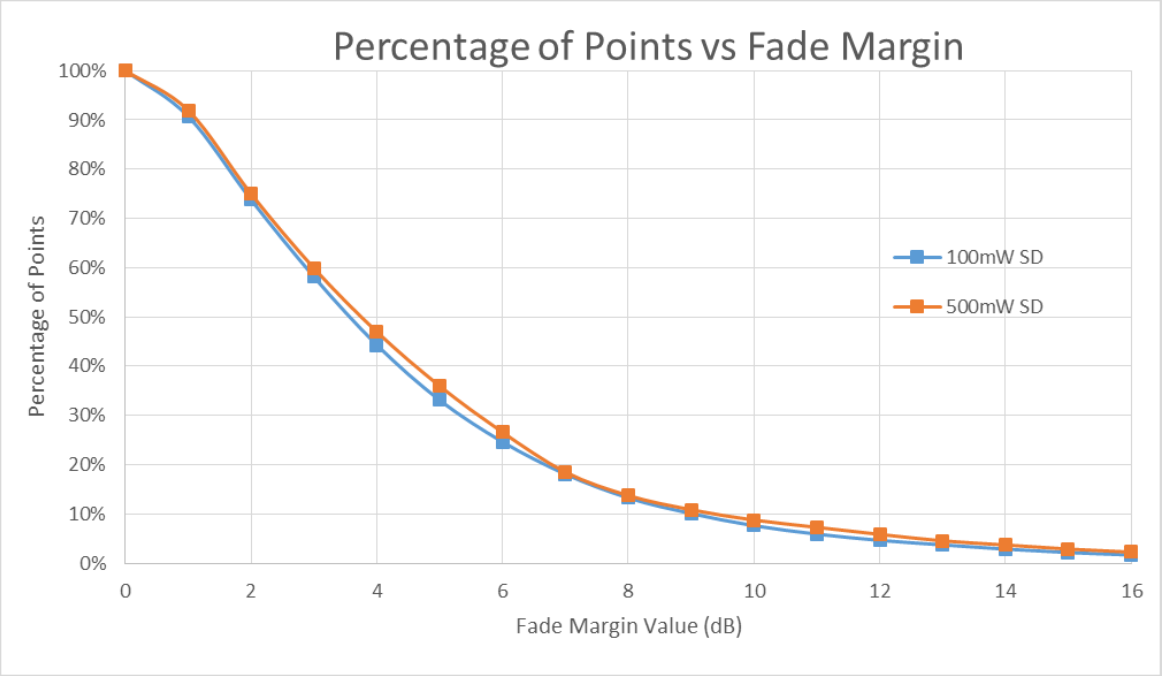

Figure 10 Fast Fade Margin

Figure 10 Fade Margin shows the average number of points recorded within increasing 1 dB steps from the median values for each multipath fast fading test. 90% of all values are less than 9 dB from the median. Fast fading measurements were taken for both 100mW and 500mW and it can be seen from Figure 10 that the fast fading levels are similar for both powers.

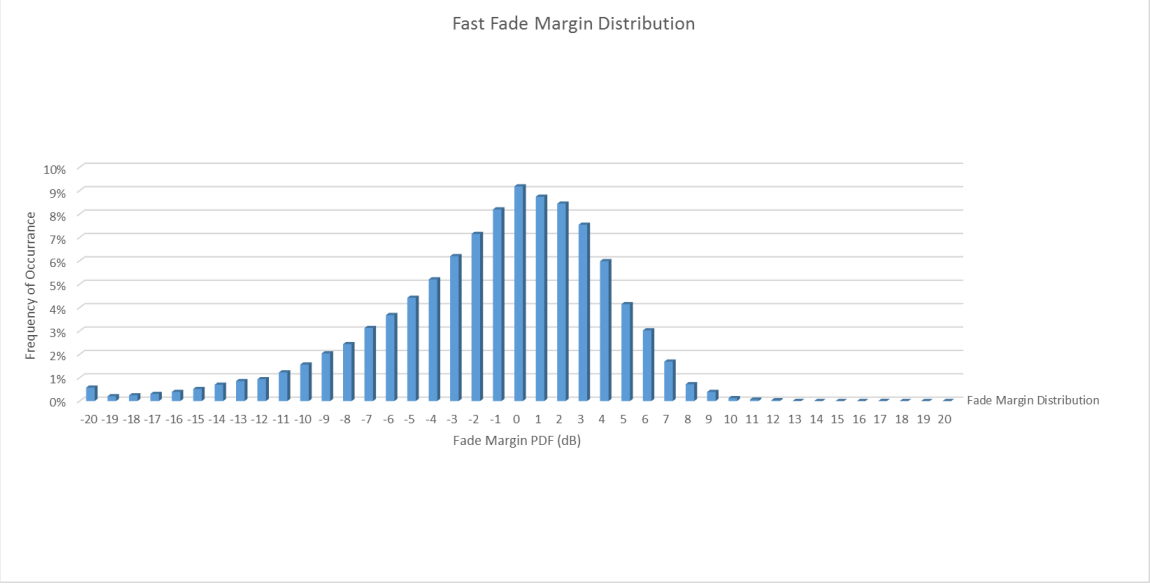

Figure 11 Fast Fading Rayleigh PDF

The fast fade margin PDF in **Error! Reference source not found.** shows that the building has a Rayleigh fast fading characteristic. This is explained in more detail in the main report.

It can be seen that all values fall within the limits of collated data for all sites. All measured median values are within the 25 mW path loss value of 108dB.

5 Appendix A – Building Plan

6 Appendix B – Test Locations

Team	Test	Floor	Inside/outside	Grid Reference
-	Tx 1/3	Ground	Inside	N7
-	Tx 2	Ground	Outside	O11
1	Rx 1	Ground	Inside	O7
1	Rx 2	Ground	Inside	U7
1	Rx 3	Ground	Inside	L8
1	Rx 4	Ground	Inside	H8
1	Rx 5	Ground	Inside	H14
1	Rx 6	Ground	Inside	M14
1	Rx 7	Ground	Inside	O14
1	Rx 8	Ground	Inside	V14
1	Rx 9	Ground	Outside	H8
1	Rx 10	Ground	Outside	H14
1	Rx 11	First	Inside	H14
1	Rx 12	Ground	Outside	U7
1	Rx 13	First	Inside	U7
1	Rx 14	Third	Inside	H14
2	Rx 9	First	Inside	O7
2	Rx 10	First	Inside	U7
2	Rx 11	First	Inside	L8
2	Rx 12	First	Inside	H8
2	Rx 13	First	Inside	H14
2	Rx 14	First	Inside	M14
2	Rx 15	First	Inside	O14
2	Rx 16	First	Inside	V14

Spectrum Engineering Services

Smart Meter RF Survey Site Report

Carey Mansions

Appendix A.5

Publication Date: 19 October 2015

Version: 1.2

OFCOM_SES(15)010.A.5

Document Control

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Author(s):	Dave Smith
Checked by:	Alistair Abington
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1.2	19/10/15	DS	Changed Figures

Contents

Section Page

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This document details the results and findings for the DECC smart meter RF survey of multiple dwelling units. The survey was to examine the path loss measurements within different types of multiple dwelling units.

Before reading this report appendix, the main report shall be read, as this contains explanations to the testing procedure, how the data was processed and a description to the results presentation.

On the 07/07/2015, Ofcom engineers conducted a radio propagation survey at the Multiple Dwelling Units (MDU) property described below. This survey is part of the drive by the Department of Energy and Climate Change (DECC) to rollout Smart Meters in every UK home.

As part of this program, DECC is keen to understand how radio frequency signals propagate through the different MDU.

Transmit and receive locations for the test equipment were typical locations where you may find the electricity and gas meters in these types of buildings. These locations were identified with the assistance of energy suppliers.

Table 1 Site Details

Detail	Description
Property Identifier	Carey Mansions
Property Type	Block of flats repeated along terrace
Material of Construction	Brick and concrete
Type of Exterior Wall	Solid brick
Property Age	Circa 1930s
Gas Meter Location	Assumed in flats
Electricity Meter Location	Assumed in flats

Figure 1 Front of Property

Radio frequency path loss measurements were conducted in the 868MHz short range device band, typically used for short range indoor applications.

The measurements were carried out in predefined locations within the building in consultation with the energy suppliers.

2 Path Loss Survey Methodology

A detailed description of the methodology can be found in a separate document.[1]

2.1 Number of Locations Tested

Ofcom tested a combined total of thirteen receive locations within the property and outside, using signals from two transmitter locations. The receive antenna was tested in two orientations, vertical and horizontal. A total of 52 test files were recorded for Carey Mansions.

The two transmit locations used:

1. In the entrance hall cupboard under stairs to flats 1 to 8.
2. At the rear of the building in the back yard against the wall for flats 1 to 8.

2.2 Measurements Recorded

Three types of measurements were carried out during the survey:

1. An interference measurement to determine the activity in the 868MHz SRD band. This was carried out at one location, close to where one of the transmitter antennas was located.
2. Receive signal level measurements using a known transmit signal. The receive signal was measured in both the vertical and horizontal orientation, at various locations throughout the MDU and outside the MDU.

The diagram below shows the typical transmit/receive equipment set up used during the MDU testing.

[1] Ofcom – Smart Meter RF Survey Methodology, Reference: OFCOM_SES(15)_011 – 868MHz Smart_Test_Method_v2.0

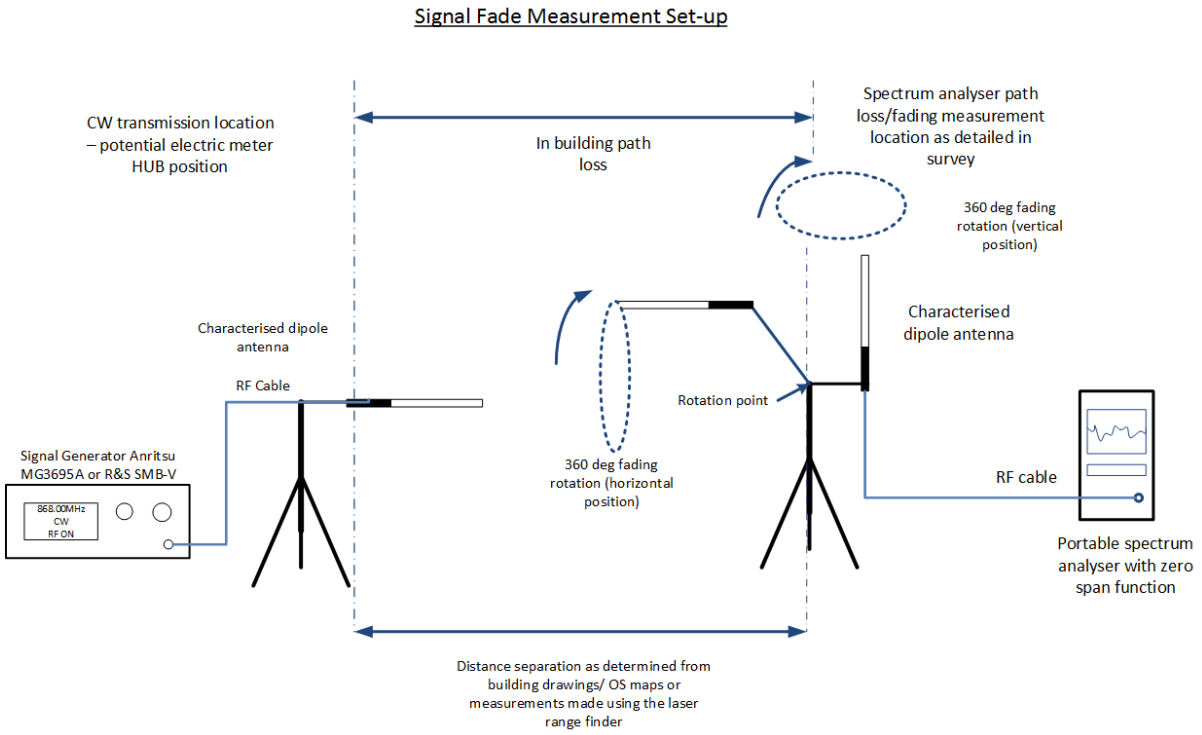


Figure 2 Equipment Set Up

2.3 Test Equipment Details

For traceability the main test equipment components used in the MDU survey are listed below with appropriate tracking details.

Table 2 Test Equipment Details

Item	Make/Model	Serial / Asset Number
Signal Generator 1	R&S SMBV100B	256587 (0471)
Signal Generator 2	Anritsu MG3695A	032006
Power Amplifier	ENI 607l-01	162
Spectrum Analyser 1	R&S FSH8	115160/028
Spectrum Analyser 2	R&S ZVH8	1155159/EJ

Table 3 Test Antenna Details

Item	Make/Model	Serial Number	VSWR
Tx Antenna 1	Radio Structures ENF900	11911	1.43
Tx Antenna 2	Radio Structures ENF900	11883	1.51
Rx Antenna 1	Radio Structures ENF900	11910	1.42
Rx Antenna 2	Radio Structures ENF900	11882	1.62

3 Site Details

3.1 Building Plan and Test Locations

See Appendix A – Building Plan which contains a plan of the property with a grid used to identify the test locations and Appendix B – Test Locations contains a table which details the test locations. The grid used in Appendix A represents a 4 meter square and is scaled to the Ordnance Survey plan drawings.

3.2 Test Heights

The test heights are provided in the table below

Table 4 Test Heights

Location	Location Name	Height
Tx1	Front Entrance Cupboard flats 1-8	1.5 m
Tx2	Rear of property flats 1-8	1 m

3.3 Photographs of Transmit Locations

Figure 3 Transmit Location 1

Figure 4 Transmit Location 2

3.4 Photographs of Receive Test Locations

The following photographs are of typical test locations within Carey Mansions. This is a four story circa 1930s brick construction terrace block building.

The following photographs are of typical test locations within Carey Mansions. All flats are entered from a central stair case in each block and the blocks are repeated along the terrace.

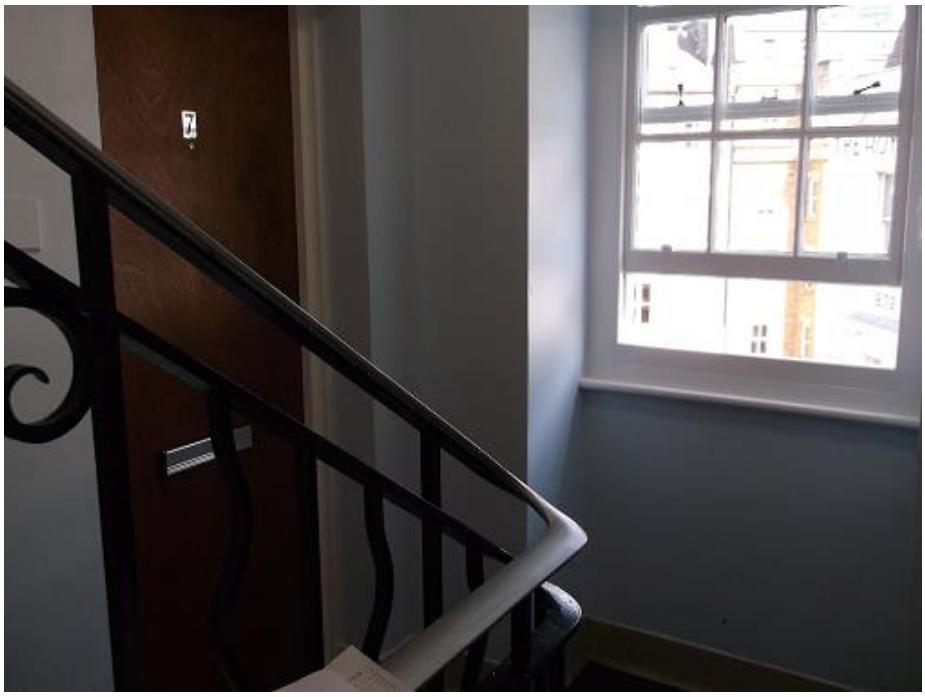


Figure 5 Test Location 1-1 Landing outside Flats 7 and 8

Figure 6 Test Location 1-2 Landing outside Flats 5 and 6

Figure 7 Test Location 1-4 outside Flats 25 to 33

4 Test Results

This section presents the processed results for the measurements taken at Carey Mansions.

4.1 Test Frequencies and Powers

The following test frequencies and powers were used in all tests at Carey Mansions.

Figure 8 shows a sweep of the 868 MHz band and the activity in the band. The two transmit frequencies can be seen in the plot.

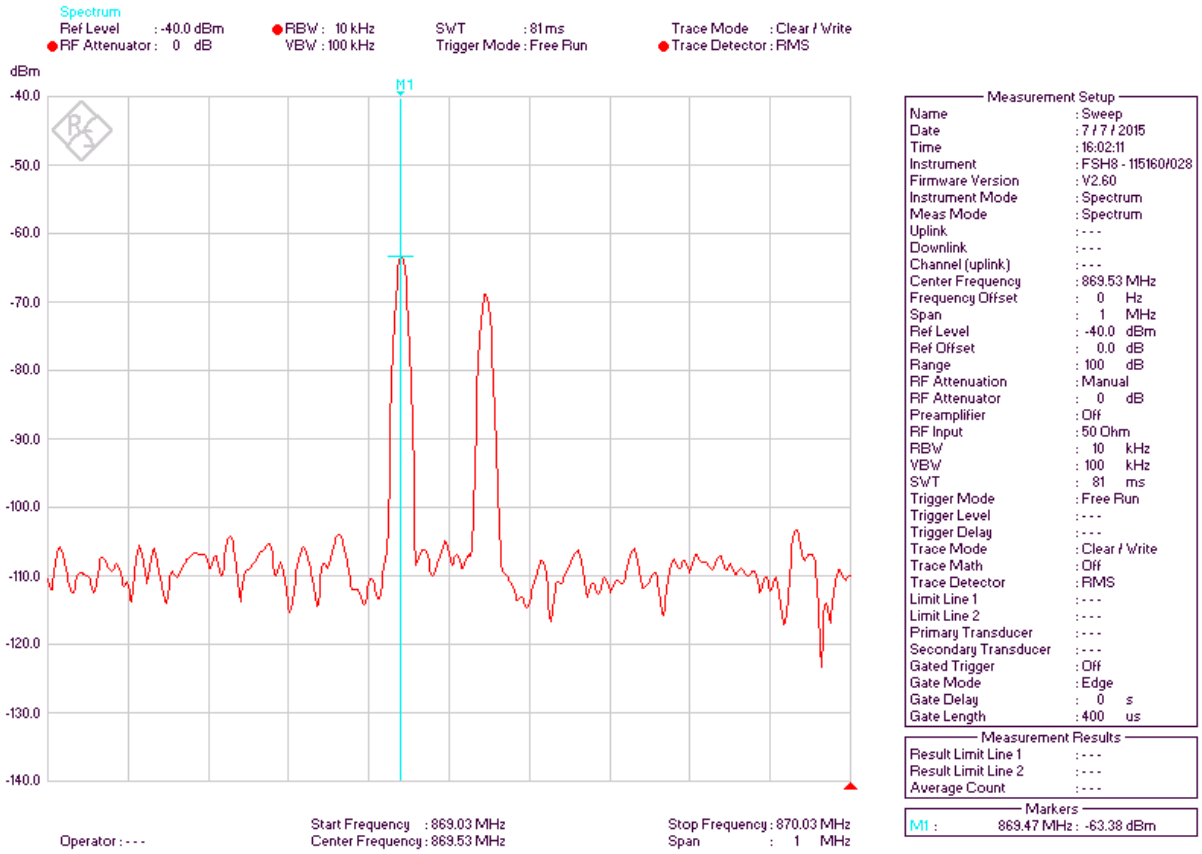


Figure 8 Scan of the 868 MHz Band

Table 5 Transmit Frequencies and Powers

Transmitter	Frequency	Power
Tx1	869.575 MHz	100mW
Tx2	869.470 MHz	100mW

Figure 9 Median Path Loss Measurements, shows values for all the measurements taken at Carey Mansions.

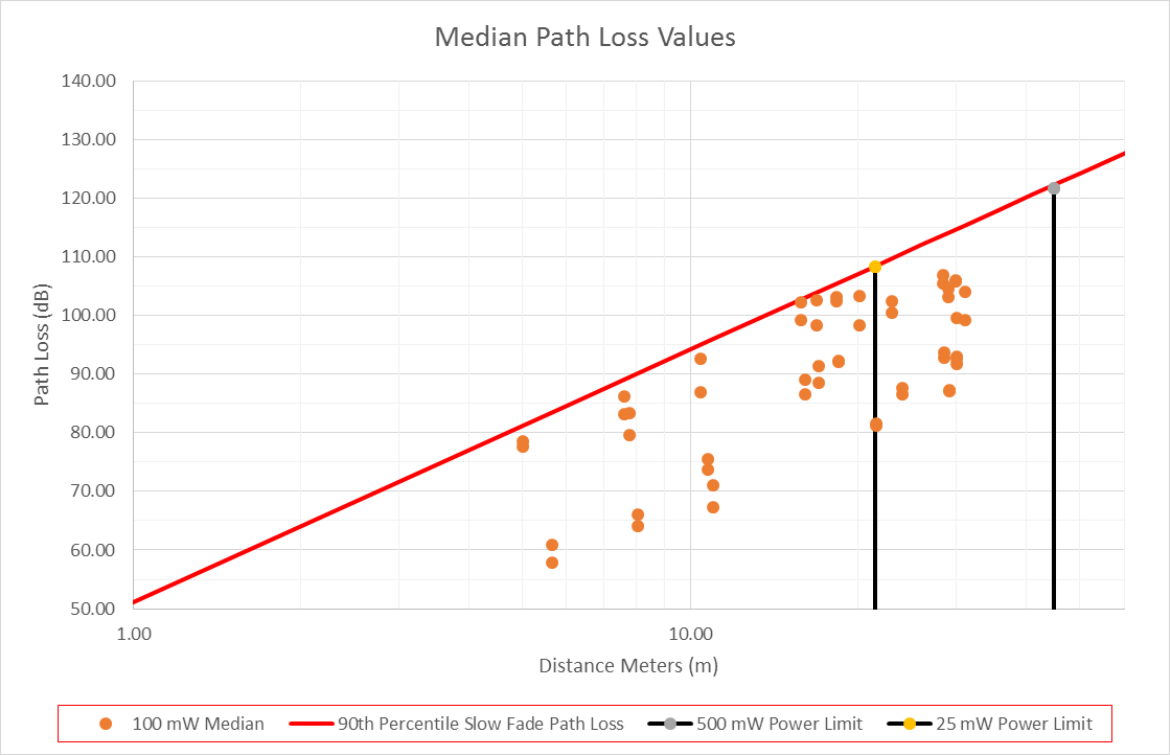


Figure 9 Median Path Loss Measurements

Path loss limit line, 25mW and 500mW power limits on the chart in Figure 9 are derived from the summary of all the data collected on all sites. Details of how these limits are derived and their formulation is contained in the final summary report, to which this document is an Appendix.

Figure 10 Fast Fade Margin shows the average number of points recorded within increasing 1 dB steps from the median values for each multipath fast fading test. 90% of all values are less than 9 dB from the median.

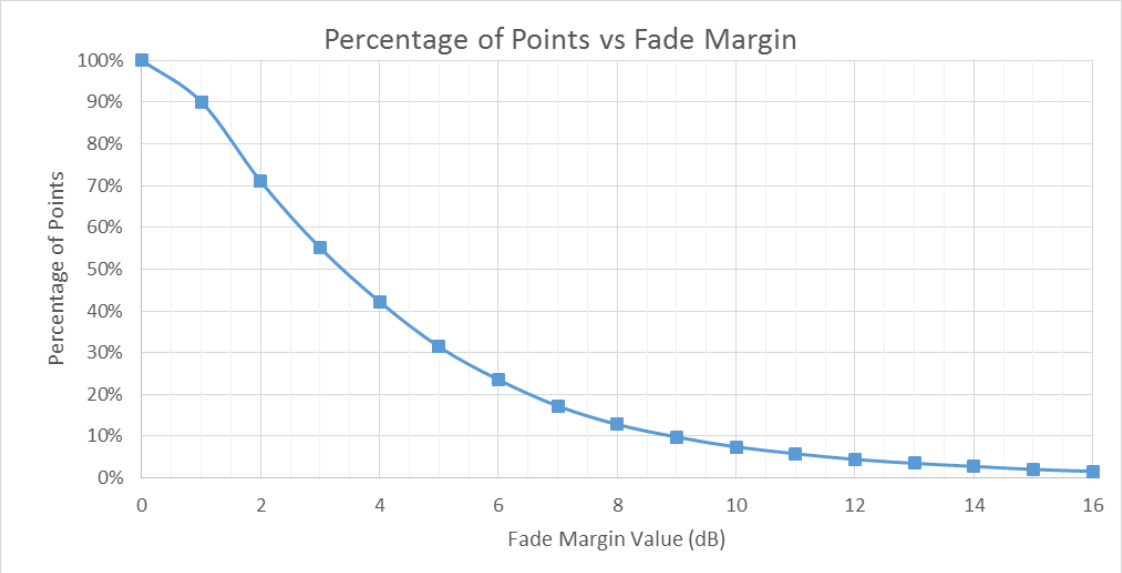


Figure 10 Fast Fade Margin

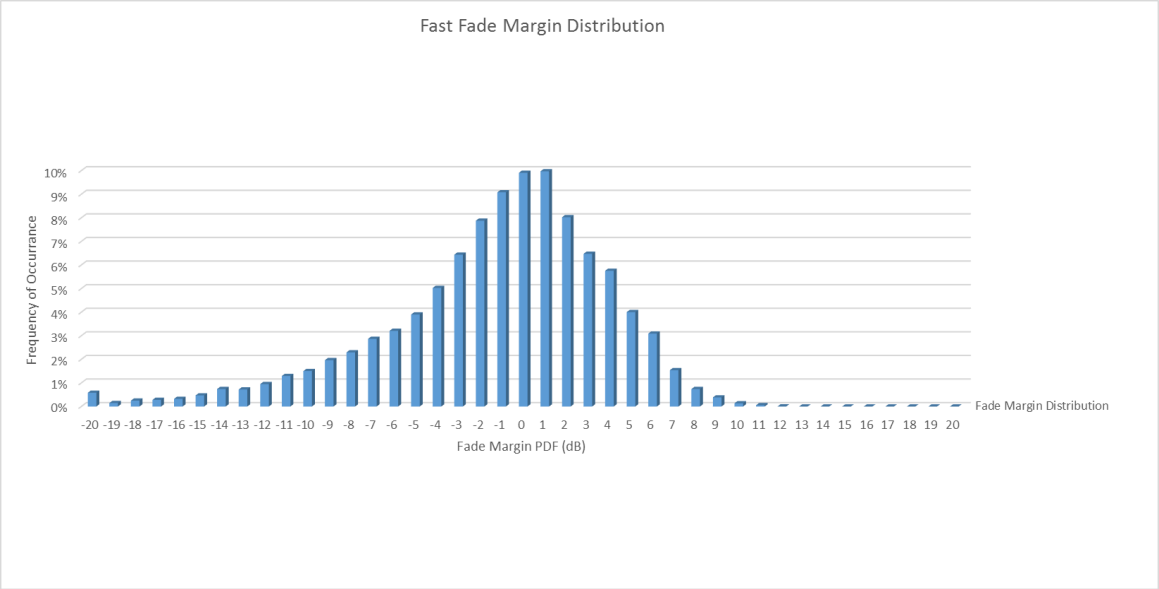
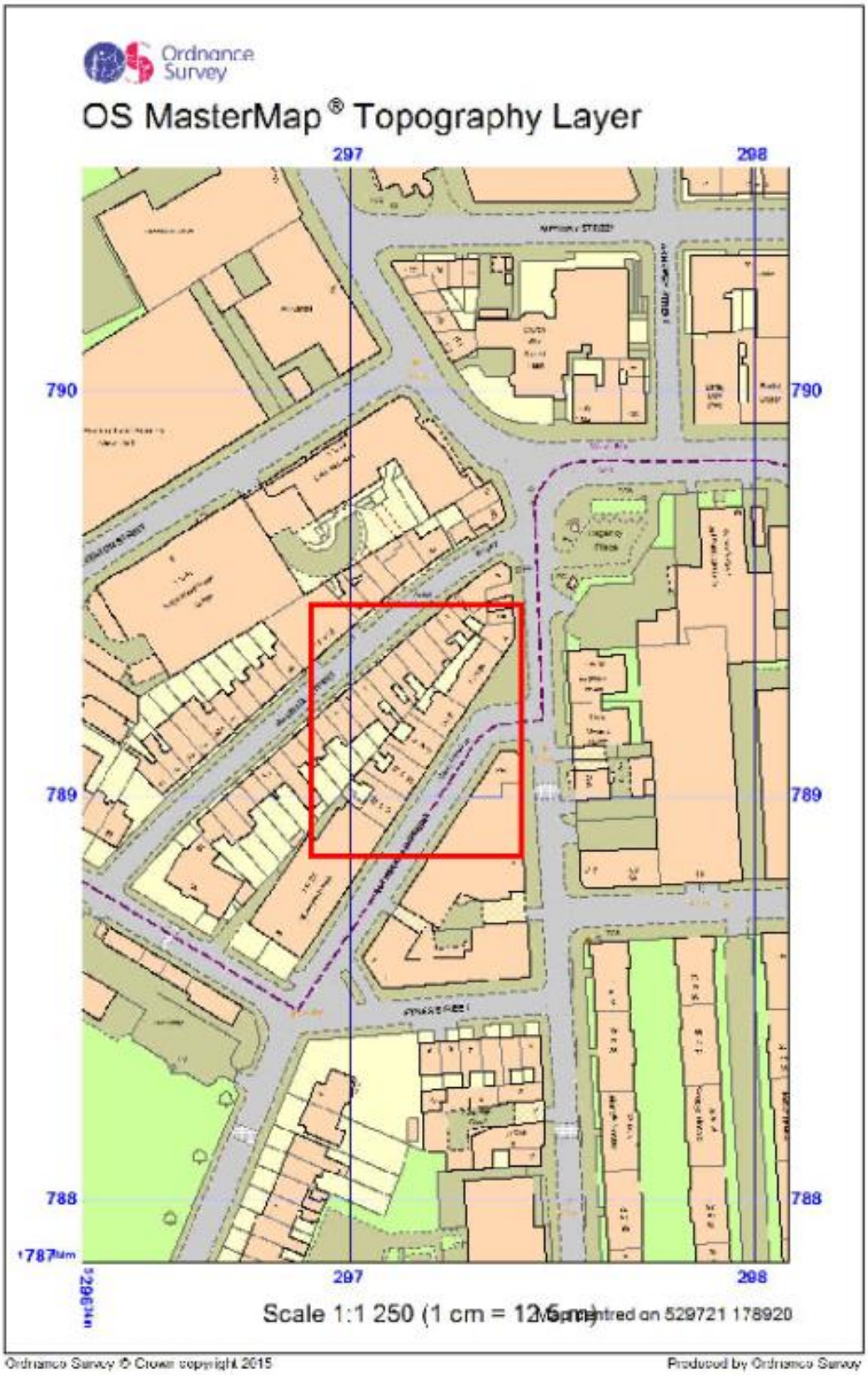
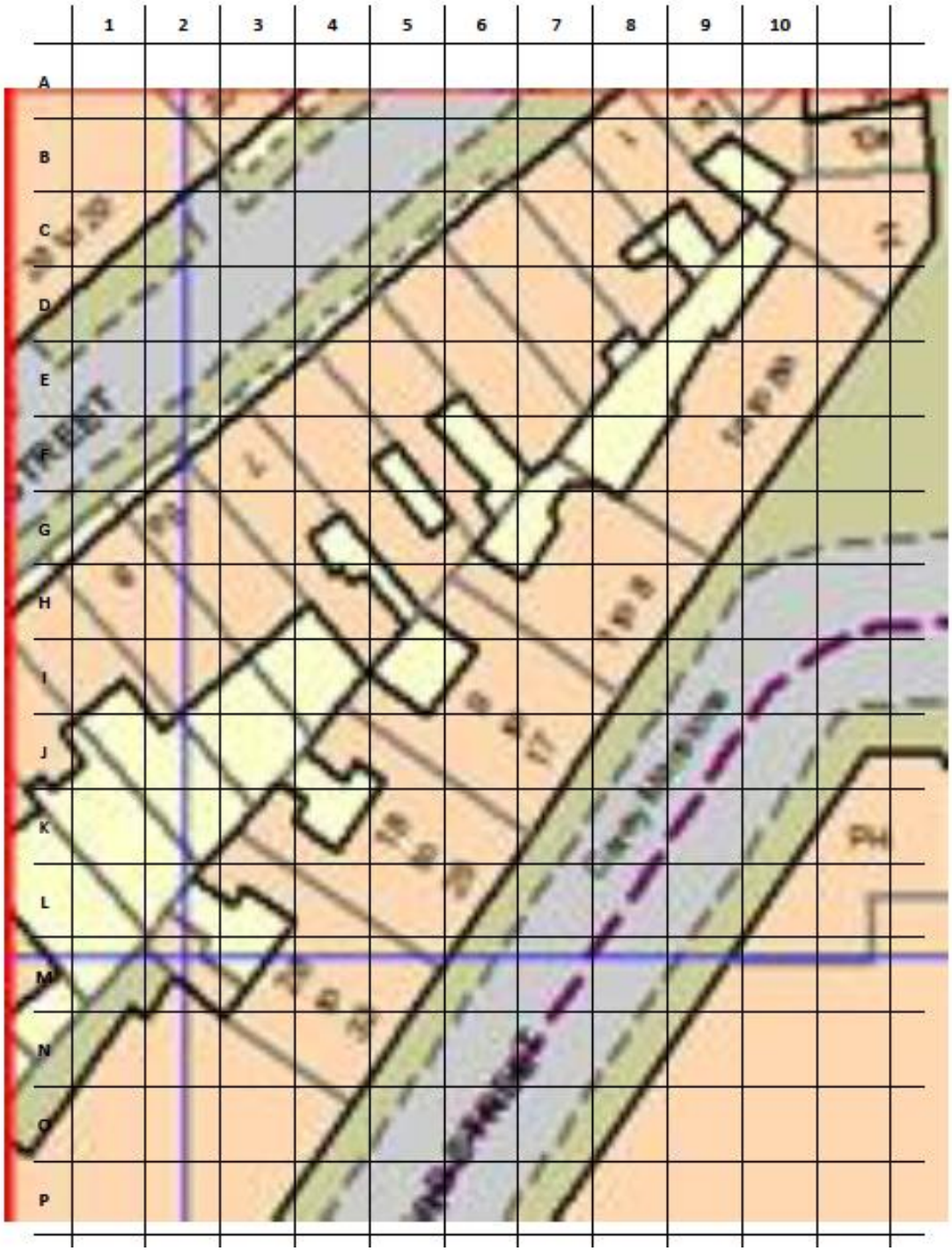


Figure 11 Fast Fading Rayleigh PDF

The fast fade margin PDF in Figure 11 shows that the building has a Rayleigh fast fading characteristic. This is explained in more detail in the main report.

5 Appendix A – Building Plan

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6 Appendix B – Test Locations

Team	Test	Floor	Inside/Outside	Grid Reference
-	Tx 1	Ground	Inside	H8
-	Tx 2	Ground	Outside	G7
1	Rx 1	Third	Inside	H8
1	Rx 2	Second	Inside	H8
1	Rx 3	First	Inside	H8
1	Rx 4	Ground	Outside	O4
1	Rx 5	Ground	Outside	L6
1	Rx 6	Ground	Outside	H9
2	Rx 1	Third	Inside	K5
2	Rx 2	Second	Inside	K5
2	Rx 3	First	Inside	K5
2	Rx 4	Ground	Inside	K4
2	Rx 5	Third	Inside	M4
2	Rx 6	Second	Inside	M4
2	Rx 7	First	Inside	M4

Spectrum Engineering Services

Smart Meter RF Survey Site Report

Dufours Place

Appendix A.6

Publication Date: 19 October 2015

Version: 1.2

OFCOM_SES(15)010.A.6

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Author(s):	Dave Smith
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0.1	21/08/15	DS	Internal Draft
1.0	11/09/15	DS	Update and Issue
1.1	30/09/15	DS	Changes to Fade Margin
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Contents

Section Page

1 Introduction

This document details the results and findings for the DECC smart meter RF survey of multiple dwelling units. The survey was to examine the path loss measurements within different types of multiple dwelling units.

Before reading this report appendix, the main report shall be read, as this contains explanations to the testing procedure, how the data was processed and a description to the results presentation.

On the 12/08/2015, Ofcom engineers conducted a radio propagation survey at the Multiple Dwelling Units (MDU) property described below. This survey is part of the drive by the Department of Energy and Climate Change (DECC) to rollout Smart Meters in every UK home.

As part of this program, DECC is keen to understand how radio frequency signals propagate through the different MDU.

Transmit and receive locations for the test equipment were typical locations where you may find the electricity and gas meters in these types of buildings. These locations were identified with the assistance of energy suppliers.

Table 1 Site Details

Detail	Description
Property Identifier	Dufours Place, London
Property Type	Block of flats
Material of Construction	Concrete
Type of Exterior Wall	Concrete
Property Age	Circa 1960s
Gas Meter Location	Assumed in flats
Electricity Meter Location	Assumed in flats

Figure 1 Front of Property

Radio frequency path loss measurements were conducted in the 868MHz short range device band, typically used for short range indoor applications.

The measurements were carried out in predefined locations within the building in consultation with the energy suppliers.

2 Path Loss Survey Methodology

A detailed description of the methodology can be found in a separate document.[1]

2.1 Number of Locations Tested

Ofcom tested a combined total of seven receive locations within the property and outside, using a signal from a single transmitter location. The receive antenna was tested in two orientations, vertical and horizontal. A total of 14 test files were recorded for Dufours Place.

The transmit location used was entrance hall by the front door.

2.2 Measurements Recorded

Three types of measurements were carried out during the survey:

1. An interference measurement to determine the activity in the 868MHz SRD band. This was carried out at one location, close to where one of the transmitter antennas was located.
2. Receive signal level measurements using a known transmit signal. The receive signal was measured in both the vertical and horizontal orientation, at various locations throughout the MDU and outside the MDU.

The diagram below shows the typical transmit/receive equipment set up used during the MDU testing.

[1] Ofcom – Smart Meter RF Survey Methodology, Reference: OFCOM_SES(15)_011 – 868MHz Smart_Test_Method_v2.0

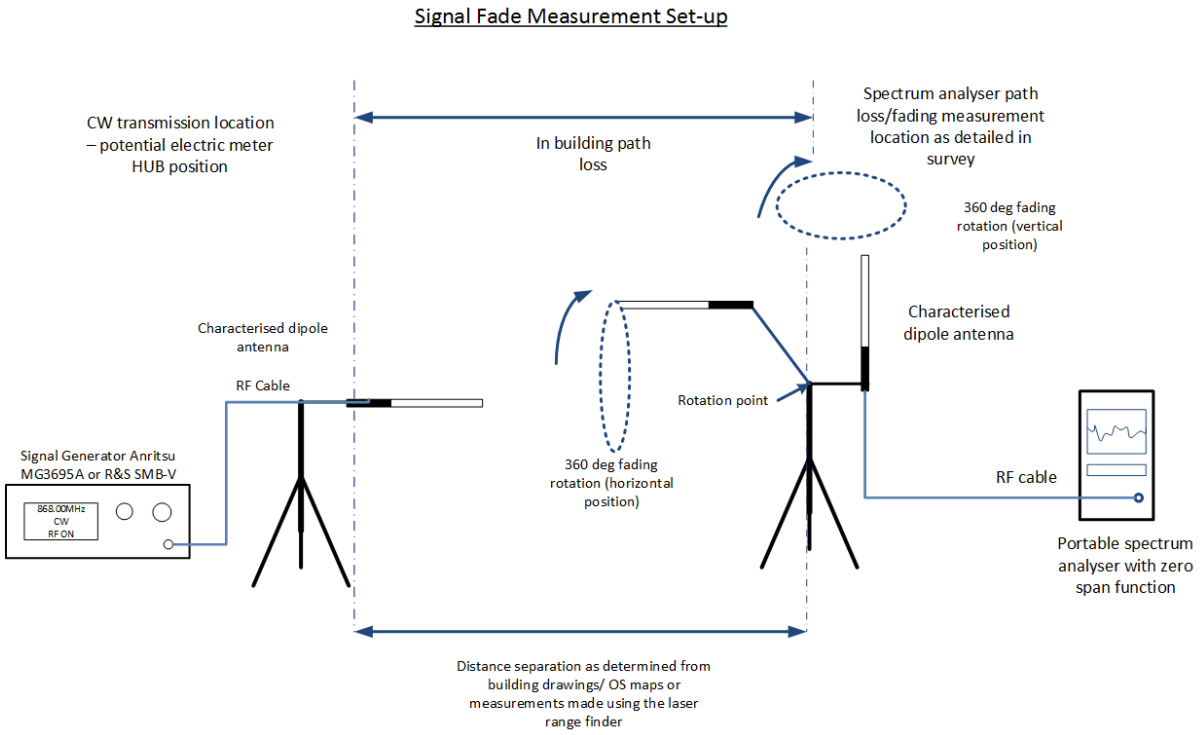


Figure 2 Equipment Set Up

2.3 Test Equipment Details

For traceability the main test equipment components used in the MDU survey are listed below with appropriate tracking details.

Table 2 Test Equipment Details

Item	Make/Model	Serial / Asset Number
Signal Generator 1	R&S SMBV100B	256587 (0471)
Signal Generator 2	Anritsu MG3695A	032006
Power Amplifier	ENI 607l-01	162
Spectrum Analyser 1	R&S FSH8	115160/028
Spectrum Analyser 2	R&S ZVH8	1155159/EJ

Table 3 Test Antenna Details

Item	Make/Model	Serial Number	VSWR
Tx Antenna 1	Radio Structures ENF900	11911	1.43
Tx Antenna 2	Radio Structures ENF900	11883	1.51
Rx Antenna 1	Radio Structures ENF900	11910	1.42
Rx Antenna 2	Radio Structures ENF900	11882	1.62

3 Site Details

3.1 Building Plan and Test Locations

See Appendix A – Building Plan, which contains a plan of the property with a grid used to identify the test locations and Appendix B – Test Locations which contains a table which details the test locations. The grid used in Appendix A represents a 4 meter square and is scaled to the Ordnance Survey plan drawings.

3.2 Test Heights

The test heights are provided in the table below

Table 4 Test Heights

Location	Location Name	Height
Tx1	Front Entrance Cupboard flats 1-8	1.5 m

3.3 Photographs of Transmit Locations

Figure 3 Transmit Location 1

3.4 Photographs of Receive Test Locations

The following photographs are of typical test locations within Dufours Place. This is a tower block of flats with a compact footprint. All floors and associated flats are accessed via a central staircase.

Figure 4 Typical Test Location on the Central Staircase

4 Test Results

This section presents the processed results for the measurements taken at Dufours Place.

4.1 Test Frequencies and Powers

The following interference sweep was carried out to determine the frequencies that could be used for the subsequent testing. **Error! Reference source not found.** shows a sweep of the 68 MHz band and the activity in the band.

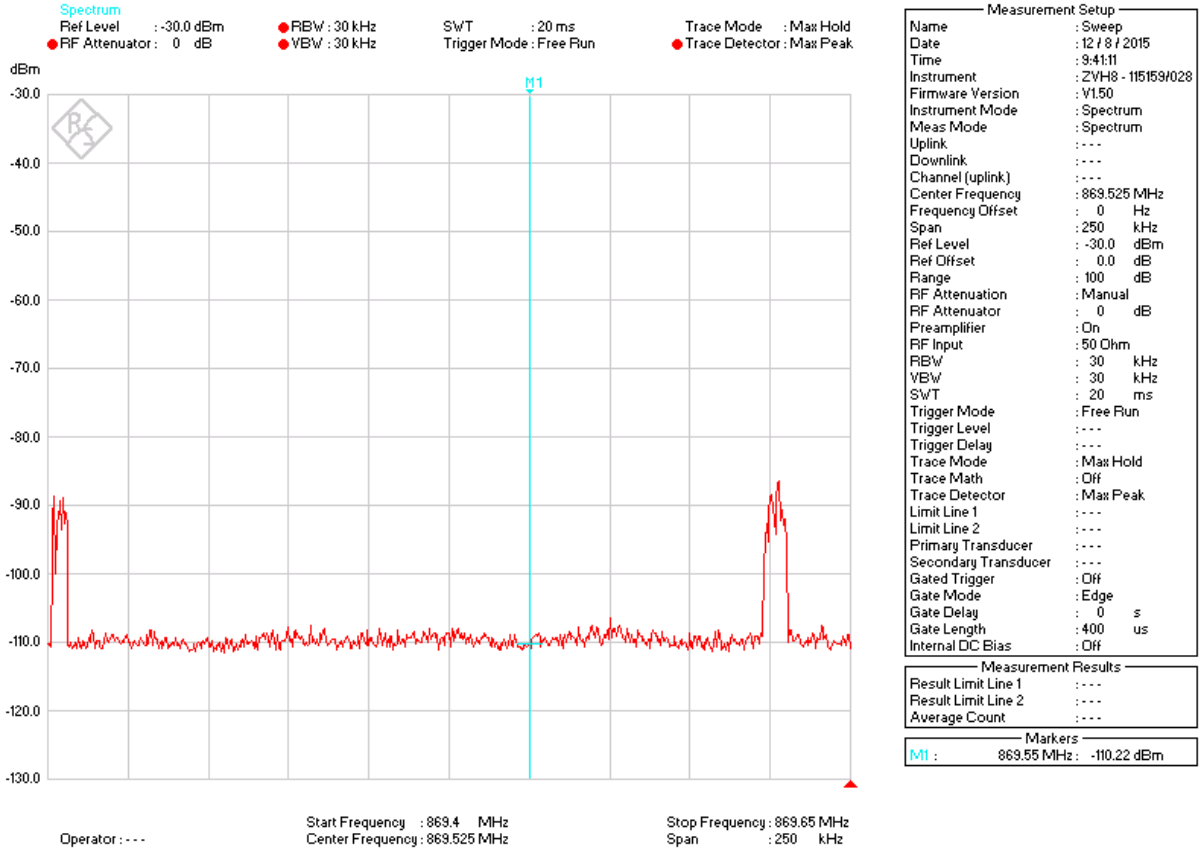


Figure 5 Scan of the 868 MHz Band

The following test frequency and power was used in all tests at Dufours Place.

Table 5 Transmit Frequencies and Powers

Transmitter	Frequency	Power
Tx1	869.550 MHz	100mW

Figure 6 Median Path Loss Measurements, shows values for all the measurements taken at Dufours Place.

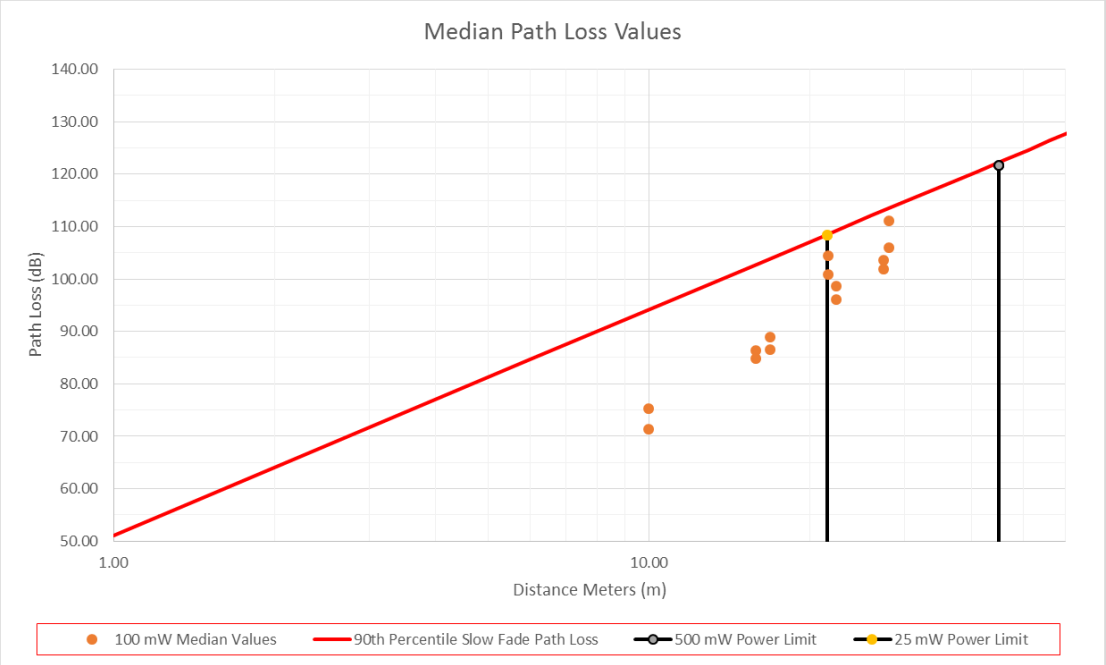


Figure 6 Median Path Loss Measurements

Path loss limit line, 25mW and 500mW power limits on the chart in Figure 6 are derived from the summary of all the data collected on all sites. Details of how these limits are derived and their formulation is contained in the final summary report, to which this document is an Appendix.

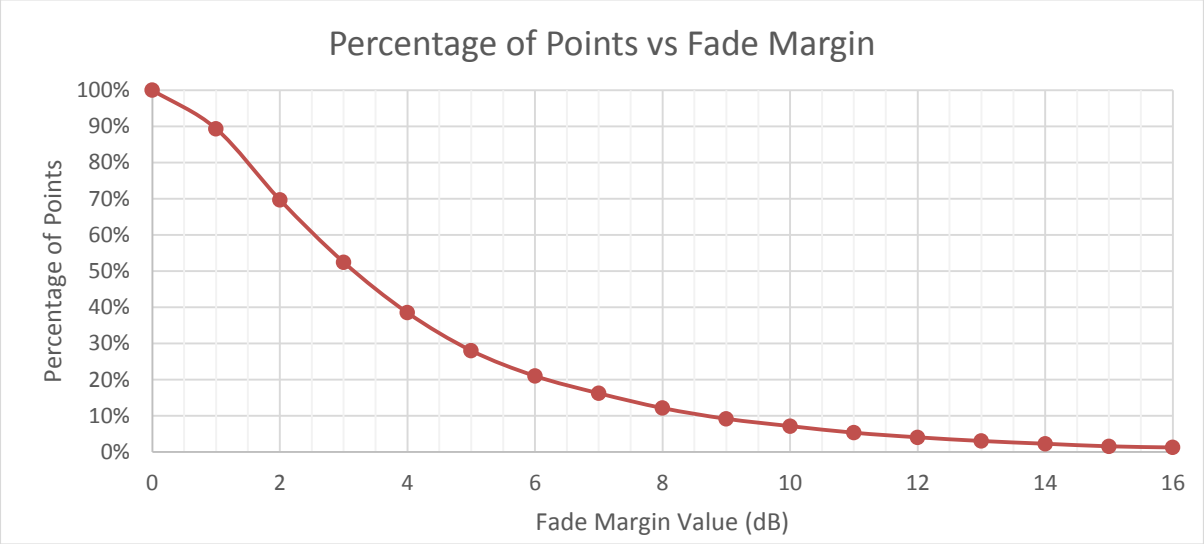


Figure 7 Fast Fade Margin

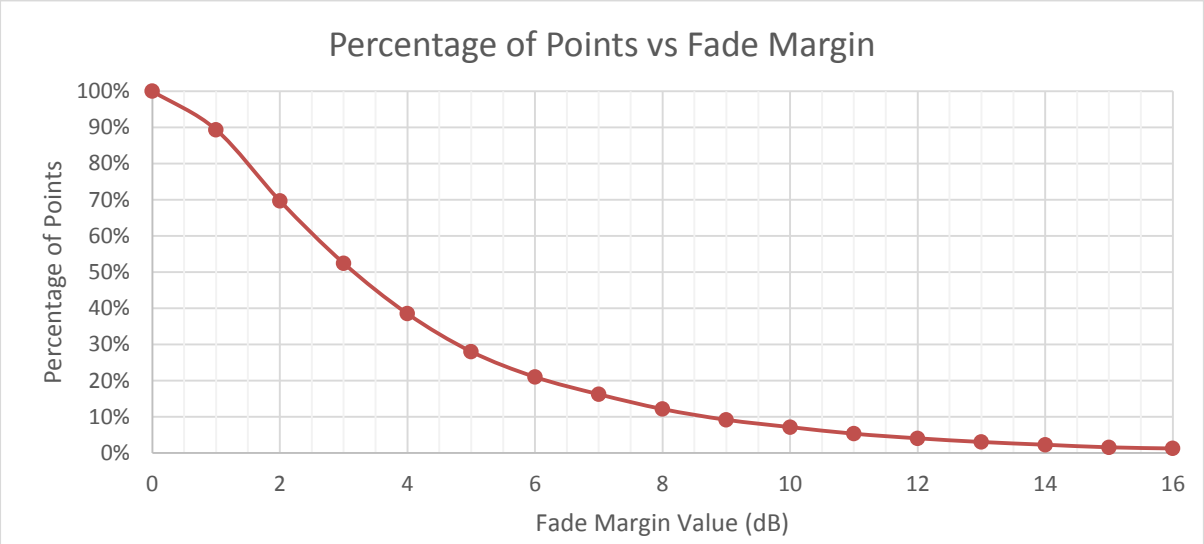


Figure 7 Fast Fade Margin shows the average number of points recorded within increasing 1 dB steps from the median values for each multipath fast fading test. 90% of all values are less than 9 dB from the median.

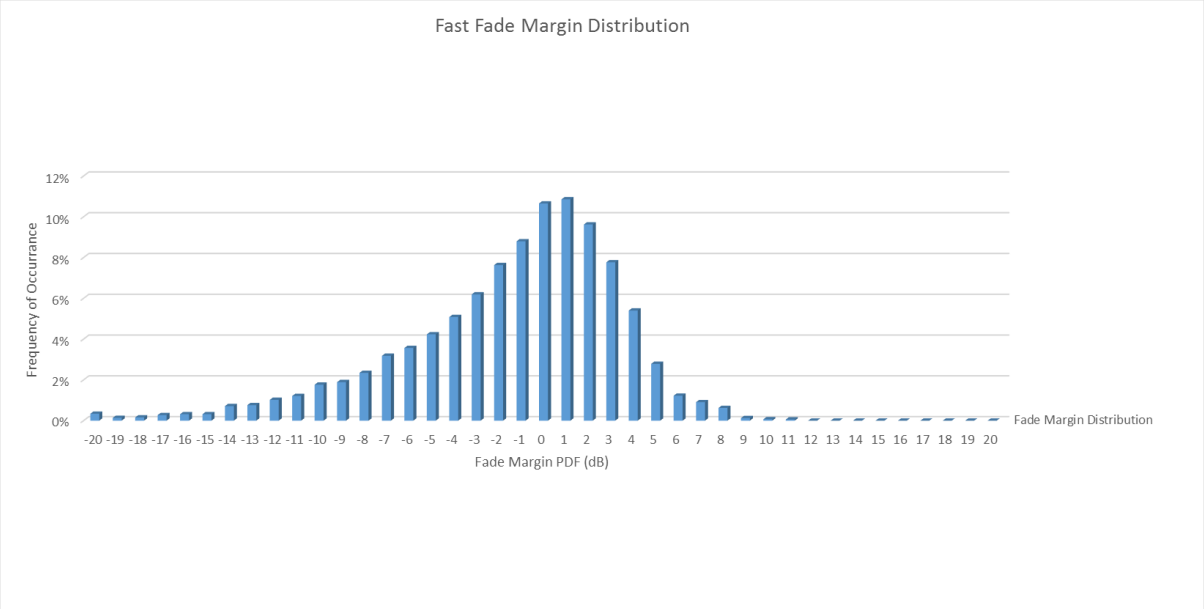
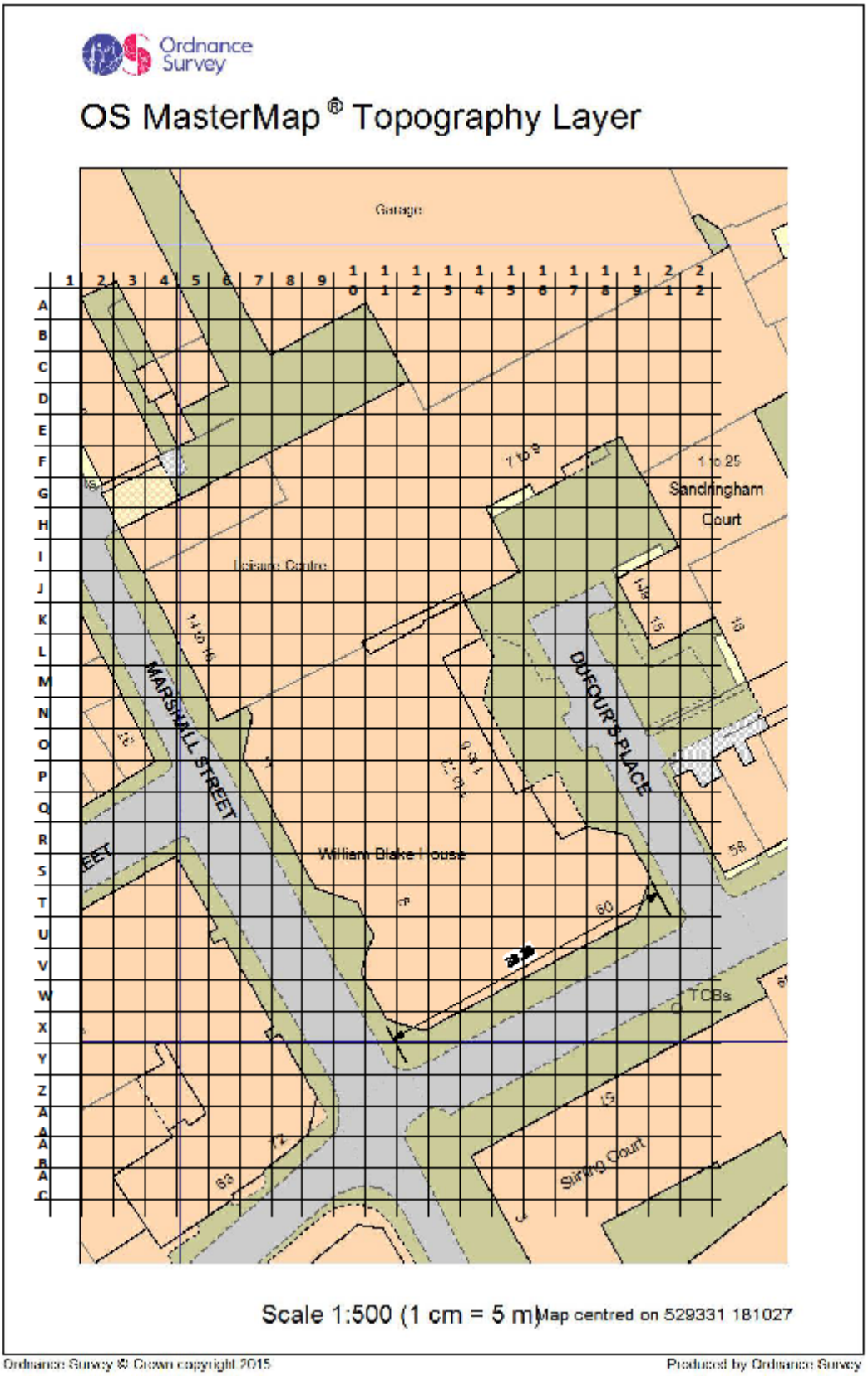


Figure 8 Fast Fading Rayleigh PDF

The fast fade margin PDF in Figure 8 shows that the building has a Rayleigh fast fading characteristic. This is explained in more detail in the main report.

5 Appendix A – Building Plan



6 Appendix B – Test Locations

Team	Test	Floor	Inside/Outside	Grid Reference
-	Tx 1	Ground	Inside	R17
1	Rx 1	Third	Inside	R16
1	Rx 2	Third	Inside	R13
1	Rx 3	Fifth	Inside	R16
1	Rx 4	Fifth	Inside	R13
1	Rx 5	Seventh	Inside	R16
1	Rx 6	Seventh	Inside	R13
1	Rx 7	Ground	Outside	R18

Spectrum Engineering Services

Smart Meter RF Survey Site Report

Henbury Court

Appendix A.7

Publication Date: 19 October 2015

Version: 1.2

OFCOM_SES(15)010.A.7

Document Control

Prepared for:	Department of Energy and Climate Change
Author(s):	Dave Smith
Checked by:	Alistair Abington
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0.1	10/08/15	DS	Internal Draft
1.0	11/09/15	DS	Update and Issue
1.1	30/09/15	DS	Changes to Fade Margin
1.2	19/10/15	DS	Changed Figures

Contents

Section Page

1 Introduction

This document details the results and findings for the DECC smart meter RF survey of multiple dwelling units. The survey was to examine the path loss measurements within different types of multiple dwelling units.

Before reading this report appendix, the main report shall be read, as this contains explanations to the testing procedure, how the data was processed and a description to the results presentation.

On the 13 July 2015, Ofcom engineers conducted a radio propagation survey at the Multiple Dwelling Units (MDU) property described below. This survey is part of the drive by the Department of Energy and Climate Change (DECC) to rollout Smart Meters in every UK home.

As part of this program, DECC is keen to understand how radio frequency signals propagate through the different MDU.

Transmit and receive locations for the test equipment were typical locations where you may find the electricity and gas meters in these types of buildings. These locations were identified with the assistance of energy suppliers.

Table 1 Site Details

Detail	Description
Property Identifier	Henbury Court, Bristol
Property Type	Purpose built 4 story flats
Material of Construction	Brick and concrete
Type of Exterior Wall	Brick
Property Age	Circa 1950s
Gas Meter Location	Assume in flats
Electricity Meter Location	Assume in flats

Figure 1 Typical Smaller MDU Henbury Court (Flats 47 – 62)

Figure 2 Larger MDU Henbury Court (Flats 1 – 30)

Radio frequency path loss measurements were conducted in the 868MHz short range device band, typically used for short range indoor applications.

The measurements were carried out in predefined locations within the building in consultation with the energy suppliers.

2 Path Loss Survey Methodology

A detailed description of the methodology can be found in a separate document.[1]

2.1 Number of Locations Tested

Ofcom tested a combined total of twenty four receive locations within the property and outside, using signals from two transmitter locations. The receive antenna was tested in two orientations, vertical and horizontal. A total of 104 test files were recorded for Henbury Court.

The two transmit locations in the small MDU used:

1. Outside entrance under first floor walk way (100 mW).
2. In meter cupboard inside ground floor room (100 mW).

The two transmit locations in the large MDU used:

1. Outside flats close to plant room (100 mW).

[1] Ofcom – Smart Meter RF Survey Methodology, Reference: OFCOM_SES(15)_011 – 868MHz Smart_Test_Method_v2.0

2. Inside plant room (100 mW).

2.2 Measurements Recorded

Three types of measurements were carried out during the survey:

1. An interference measurement to determine the activity in the 868MHz SRD band. This was carried out at one location, close to where one of the transmitter antennas was located.
2. Receive signal level measurements using a known transmit signal. The receive signal was measured in both the vertical and horizontal orientation, at various locations throughout the MDU and outside the MDU.

The diagram below shows the typical transmit/receive equipment set up used during the MDU testing.

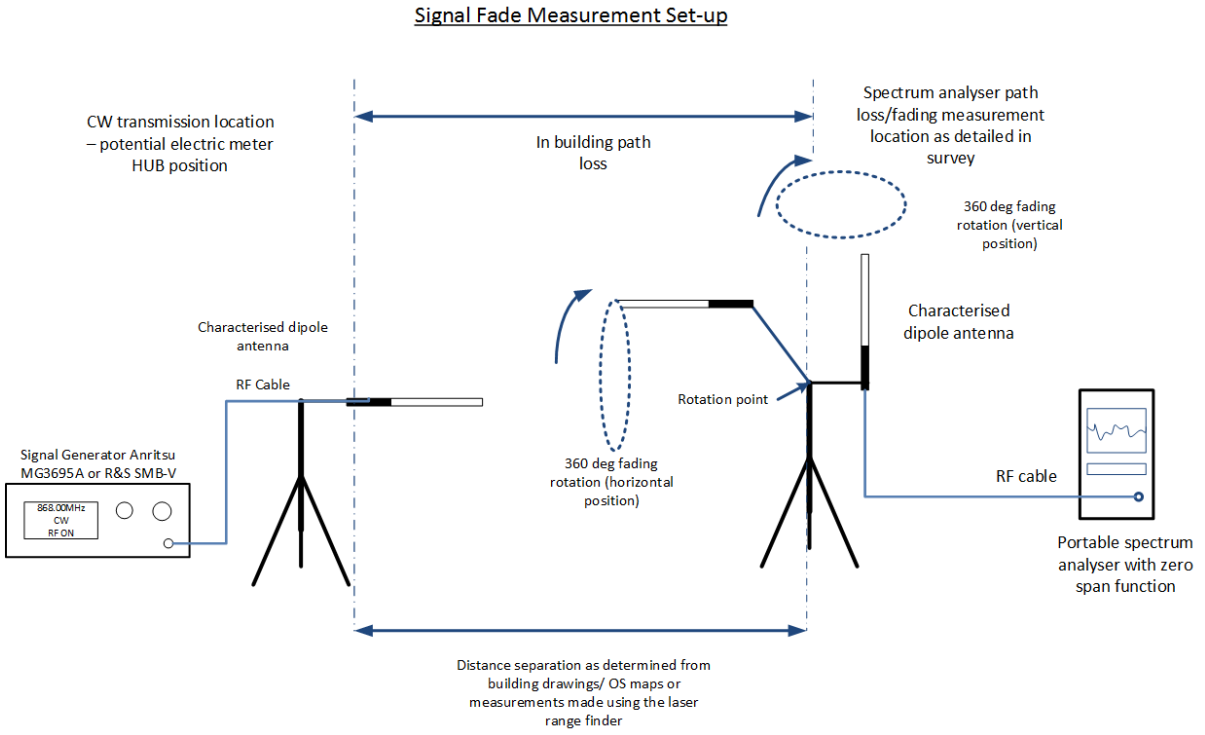

Figure 3 Equipment Set Up

2.3 Test Equipment Details

For traceability the main test equipment components used in the MDU survey are listed below with appropriate tracking details.

Table 2 Test Equipment Details

Item	Make/Model	Serial / Asset Number
Signal Generator 1	R&S SMBV100B	256587 (0471)
Signal Generator 2	Anritsu MG3695A	032006
Power Amplifier	ENI 607l-01	162
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Item	Make/Model	Serial Number	VSWR
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Rx Antenna 1	Radio Structures ENF900	11910	1.42
Rx Antenna 2	Radio Structures ENF900	11882	1.62

3 Site Details

3.1 Building Plan and Test Locations

See Appendix A – Building Plan which contains a plan of the property with a grid used to identify the test locations and Appendix B – Test Locations contains a table which details the test locations. The grid used in Appendix A represents a 4 meter square and is scaled to the Ordnance Survey plan drawings.

3.2 Test Heights

The test heights are provided in the table below

Table 4 Test Heights

Location	Location Name	Height
Tx1	Outside plant room window	1.5 m
Tx2	In plant room	1.5 m

3.3 Photographs of Transmit Locations

Figure 4 Transmit Location 1 and 2 (inside door to right of Test Equipment)

3.4 Photographs of Receive Test Locations

The following photographs are of typical test locations within Henbury Court. The flats in the smaller MDU are entered from a central stair case in the block, with four flats on each floor. The larger block comprised of a terrace of blocks, with each block of flats accessed from its own staircase.

The figures below show typical test locations within the public areas of the flats.

Figure 5 Sample Test Location 1

Figure 6 Sample Test Location 2

Figure 7 Sample Test Location 3

Figure 8 Sample Test Location 4

4 Test Results

This section presents the processed results for the measurements taken at Henbury Court.

4.1 Test Frequencies and Powers

The following interference sweep was carried out to determine the frequencies that could be used for the subsequent testing. Figure 9 shows a sweep of the 868 MHz band and the activity in the band.

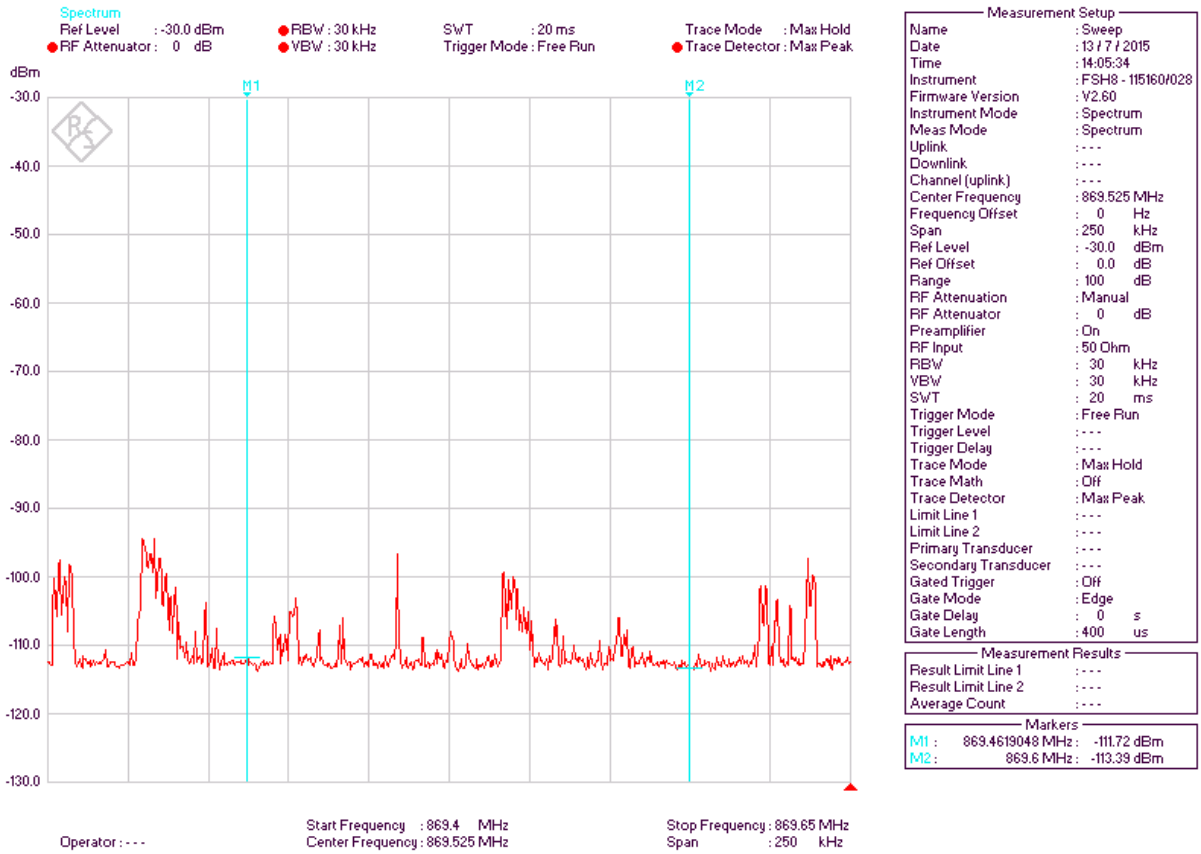


Figure 9 Scan of the 868 MHz Band

The following test frequencies and powers were used in all tests at Henbury Court.

Table 5 Transmit Frequencies and Powers

Transmitter	Frequency	Power
Tx 1	869.450 MHz	100mW
Tx 2	869.600 MHz	100mW

Figure 10 shows the median values for all the measurements taken at Henbury Court using 100 mW.

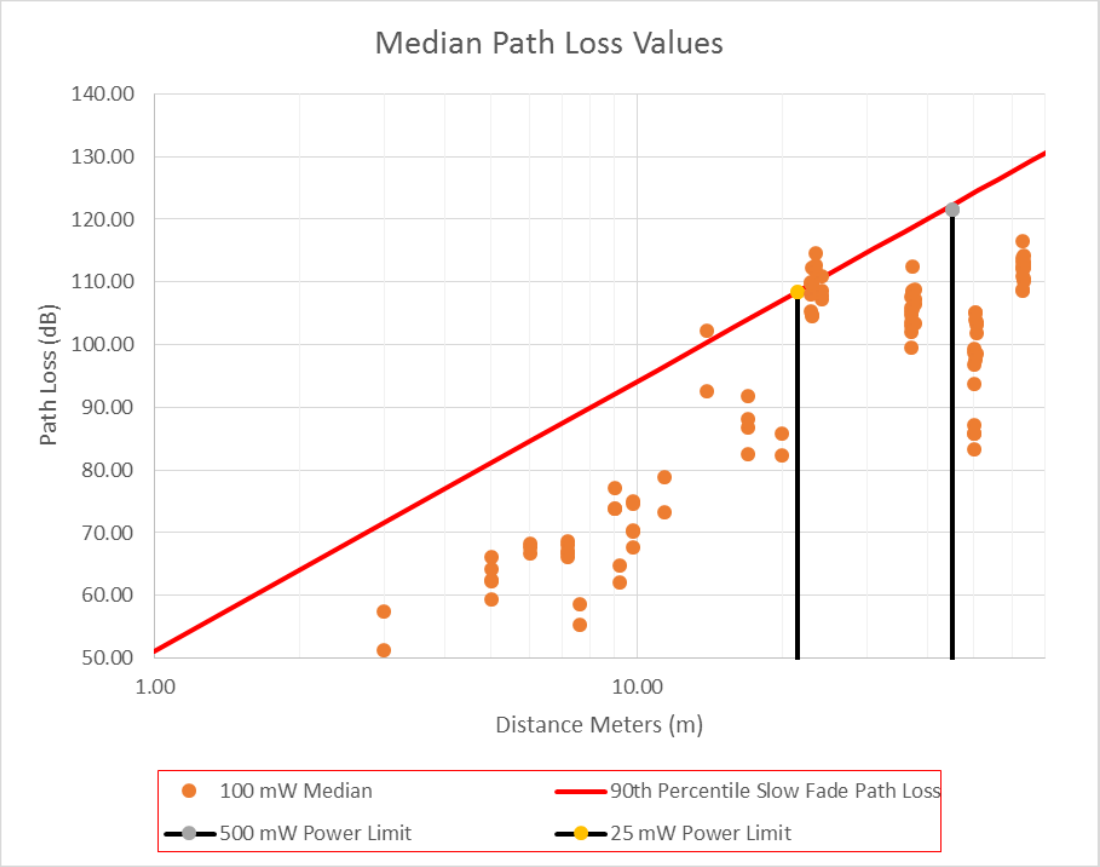


Figure 10 Median Path Loss Measurements

Path loss limit line, 25mW and 500mW power limits on the chart in Figure 10 are derived from the summary of all the data collected on all sites. Details of how these limits are derived and their formulation is contained in the final summary report, to which this document is an Appendix.

An observation can be made from Figure 10 Median Path Loss Measurements, which approximate to 90% of all measurements lying within the 25 mW maximum path loss value of 108dB.

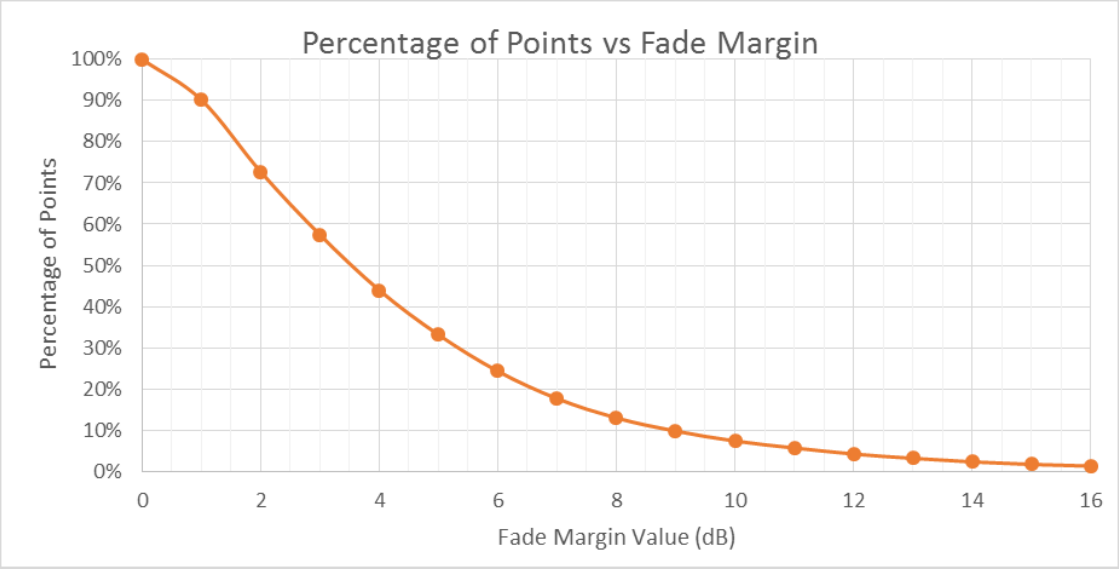


Figure 11 Fast Fade Margin

Figure 11 Fast Fade Margin shows the average number of points recorded within increasing 1 dB steps from the median values for each multipath fast fading test. 90% of all values are less than 9 dB from the median

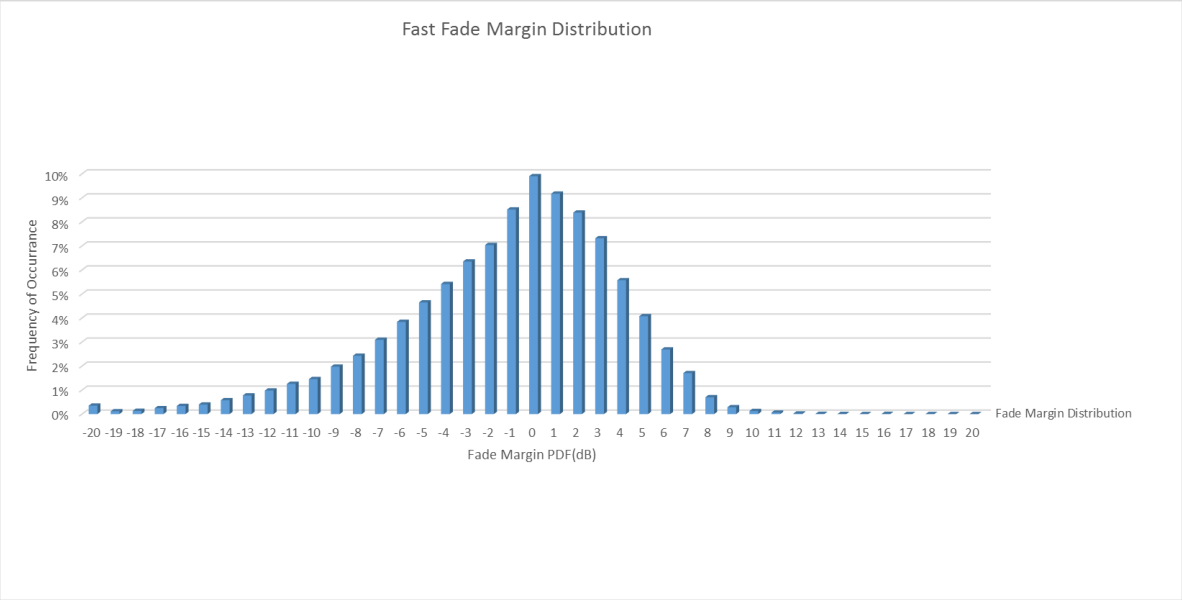
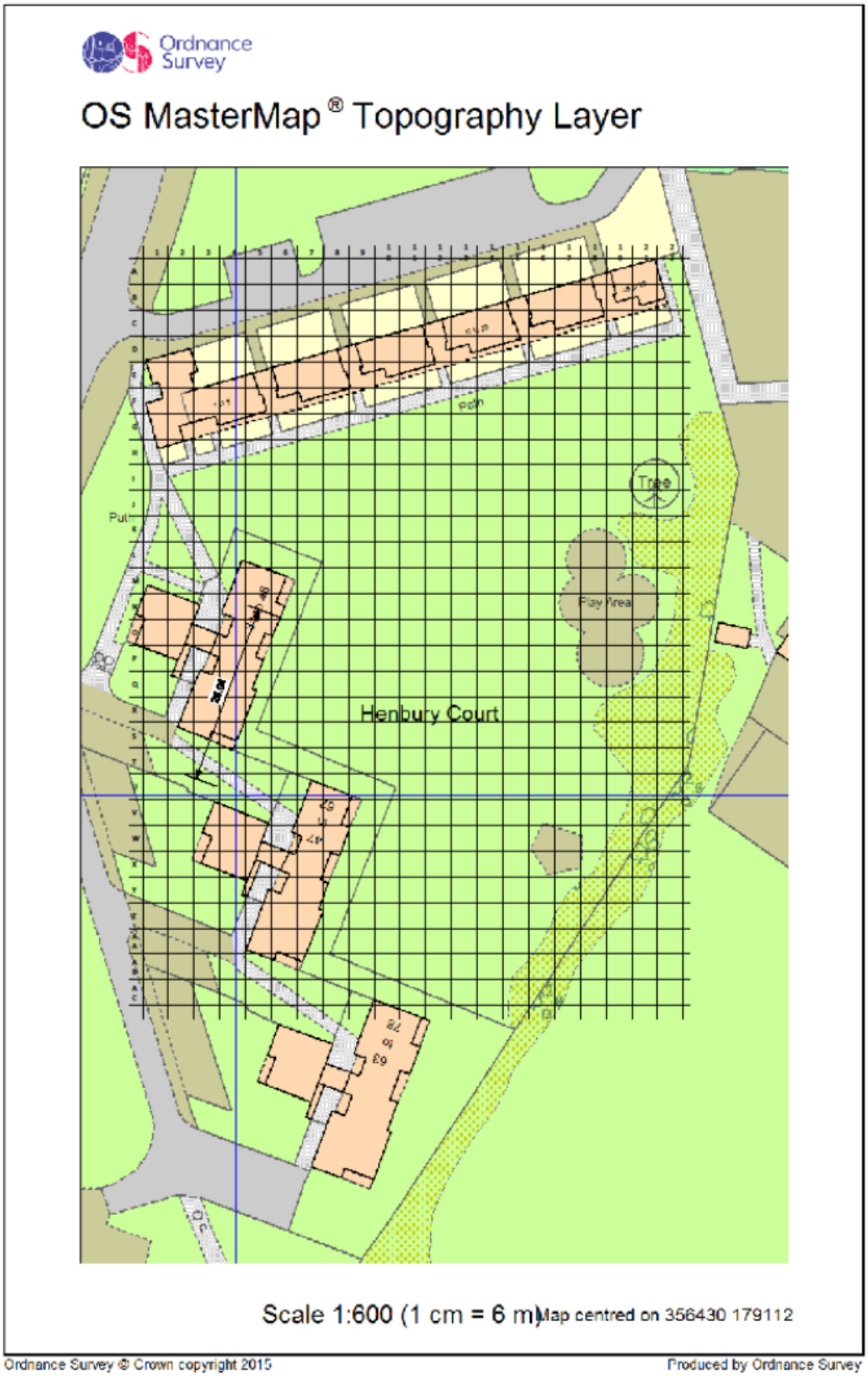


Figure 12 Fast Fading Rayleigh PDF

The fast fade margin PDF in Figure 12 shows that the building has a Rayleigh fast fading characteristic. This is explained in more detail in the main report.

5 Appendix A – Building Plan



6 Appendix B – Test Locations

6.1 Flats 47 to 62

Team	Test	Floor	Inside/Outside	Grid Reference
-	Tx 1	Ground	Outside	X6
-	Tx 2	Ground	Inside	W6
1	Rx 1	Third	Inside	W7
1	Rx 2	Third	Inside	Y5
1	Rx 3	Second	Inside	W7
1	Rx 4	First	Inside	W7
2	Rx 1	Second	Inside	O2
2	Rx 2	First	Inside	O2
2	Rx 3	Ground	Outside	AB7
2	Rx 4	Ground	Outside	V9

6.2 Flats 1 to 30

Team	Test	Floor	Inside/Outside	Grid Reference
-	Tx 1	Ground	Outside	F1
-	Tx 2	Ground	Inside	E1
1	Rx 1	Ground	Inside	E9
1	Rx 2	First	Inside	E9
1	Rx 3	Second	Inside	E9
1	Rx 4	Third	Inside	E9
1	Rx 5	Ground	Inside	C15
1	Rx 6	First	Inside	C15
1	Rx 7	Second	Inside	C15
1	Rx 8	Third	Inside	C15
2	Rx 1	Ground	Inside	F5
2	Rx 2	First	Inside	F5
2	Rx 3	Second	Inside	F5
2	Rx 4	Third	Inside	F5
2	Rx 5	Ground	Inside	D12
2	Rx 6	First	Inside	D12
2	Rx 7	Second	Inside	D12
2	Rx 8	Third	Inside	D12

Spectrum Engineering Services

Smart Meter RF Survey Site Report

Lillington Gardens

Appendix A.8

Publication Date: 19 October 2015

Version: 1.2

OFCOM_SES(15)010.A.8

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Author(s):	Dave Smith
Checked by:	Alistair Abington
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Contact Details:	Office of Communications Baldock Radio Station, Royston Road, Baldock. SG7 6SH. Tel: 01462 428500

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Section Page

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This document details the results and findings for the DECC smart meter RF survey of multiple dwelling units. The survey was to examine the path loss measurements within different types of multiple dwelling units.

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On the 06 July 2015, Ofcom engineers conducted a radio propagation survey at the Multiple Dwelling Units (MDU) property described below. This survey is part of the drive by the Department of Energy and Climate Change (DECC) to rollout Smart Meters in every UK home.

As part of this program, DECC is keen to understand how radio frequency signals propagate through the different MDU.

Transmit and receive locations for the test equipment were typical locations where you may find the electricity and gas meters in these types of buildings. These locations were identified with the assistance of energy suppliers.

Walk testing of the high power transmitted was carried out at this location and the results are summarised in Section 7 of the main report.

Table 1 Site Details

Detail	Description
Property Identifier	Lillington Gardens
Property Type	Complex of flats over multiple floors and wide area
Material of Construction	Brick and concreate
Type of Exterior Wall	Brick
Property Age	Built in phases between 1961 and 1980
Gas Meter Location	In flats
Electricity Meter Location	In flats

Figure 1 Typical Property View

Radio frequency path loss measurements were conducted in the 868MHz short range device band, typically used for short range indoor applications.

The measurements were carried out in predefined locations within the building in consultation with the energy suppliers.

2 Path Loss Survey Methodology

A detailed description of the methodology can be found in a separate document.[1]

2.1 Number of Locations Tested

Ofcom tested a combined total of thirteen receive locations within the property and outside, using signals from two transmitter locations. The receive antenna was tested in two orientations, vertical and horizontal. A total of 91 test files were recorded for Lillington Gardens.

The four transmit locations used:

1. Day 1 In the garage at basement level (100 mW).
2. Day 2 Near to plant room at front entrance (100 mW).
3. Day 2 In the electricity cupboard close to main entrance (100 mW)

[1] Ofcom – Smart Meter RF Survey Methodology, Reference: OFCOM_SES(15)_011 – 868MHz Smart_Test_Method_v2.0

4. Day 2 Parkinson flats, top floor close to flat 66 (500 mW).

2.2 Measurements Recorded

Three types of measurements were carried out during the survey:

1. An interference measurement to determine the activity in the 868MHz SRD band. This was carried out at one location, close to where one of the transmitter antennas was located.
2. Receive signal level measurements using a known transmit signal. The receive signal was measured in both the vertical and horizontal orientation, at various locations throughout the MDU and outside the MDU.

The diagram below shows the typical transmit/receive equipment set up used during the MDU testing.

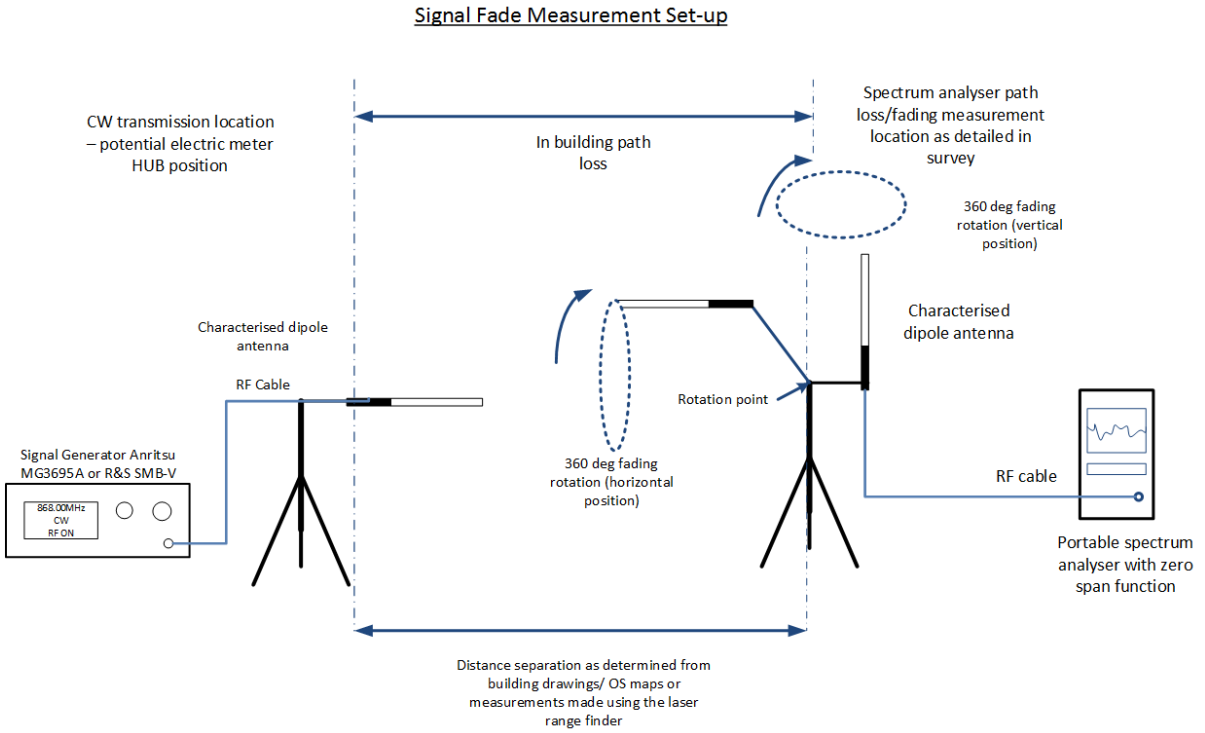

Figure 2 Equipment Set Up

2.3 Test Equipment Details

For traceability the main test equipment components used in the MDU survey are listed below with appropriate tracking details.

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Item	Make/Model	Serial / Asset Number
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3 Site Details

3.1 Building Plan and Test Locations

See Appendix A – Building Plan which contains a plan of the property with a grid used to identify the test locations and Appendix B – Test Locations contains a table which details the test locations. The grid used in Appendix A represents a 4 meter square and is scaled to the Ordnance Survey plan drawings.

3.2 Test Heights

The test heights are provided in the table below

Table 4 Test Heights

Location	Location Name	Height
D1 – Tx 1	Basement Garage	1.5 m
D2 – Tx 1	Inside main entrance electrical cuboard	1.5 m
D2 – Tx 2	Front of property plant room	1.5 m
D2 – Tx 3	Top floor rear of Parkinson House	1.5 m

3.3 Photographs of Transmit Locations

Figure 3 Day 1 Transmit Location 1

Figure 4 Day 2 Transmit Location 1

Figure 5 Day 2 Transmit Location 2

3.4 Photographs of Receive Test Locations

The following photographs are of typical test locations within Lillington Gardens. Access to flats is via a mixture of terrace walkways, stars case, lifts and communal access areas.

Figure 6 Test Location 1-1 Landing Outside Main Entrance

Figure 7 Test Location 1-2 Entrance to Flats

Figure 8 Test Location 1-3 Internal Landing

Figure 9 Test Location 2-2 Basement Garage

4 Test Results

This section presents the processed results for the measurements taken at Lillington Gardens.

4.1 Test Frequencies and Powers

The following interference sweep was carried out to determine the frequencies that could be used for the subsequent testing. Figure 10 shows a sweep of the 868 MHz band and the activity in the band.

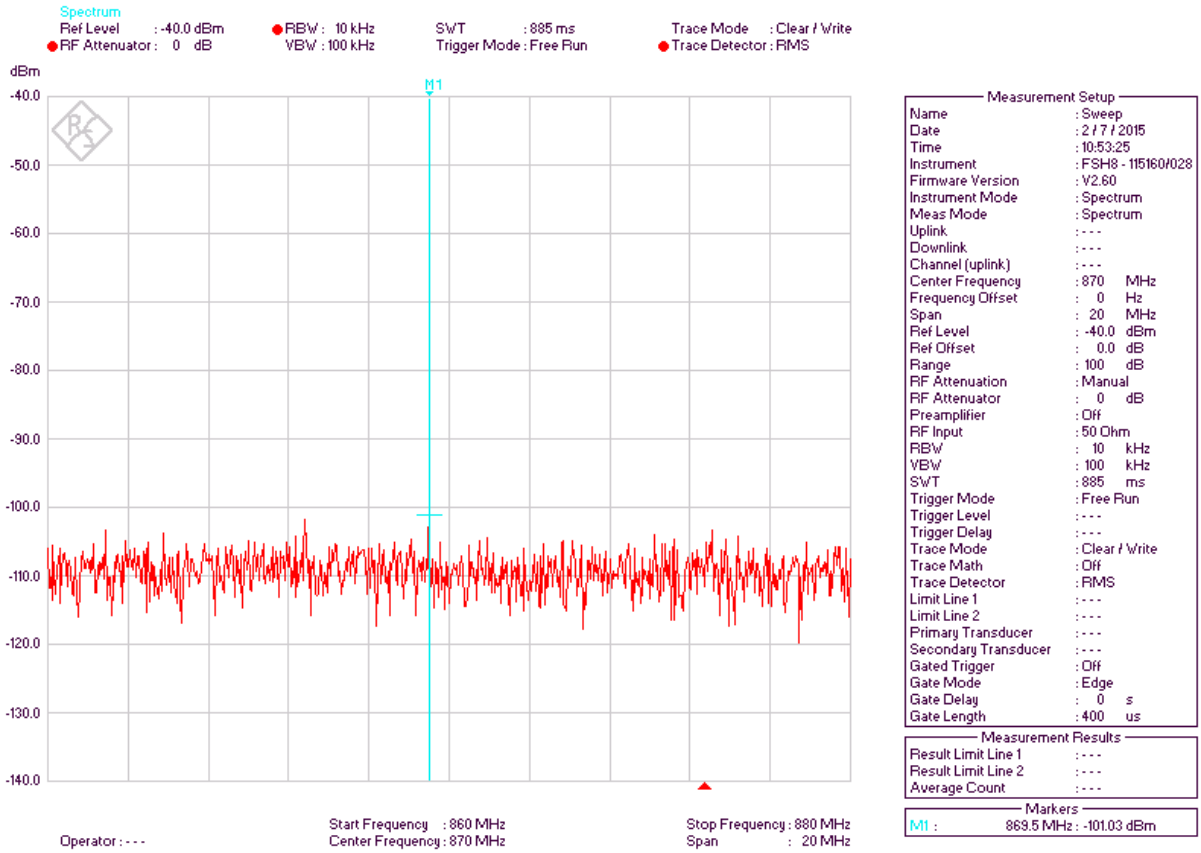


Figure 10 Scan of the 868 MHz Band

The following test frequencies and powers were used in all tests at Lillington Gardens.

Table 5 Transmit Frequencies and Powers

Transmitter	Frequency	Power
Day 1 - Tx 1	869.470 MHz	100mW
Day 2 - Tx 2	869.470 MHz	100mW
Day 2 - Tx 3	869.575 MHz	100mW
Day 2 - Tx 4	869.300 MHz	500mW

Figure 11 shows the median values for all the measurements taken at Lillington Gardens at both 100 mw and 500 mW. Figure 11 clearly shows a number of values above the 500 mW path loss budget. These are explained by understanding that the test equipment used was capable of measuring a maximum path loss of 148dB, some 23 dB better than the equipment that will be deployed for smart metering.

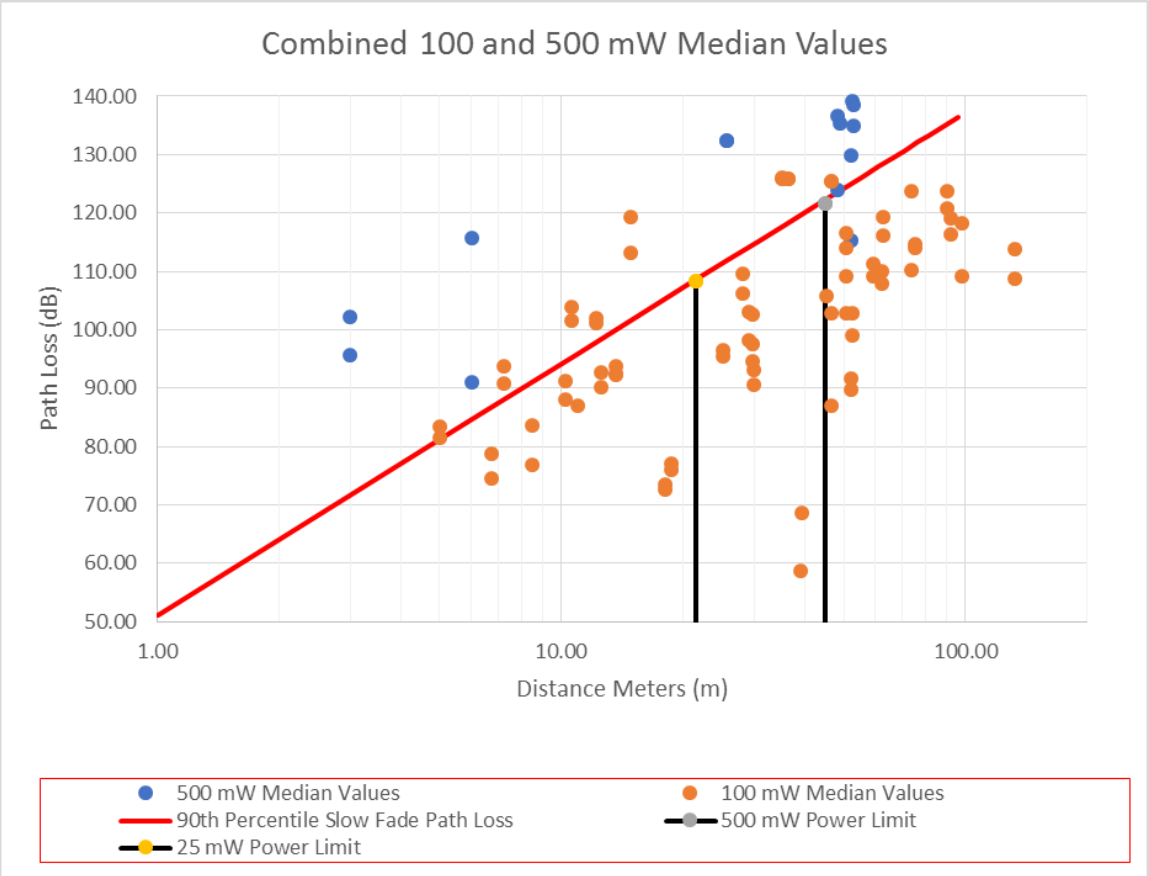


Figure 11 Median Path Loss Measurements

Path loss limit line, 25mW and 500mW power limits on the chart in Figure 11 are derived from the summary of all the data collected on all sites. Details of how these limits are derived and their formulation is contained in the final summary report, to which this document is an Appendix.

Those measurements where the median values lie beyond 80 meters from the transmitter are most likely to be relying on multipath propagation and the signals using an indirect propagation path bouncing off local clutter. Those median values between 60 and 80 meters are most likely to be using a combination of direct and indirect propagation paths.

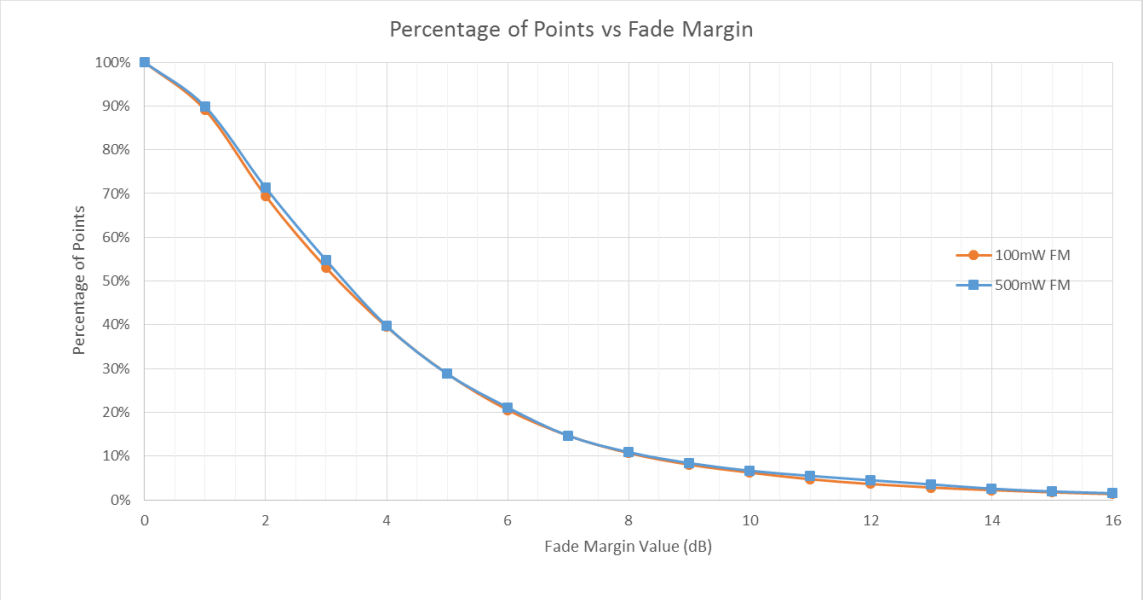


Figure 12 Fast Fade Margin

Figure 12 Fast Fade Margin shows the average number of points recorded within increasing 1 dB steps from the median values for each multipath fast fading test. 90% of all values are less than 8.4 dB from the median.

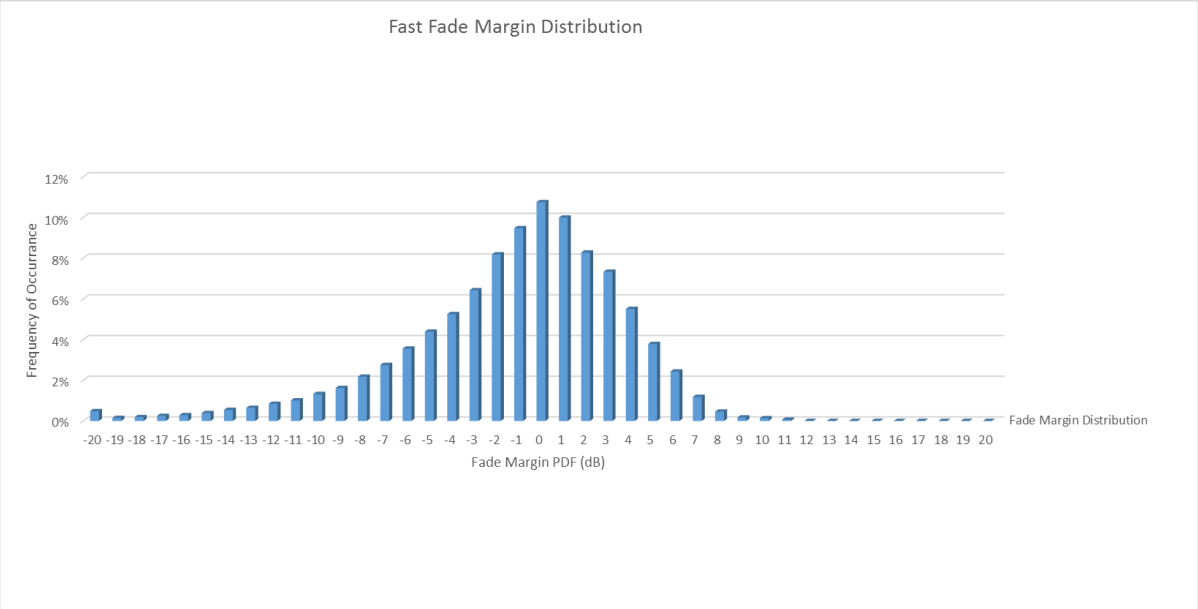
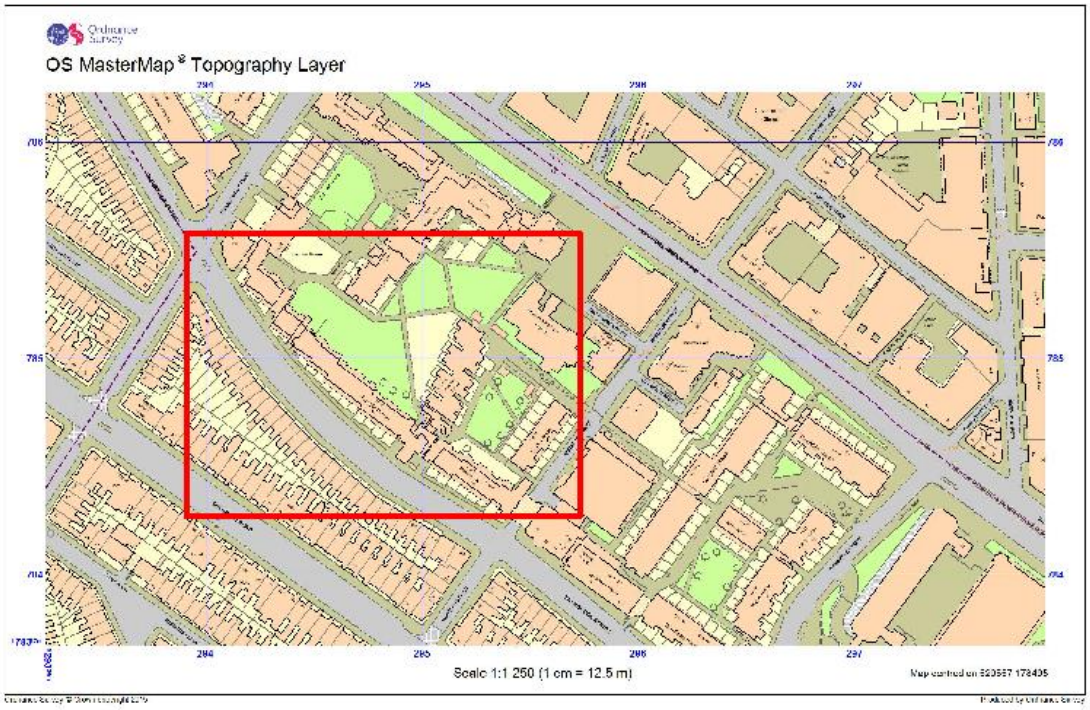


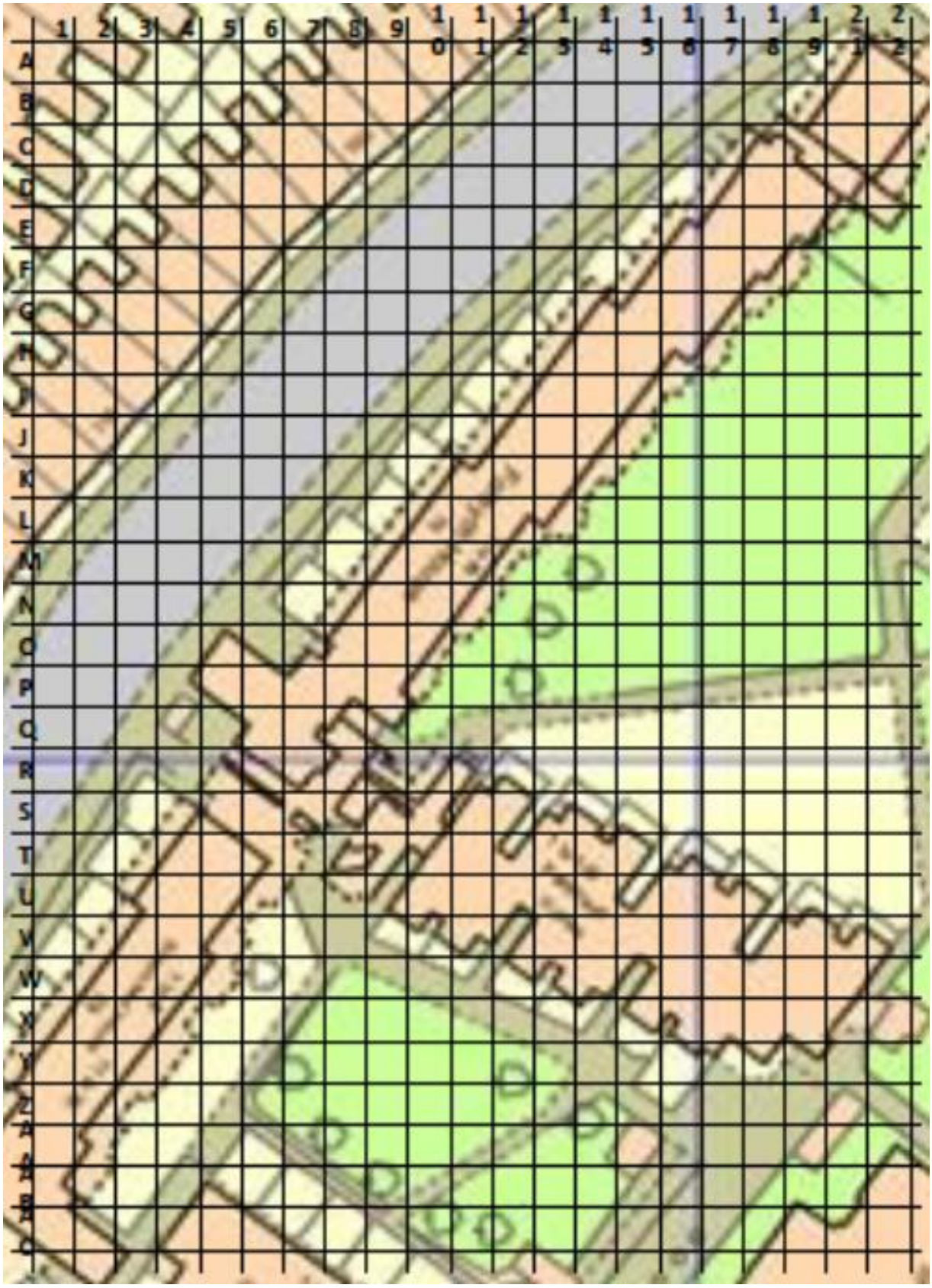
Figure 13 Fast Fading Rayleigh PDF

The fast fade margin PDF in Figure 13 shows that the building has a Rayleigh fast fading characteristic. This is explained in more detail in the main report.

5 Appendix A – Building Plan



The area highlighted contains the building of interest that was tested at Lillington Gardens and is zoomed into to be able to provide the locations of the transmitters and receive locations.



6 Appendix B – Test Locations

6.1 Day 1 Testing

Team	Test	Floor	Inside/Outside	Grid Reference
-	Tx 1	Basement Garage	Inside	W2
1	Rx 1	Ground	Outside	Q4
1	Rx 2	Ground	Outside	Q5
1	Rx 3	First	Inside	P7
2	Rx 1	Basement Garage	Inside	T4
2	Rx 2	Basement Garage	Inside	V3
2	Rx 3	Basement Garage	Inside	Y7
2	Rx 4	Basement Garage	Inside	AC8
2	Rx 5	Ground	Outside	AE13
2	Rx 6	Ground	Outside	AA16
2	Rx 7	Ground	Outside	Z15
2	Rx 8	Third	Inside	AA0
2	RX 9	Third	Inside	No Signal
2	Rx 10	Second	Inside	X1
2	Rx 11	Second	Inside	V3

6.2 Day 2 Testing

Team	Test	Floor	Inside/Outside	Grid Reference
-	Tx 2	Ground	Outside	Q5
-	Tx 3	Ground	Inside	P6
-	Tx 4	Third	Inside	W21
1	Rx 1	Third	Inside	R7
1	Rx 2	Second	Inside	R7
1	Rx 3	Third	Inside	A22
1	Rx 4	Third	Inside	E18
1	Rx 10	Third	Inside	S10
1	Rx 11	Second	Inside	S10
1	Rx 12	Second	Inside	T11
1	Rx 13	Second	Inside	W21
1	Rx 14	First	Inside	T11
1	Rx 15	First	Inside	S10
1	Rx 16	First	Inside	W21
1	Rx 17	First	Inside	V15
2	Rx 1	First	Inside	Q6
2	Rx 2	Second	Inside	Q6
2	Rx 3	Third	Inside	E16
2	Rx 4	Third	Inside	G14
2	Rx 5	Third	Inside	K11
2	Rx 6	Third	Inside	P9
2	Rx 7	Ground	Outside	C19
2	Rx 8	Ground	Outside	Q9

Spectrum Engineering Services

Smart Meter RF Survey Site Report

Loanhead Farm

Appendix A.9

Publication Date: 19 October 2015

Version: 1.2

OFCOM_SES(15)010.A.9

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Author(s):	Dave Smith
Checked by:	Alistair Abington
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Contents

Section Page

1 Introduction

This document details the results and findings for the DECC smart meter RF survey of multiple dwelling units. The survey was to examine the path loss measurements within different types of multiple dwelling units.

Before reading this report appendix, the main report shall be read, as this contains explanations to the testing procedure, how the data was processed and a description to the results presentation.

On the 30 July 2015, Ofcom engineers conducted a radio propagation survey at the Multiple Dwelling Units (MDU) property described below. This survey is part of the drive by the Department of Energy and Climate Change (DECC) to rollout Smart Meters in every UK home.

As part of this program, DECC is keen to understand how radio frequency signals propagate through the different MDU.

Transmit and receive locations for the test equipment were typical locations where you may find the electricity and gas meters in these types of buildings. These locations were identified with the assistance of energy suppliers.

Table 1 Site Details

Detail	Description
Property Identifier	Loanhead Farm
Property Type	Farm Buildings
Material of Construction	Rendered rubble, brick and tile
Type of Exterior Wall	Rendered Rubble and brick
Property Age	Circa 19th Century
Gas Meter Location	No gas on site
Electricity Meter Location	Electricity meter in separate building at far side of steading,

Figure 1 Typical View Loanhead Farm

Radio frequency path loss measurements were conducted in the 868MHz short range device band, typically used for short range indoor applications.

The measurements were carried out in predefined locations within the building in consultation with the energy suppliers.

2 Path Loss Survey Methodology

A detailed description of the methodology can be found in a separate document.[1]

2.1 Number of Locations Tested

Ofcom tested a combined total of six receive locations within the property and outside, using signals from two different transmitter locations, with a transmit power of 100 mW. The receive antenna was tested in two orientations, vertical and horizontal. A total of 24 test files were recorded for Loanhead Farm.

The two transmit locations in the MDU used:

1. Inside tack room near electricity meter (100 mW).
2. Outside adjacent to silo (100 mW).

2.2 Measurements Recorded

Three types of measurements were carried out during the survey:

1. An interference measurement to determine the activity in the 868MHz SRD band. This was carried out at one location, close to where one of the transmitter antennas was located.
2. Receive signal level measurements using a known transmit signal. The receive signal was measured in both the vertical and horizontal orientation, at various locations throughout the MDU and outside the MDU.

The diagram below shows the typical transmit/receive equipment set up used during the MDU testing.

[1] Ofcom – Smart Meter RF Survey Methodology, Reference: OFCOM_SES(15)_011 – 868MHz Smart_Test_Method_v2.0

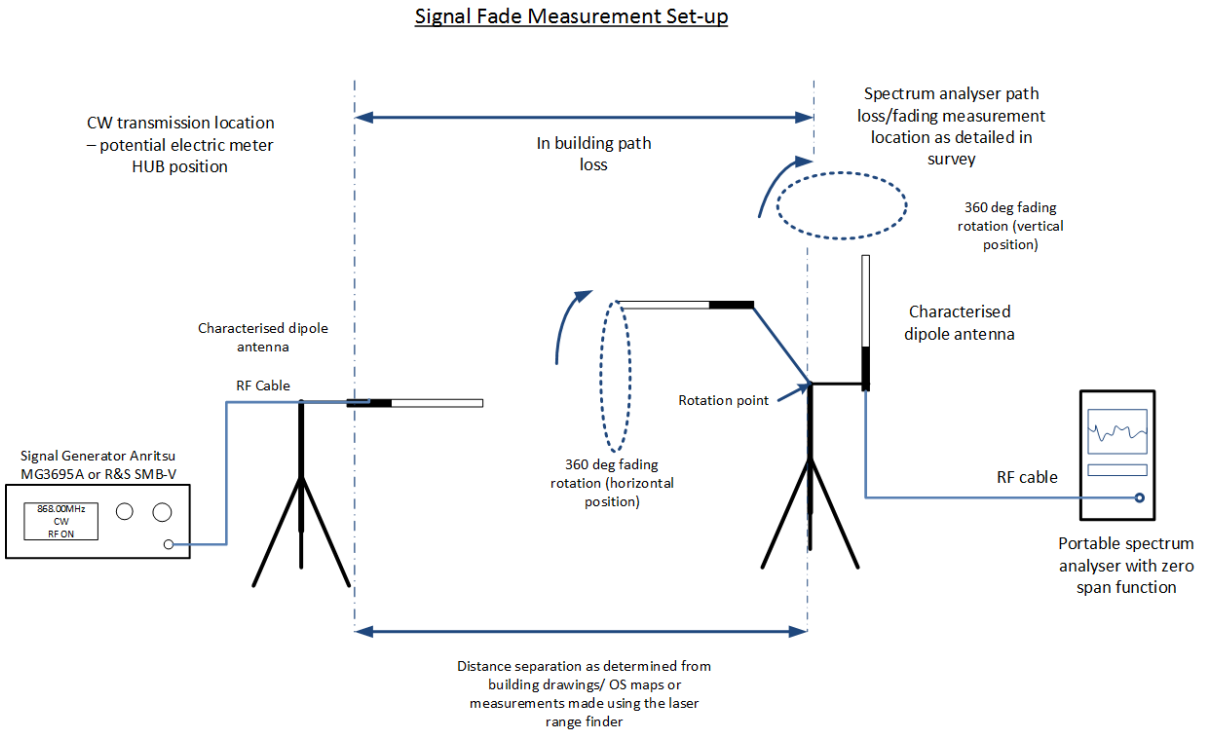


Figure 2 Equipment Set Up

2.3 Test Equipment Details

For traceability the main test equipment components used in the MDU survey are listed below with appropriate tracking details.

Table 2 Test Equipment Details

Item	Make/Model	Serial / Asset Number
Signal Generator 1	R&S SMBV100B	256587 (0471)
Signal Generator 2	Anritsu MG3695A	032006
Power Amplifier	ENI 607l-01	162
Spectrum Analyser 1	R&S FSH8	115160/028
Spectrum Analyser 2	R&S ZVH8	1155159/EJ

Table 3 Test Antenna Details

Item	Make/Model	Serial Number	VSWR
Tx Antenna 1	Radio Structures ENF900	11911	1.43
Tx Antenna 2	Radio Structures ENF900	11883	1.51
Rx Antenna 1	Radio Structures ENF900	11910	1.42
Rx Antenna 2	Radio Structures ENF900	11882	1.62

3 Site Details

3.1 Building Plan and Test Locations

See Appendix A – Building Plan, which contains a plan of the property with a grid used to identify the test locations and Appendix B – Test Locations contains a table which details the test locations. The grid used in Appendix A represents a 4 meter square and is scaled to the Ordnance Survey plan drawings.

3.2 Test Heights

The test heights are provided in the table below

Table 4 Test Heights

Location	Location Name	Height
Tx 1	Inside tack room close to electricity meter	1.5 m
Tx 2	Outside close to horse mill	1.5 m

3.3 Photographs of Transmit Locations

No photographs of transmit locations available.

3.4 Photographs of Receive Test Locations

The following photographs are of typical test locations within Loanhead Farm. This location is a farm with outbuildings and is used to represent barns converted to MDU.

The figures below show typical test locations around the farm.

Figure 3 Sample Test Location 1

Figure 4 Sample Test Location 2

Figure 5 Sample Test Location 3

4 Test Results

This section presents the processed results for the measurements taken at Loanhead Farm.

4.1 Test Frequencies and Powers

The following interference sweep was carried out to determine the frequencies that could be used for the subsequent testing. Figure 6 shows a sweep of the 868 MHz band and the activity in the band.

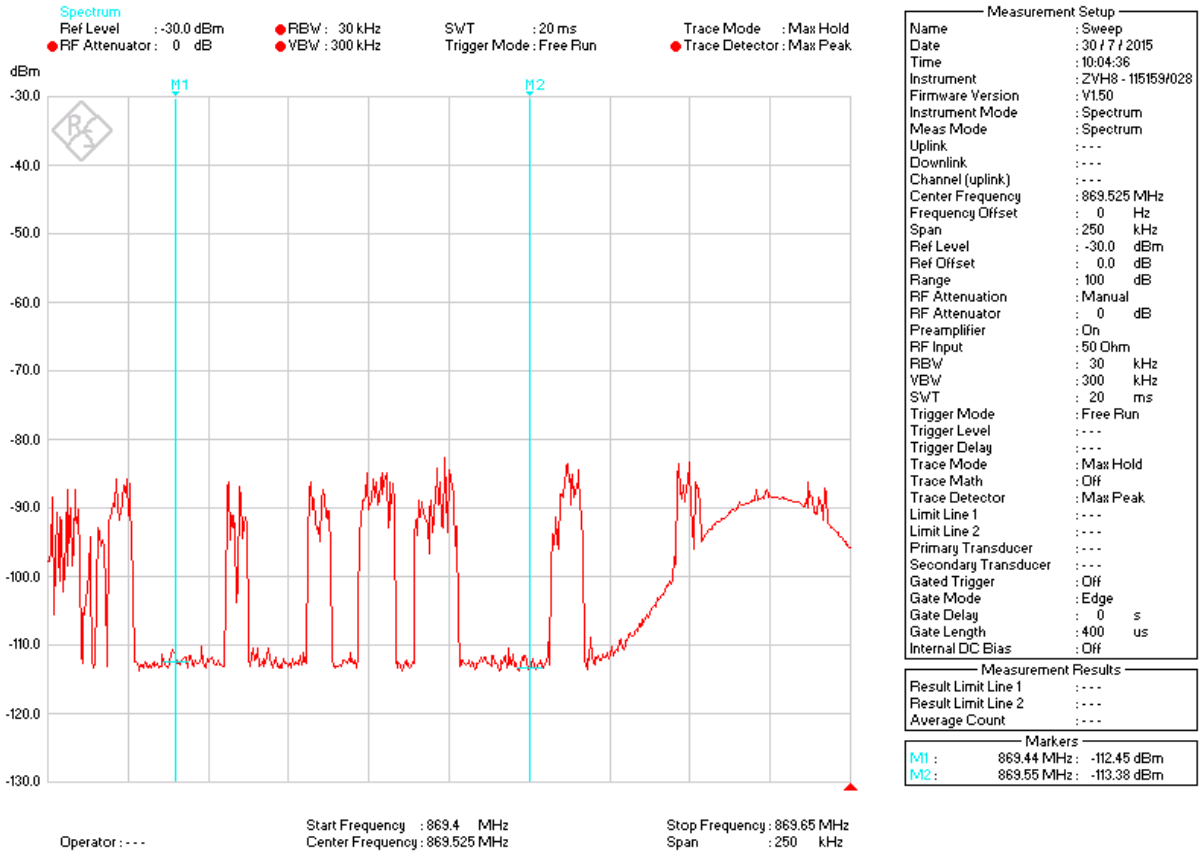


Figure 6 Scan of the 868 MHz Band

The following test frequencies and powers were used in all tests at Loanhead Farm.

Table 5 Transmit Frequencies and Powers

Transmitter	Frequency	Power
Tx 1	869.440 MHz	100mW
Tx 2	869.550MHz	100mW

Figure 7 shows the median values for all the measurements taken at Loanhead Farm for 100 mW.

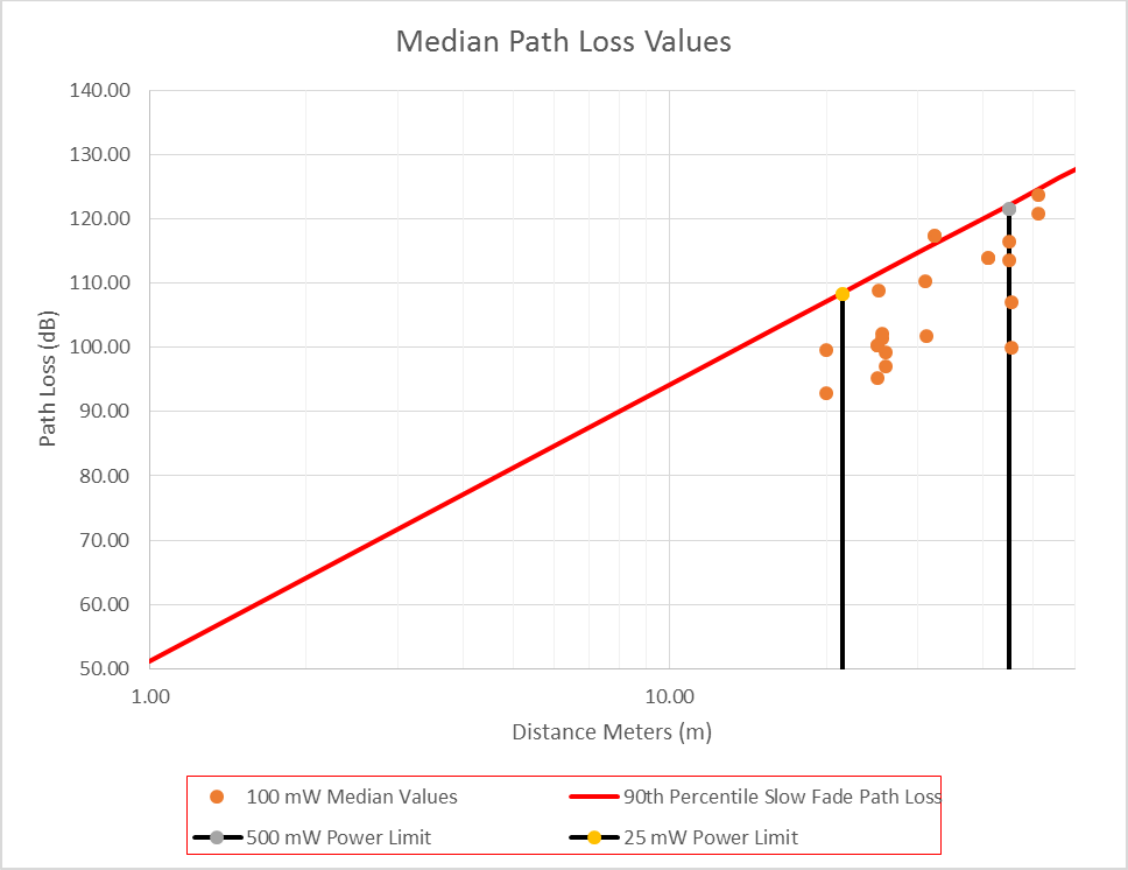


Figure 7 Median Path Loss Measurements

Path loss limit line, 25mW and 500mW power limits on the chart in Figure 7 are derived from the summary of all the data collected on all sites. Details of how these limits are derived and their formulation is contained in the final summary report, to which this document is an Appendix.

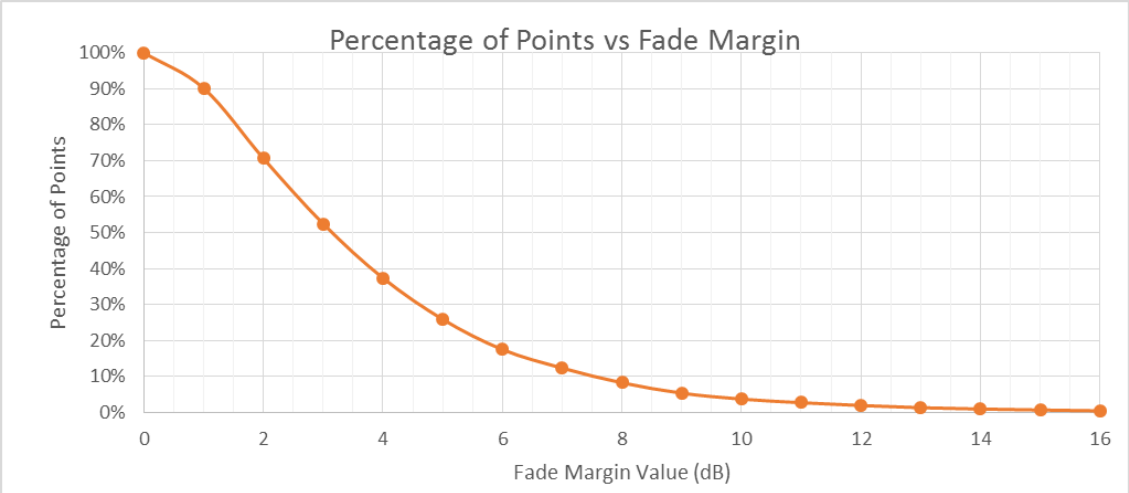


Figure 8 Fast Fade Margin

Figure 8 Fast Fade Margin shows the average number of points recorded within increasing 1 dB steps from the median values for each multipath fast fading test. 90% of all values are less than 7.5 dB from the median.

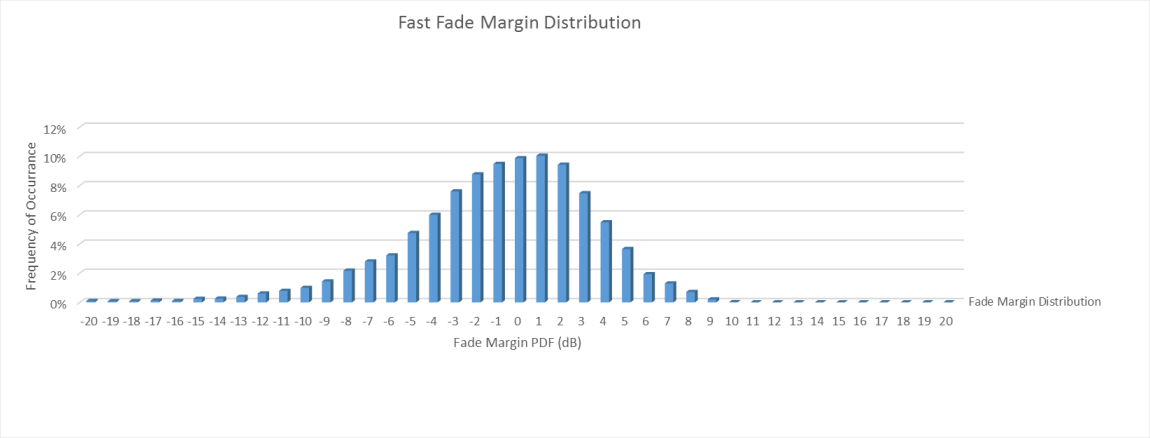
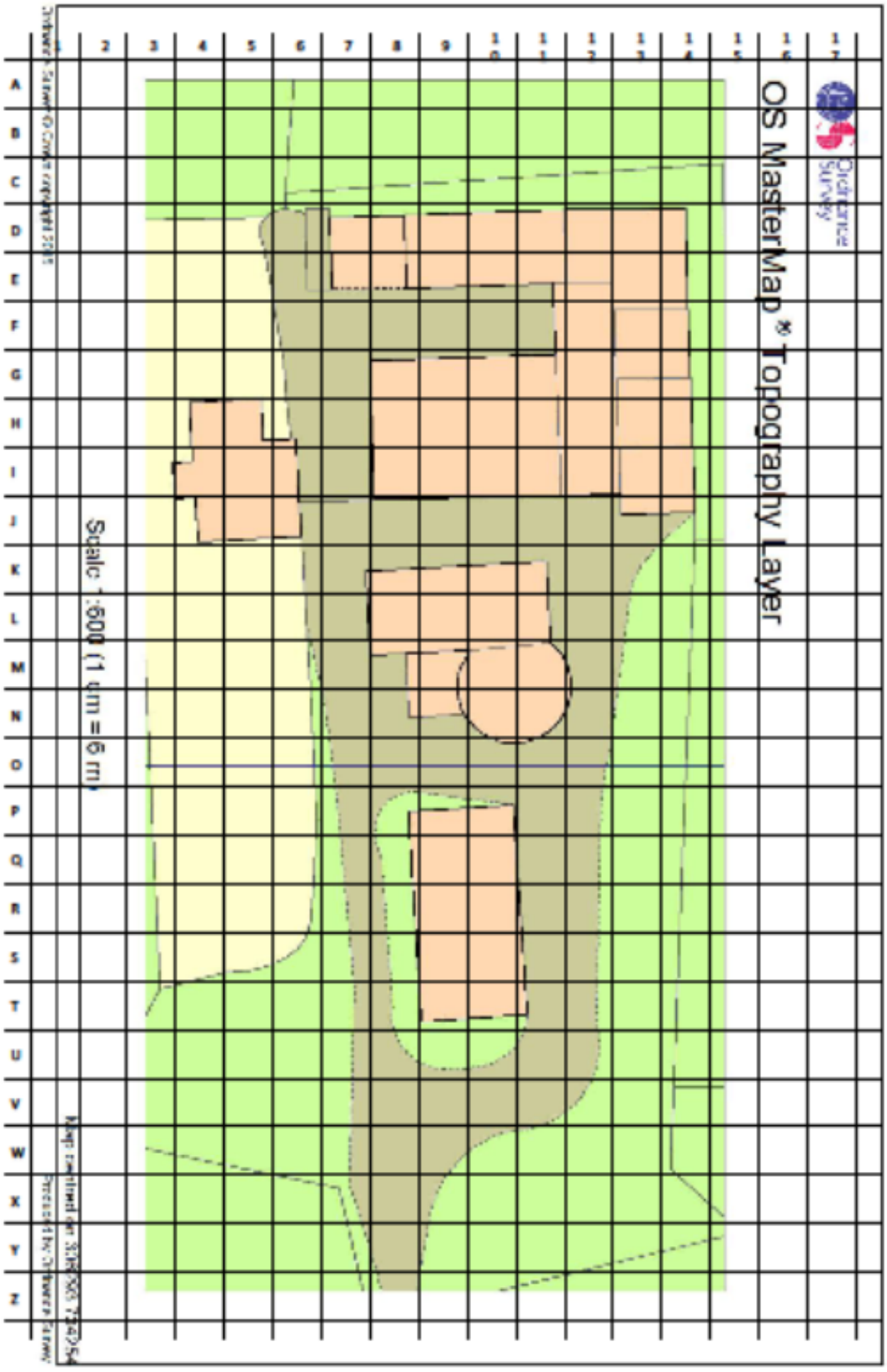


Figure 9 Fast Fading Rayleigh PDF

The fast fade margin PDF in Figure 9 shows that the building has a Rayleigh fast fading characteristic. This is explained in more detail in the main report.

5 Appendix A – Building Plan



OFCOM_SES(15)010.A.9

6 Appendix B – Test Locations

Team	Test	Floor	Insight/Outside	Grid Reference
-	Tx 1	Ground	Inside	D14
-	Tx 2	Ground	Outside	M8
1	Rx 1	Ground	Outside	J4
1	Rx 2	Ground	Inside	I5
1	Rx 3	Ground	Inside	M9
1	Rx 4	Ground	Inside	H8
1	Rx 5	Ground	Inside	D9
1	Rx 6	Ground	Outside	J14

Spectrum Engineering Services

Smart Meter RF Survey Site Report

Marshall Place

Appendix A.10

Publication Date: 19 October 2015

Version: 1.2

OFCOM_SES(15)010.A.10

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1.2	19/10/15	DS	Changed Figures

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On the 30 July 2015, Ofcom engineers conducted a radio propagation survey at the Multiple Dwelling Units (MDU) property described below. This survey is part of the drive by the Department of Energy and Climate Change (DECC) to rollout Smart Meters in every UK home.

As part of this program, DECC is keen to understand how radio frequency signals propagate through the different MDU.

Transmit and receive locations for the test equipment were typical locations where you may find the electricity and gas meters in these types of buildings. These locations were identified with the assistance of energy suppliers.

Table 1 Site Details

Detail	Description
Property Identifier	Marshall Place, Perth
Property Type	Terraced
Material of Construction	Sand stone block and tile
Type of Exterior Wall	Sand stone block
Property Age	1820
Gas Meter Location	In property of ground floor flat
Electricity Meter Location	In hall of ground floor flat property

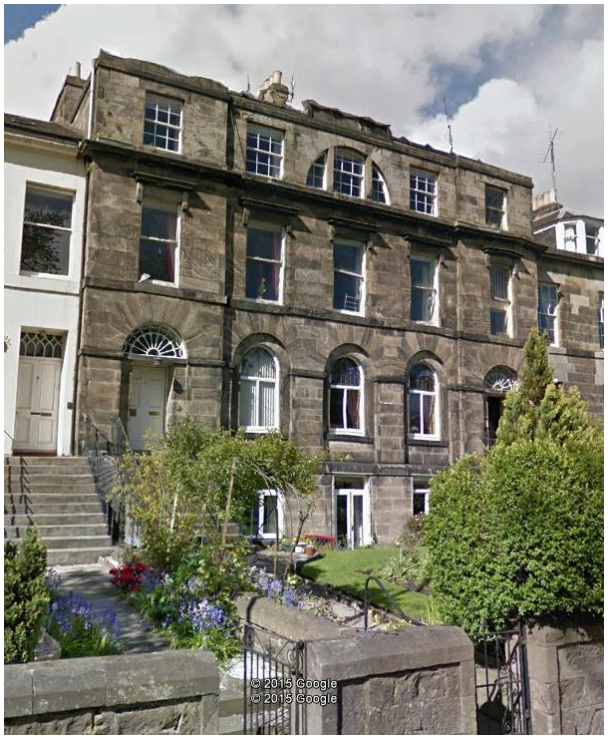

Figure 1 External View Marshall Place

Radio frequency path loss measurements were conducted in the 868MHz short range device band, typically used for short range indoor applications.

The measurements were carried out in predefined locations within the building in consultation with the energy suppliers.

2 Path Loss Survey Methodology

A detailed description of the methodology can be found in a separate document.[1]

2.1 Number of Locations Tested

Ofcom tested a combined total of twenty four receive locations within the property and outside, using signals from two transmitter locations. The receive antenna was tested in two orientations, vertical and horizontal. A total of 104 test files were recorded for Marshall Place.

The two transmit locations in the small MDU used:

1. Stone built outbuilding (100 mW).
2. At rear door of property (100 mW).

2.2 Measurements Recorded

Three types of measurements were carried out during the survey:

1. An interference measurement to determine the activity in the 868MHz SRD band. This was carried out at one location, close to where one of the transmitter antennas was located.
2. Receive signal level measurements using a known transmit signal. The receive signal was measured in both the vertical and horizontal orientation, at various locations throughout the MDU and outside the MDU.

The diagram below shows the typical transmit/receive equipment set up used during the MDU testing.

[1] Ofcom – Smart Meter RF Survey Methodology, Reference: 868MHz Smart_Test_Method_v2.0

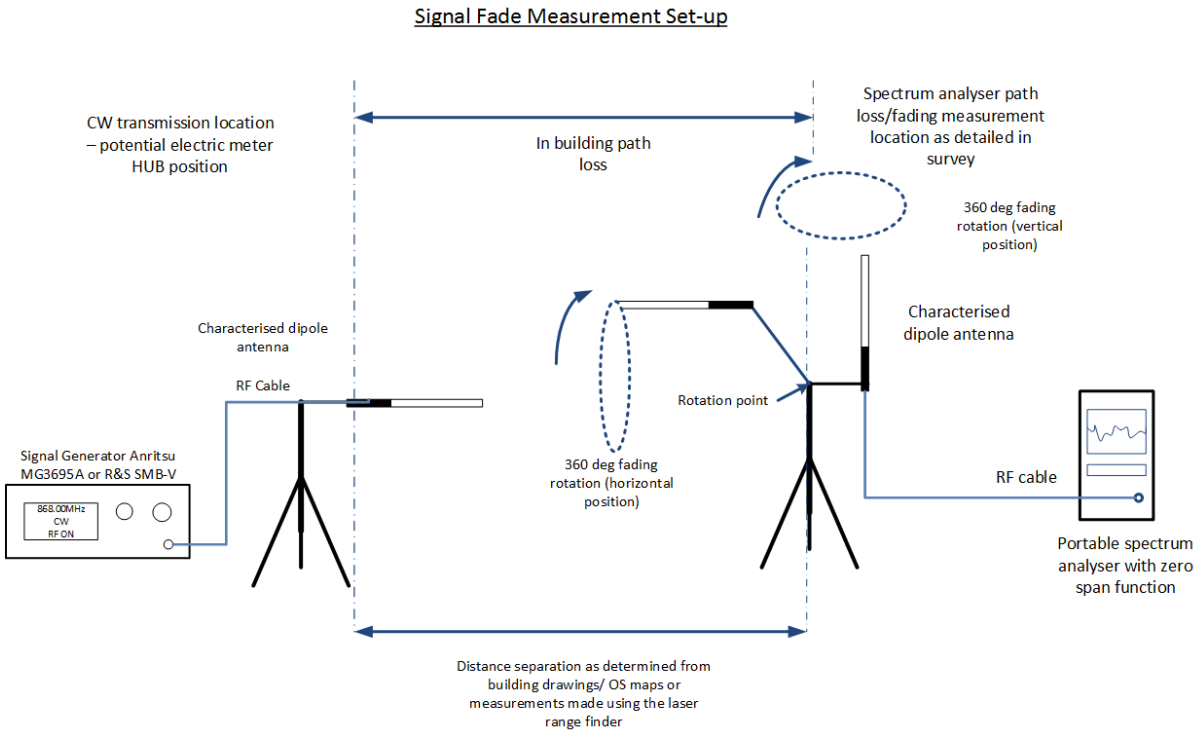

Figure 2 Equipment Set Up

2.3 Test Equipment Details

For traceability the main test equipment components used in the MDU survey are listed below with appropriate tracking details.

Table 2 Test Equipment Details

Item	Make/Model	Serial / Asset Number
Signal Generator 1	R&S SMBV100B	256587 (0471)
Signal Generator 2	Anritsu MG3695A	032006
Power Amplifier	ENI 607l-01	162
Spectrum Analyser 1	R&S FSH8	115160/028
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Tx Antenna 1	Radio Structures ENF900	11911	1.43
Tx Antenna 2	Radio Structures ENF900	11883	1.51
Rx Antenna 1	Radio Structures ENF900	11910	1.42
Rx Antenna 2	Radio Structures ENF900	11882	1.62

3 Site Details

3.1 Building Plan and Test Locations

See Figure 11 Fast Fading Rayleigh PDF

The fast fade margin PDF in Figure 11 shows that the building has a Rayleigh fast fading characteristic. This is explained in more detail in the main report.

Appendix A – Building Plan, which contains a plan of the property with a grid used to identify the test locations and Appendix B – Test Locations contains a table which details the test locations. The grid used in Appendix A represents a 4 meter square and is scaled to the Ordnance Survey plan drawings.

3.2 Test Heights

The test heights are provided in the table below

Table 4 Test Heights

Location	Location Name	Height
Tx1	Inside stone outbuilding at rear	1.5 m
Tx2	Outside rear door of property	1.5 m

3.3 Photographs of Transmit Locations

Figure 3 Transmit Location 1

Figure 4 Transmit Location 2

3.4 Photographs of Receive Test Locations

The following photographs are of typical test locations within Marshall Place. The building comprises of four individual flat dwellings of basement, ground floor first floor and roof. Each flat has its own separate entrance. Situated at the rear of the property, is a dance room connected to the back of the garage and this was also used as a measurement location. The core measurements were conducted in various parts of the ground floor flat and no internal measurements were conducted at the other flats.

The figures below show typical test locations

Figure 5 Sample Test Location 1

Figure 6 Sample Test Location 2

Figure 7 Sample Test Location 3

4 Test Results

This section presents the processed results for the measurements taken at Marshall Place.

4.1 Test Frequencies and Powers

The following interference sweep was carried out to determine the frequencies that could be used for the subsequent testing. Figure 8 shows a sweep of the 868 MHz band and the activity in the band.

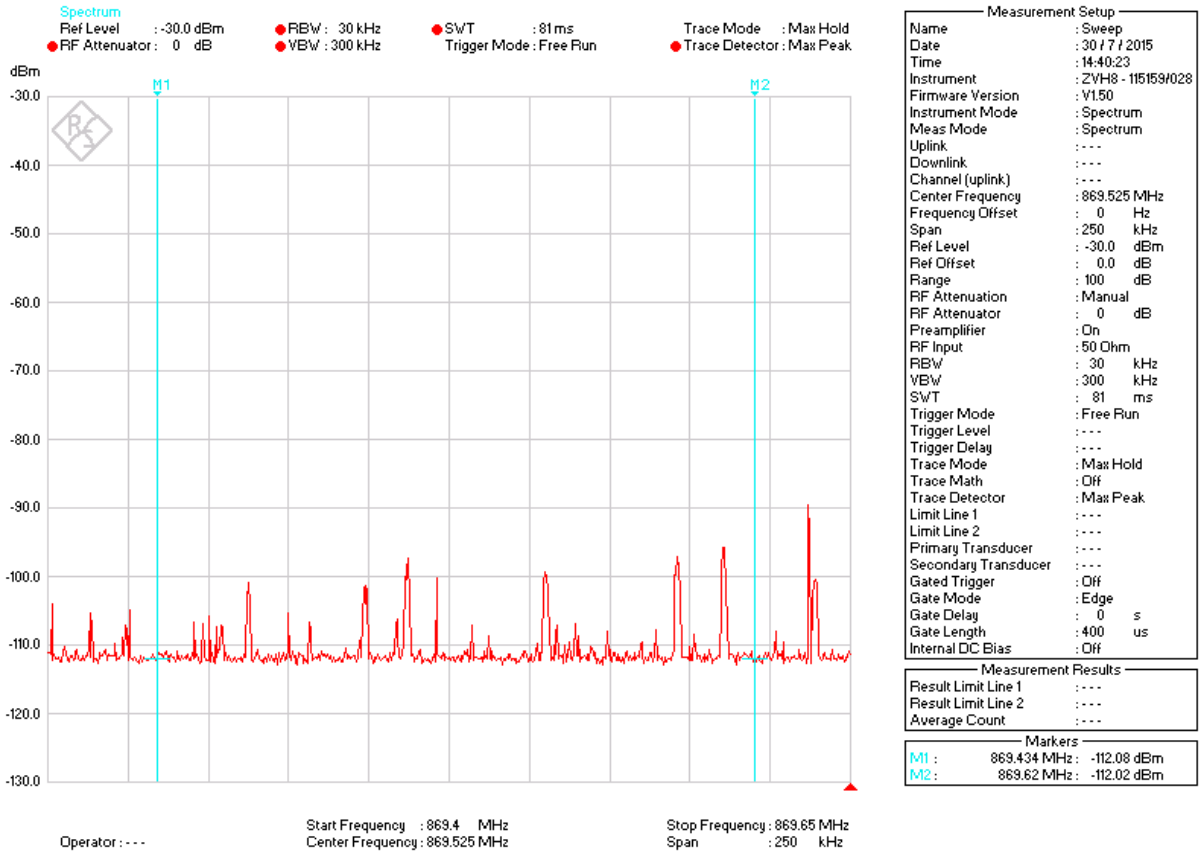


Figure 8 Scan of the 868 MHz Band

The following test frequencies and powers were used in all tests at Marshall Place.

Table 5 Transmit Frequencies and Powers

Transmitter	Frequency	Power
Tx 1	869.430 MHz	100mW
Tx 2	869.600 MHz	100mW

Figure 9 shows the median values for all the measurements taken at Marshall Place using 100 mW.

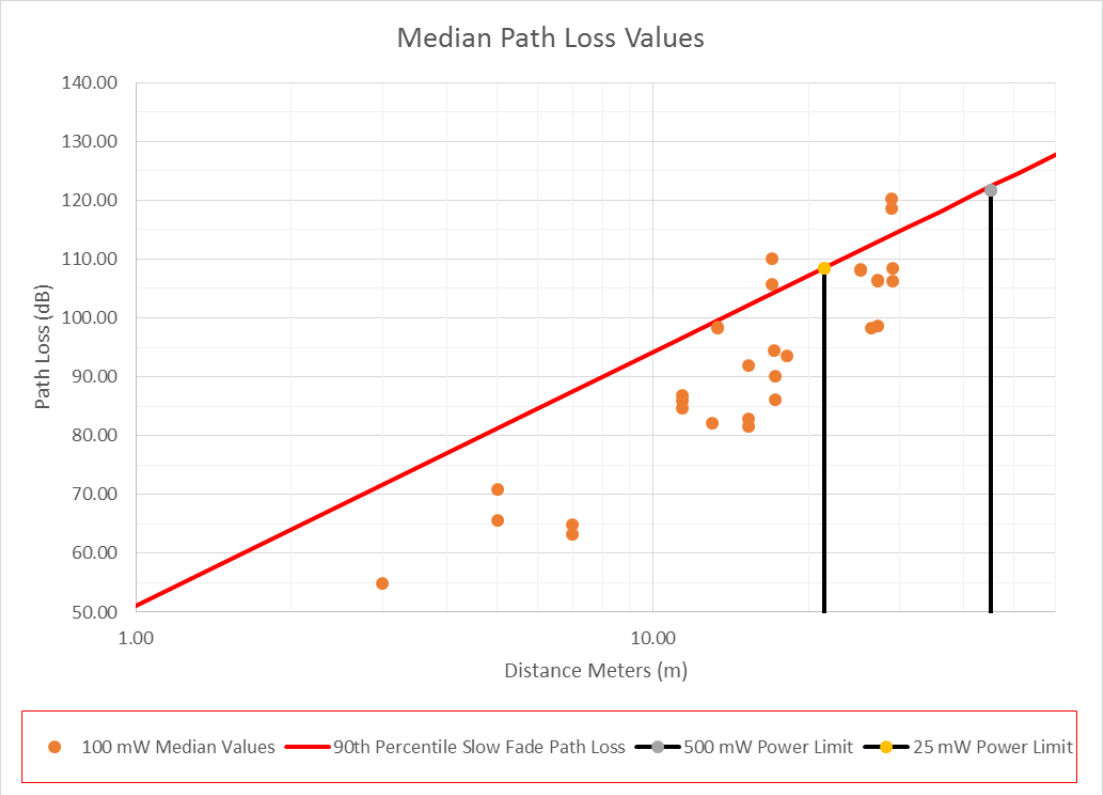


Figure 9 Median Path Loss Measurements

Path loss limit line, 25mW and 500mW power limits on the chart in Figure 9 are derived from the summary of all the data collected on all sites. Details of how these limits are derived and their formulation is contained in the final summary report, to which this document is an Appendix.

An observation can be made from Figure 9 Median Path Loss Measurements, which approximate to 90% of all measurements lying within the 25 mW maximum path loss value of 108dB.

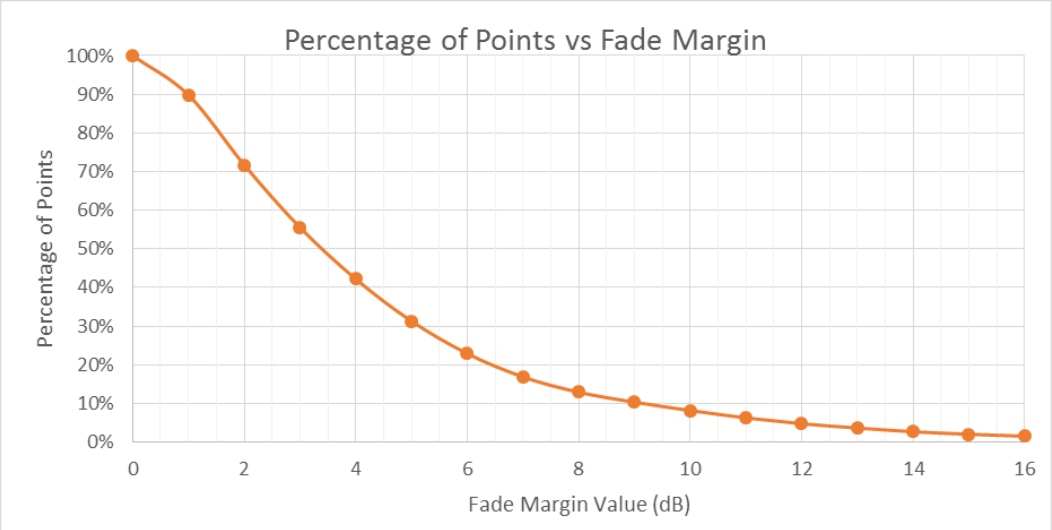
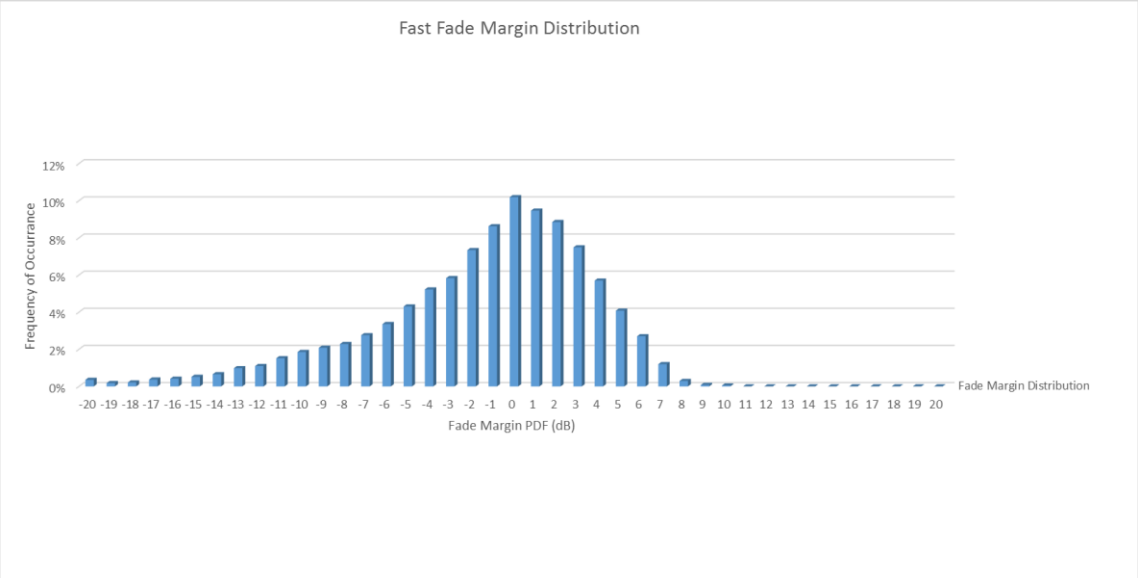


Figure 10 Fast Fade Margin

Figure 10 Fast Fade Margin shows the average number of points recorded within increasing 1 dB steps from the median values for each multipath fast fading test. 90% of all values are less than 9 dB from the median.



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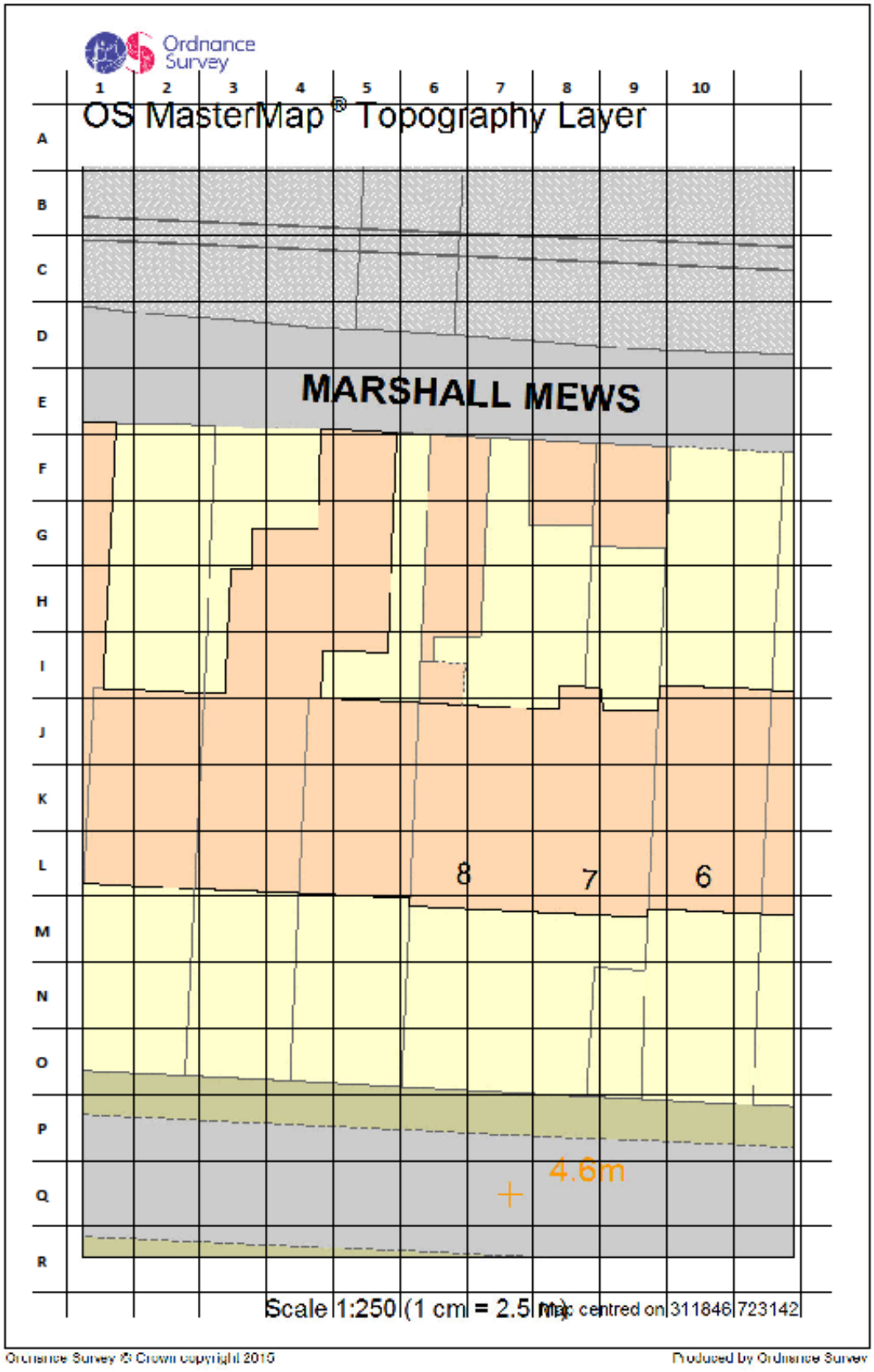

6 Appendix B – Test Locations

Team	Test	Floor	Inside/Outside	Grid Reference
-	Tx 1	Ground	Inside	F6
-	Tx 2	Ground	Outside	I6
1	Rx 1	Ground	Inside	G6
1	Rx 2	Ground	Outside	I6
1	Rx 3	Ground	Inside	L6
1	Rx 4	Ground	Outside	M6
1	Rx 5	Ground	Outside	M7
1	Rx 6	Ground	Inside	L7
1	Rx 7	Ground	Inside	K7
1	Rx 8	Ground	Inside	F6

Spectrum Engineering Services

Smart Meter RF Survey Site Report

Mawdeley House

Appendix A.11

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On the 15 July 2015, Ofcom engineers conducted a radio propagation survey at the Multiple Dwelling Units (MDU) property described below. This survey is part of the drive by the Department of Energy and Climate Change (DECC) to rollout Smart Meters in every UK home.

As part of this program, DECC is keen to understand how radio frequency signals propagate through the different MDU.

Transmit and receive locations for the test equipment were typical locations where you may find the electricity and gas meters in these types of buildings. These locations were identified with the assistance of energy suppliers.

Walk testing of the high power transmitted was carried out at this location and the results are summarised in Section 7 of the main report.

Table 1 Site Details

Detail	Description
Property Identifier	Mawdeley House
Property Type	Large block of flats
Material of Construction	Brick and concreate
Type of Exterior Wall	Brick
Property Age	Built in 1960s
Gas Meter Location	Assumed in flats
Electricity Meter Location	Assumed in flats

Figure 1 Typical Property View

Radio frequency path loss measurements were conducted in the 868MHz short range device band, typically used for short range indoor applications.

The measurements were carried out in predefined locations within the building in consultation with the energy suppliers.

2 Path Loss Survey Methodology

A detailed description of the methodology can be found in a separate document.[1]

2.1 Number of Locations Tested

Ofcom tested a combined total of thirteen receive locations within the property and outside, using signals from two transmitter locations. The receive antenna was tested in two orientations, vertical and horizontal. A total of 68 test files were recorded for Mawdeley House.

The three transmit locations used:

1. Outside entrance to flats below ground level (100 mW).
2. Under stairs cupboard on ground floor (100 mW).
3. Top floor landing (500 mW)

2.2 Measurements Recorded

Three types of measurements were carried out during the survey:

1. An interference measurement to determine the activity in the 868MHz SRD band. This was carried out at one location, close to where one of the transmitter antennas was located.
2. Receive signal level measurements using a known transmit signal. The receive signal was measured in both the vertical and horizontal orientation, at various locations throughout the MDU and outside the MDU.

The diagram below shows the typical transmit/receive equipment set up used during the MDU testing.

[1] Ofcom – Smart Meter RF Survey Methodology, Reference: 868MHz Smart_Test_Method_v2.0 OFCOM_SES(15)010.A.11

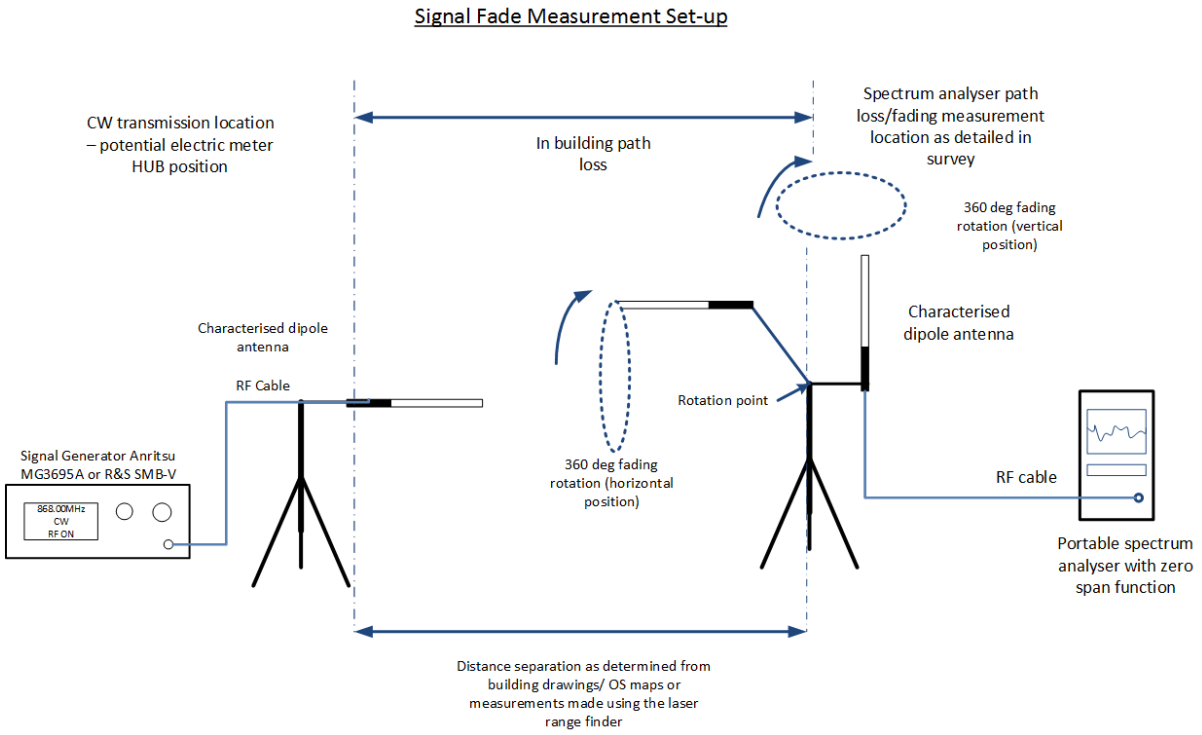

Figure 2 Equipment Set Up

2.3 Test Equipment Details

For traceability the main test equipment components used in the MDU survey are listed below with appropriate tracking details.

Prior to the commencement of daily testing the RF level from the Transmit antennas was calibrated to 100mW (500mW as required).

Table 2 Test Equipment Details

Item	Make/Model	Serial / Asset Number
Signal Generator 1	R&S SMBV100B	256587 (0471)
Signal Generator 2	Anritsu MG3695A	032006
Power Amplifier	ENI 607l-01	162
Spectrum Analyser 1	R&S FSH8	115160/028
Spectrum Analyser 2	R&S ZVH8	1155159/EJ

Table 3 Test Antenna Details

Item	Make/Model	Serial Number	VSWR
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3 Site Details

3.1 Building Plan and Test Locations

See Appendix A – Building Plan, which contains a plan of the property with a grid used to identify the test locations and Appendix B – Test Locations contains a table which details the test locations. The grid used in Appendix A represents a 4 meter square and is scaled to the Ordnance Survey plan drawings.

3.2 Test Heights

The test heights are provided in the table below

Table 4 Test Heights

Location	Location Name	Height
Tx 1	Outside plant room window	1.5 m
Tx 2	In plant room	1.5 m
Tx 3	Top floor landing	1.5 m

3.3 Photographs of Transmit Locations

Figure 3 Transmit Location 1

Figure 4 Transmit Location 2

3.4 Photographs of Receive Test Locations

The following photographs are of typical test locations within Mawdeley House. All flats are entered from a central corridor with each floor accessed from a staircase or lift at either end of the building.

Figure 5 Sample Test Location 1

Figure 6 Sample Test Location 2

Figure 7 Sample Test Location 3

Figure 8 Sample Test Location 4

4 Path Loss Test Results

This section presents the processed results for the path loss measurements taken at Mawdeley House.

4.1 Test Frequencies and Powers

The following interference sweep was carried out to determine the frequencies that could be used for the subsequent testing. Figure 9 shows a sweep of the 868 MHz band and the activity in the band.

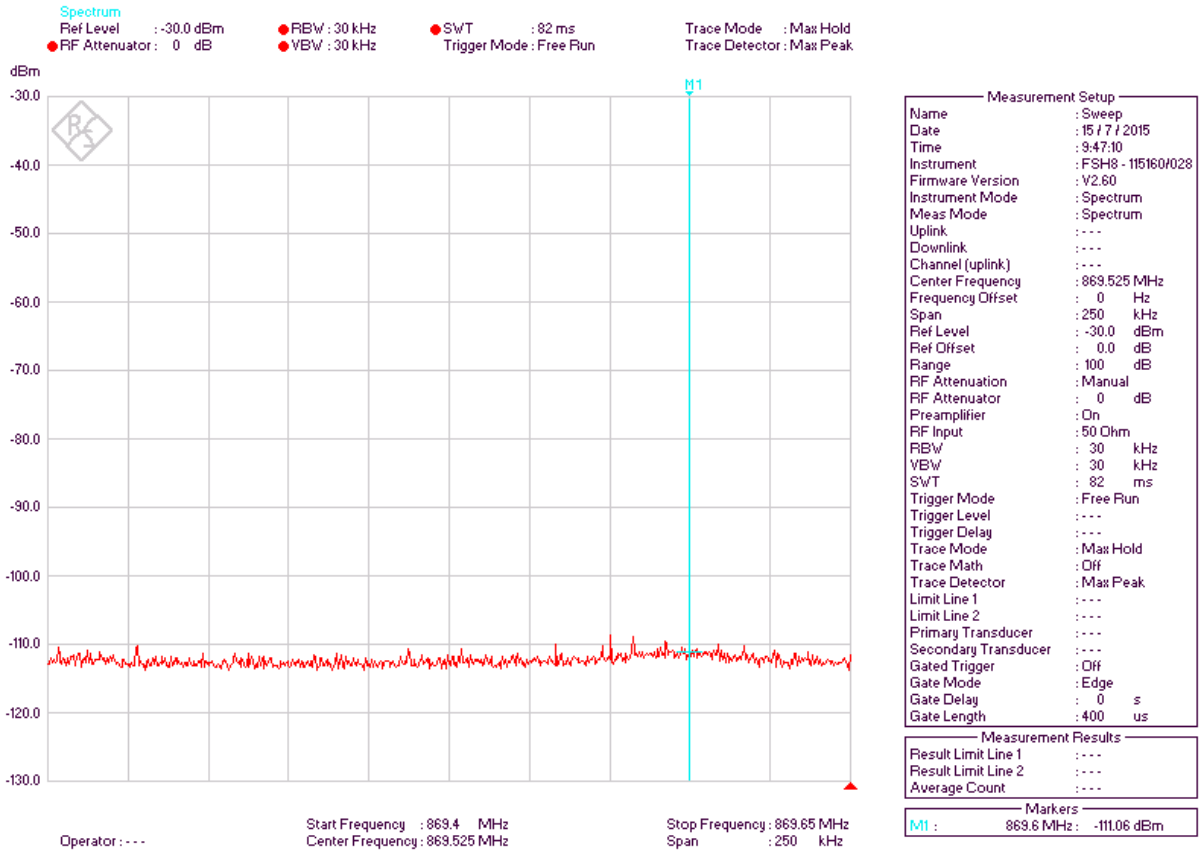


Figure 9 Scan of the 868 MHz Band

The following test frequencies and powers were used in all tests at Mawdeley House.

Table 5 Transmit Frequencies and Powers

Transmitter	Frequency	Power
Tx 1	869.590 MHz	100mW
Tx 2	869.492 MHz	100mW
Tx 3	869.492 MHz	500mW

Figure 10 shows the median values for all the measurements taken at Mawdeley House at both 100 and 500 mW.

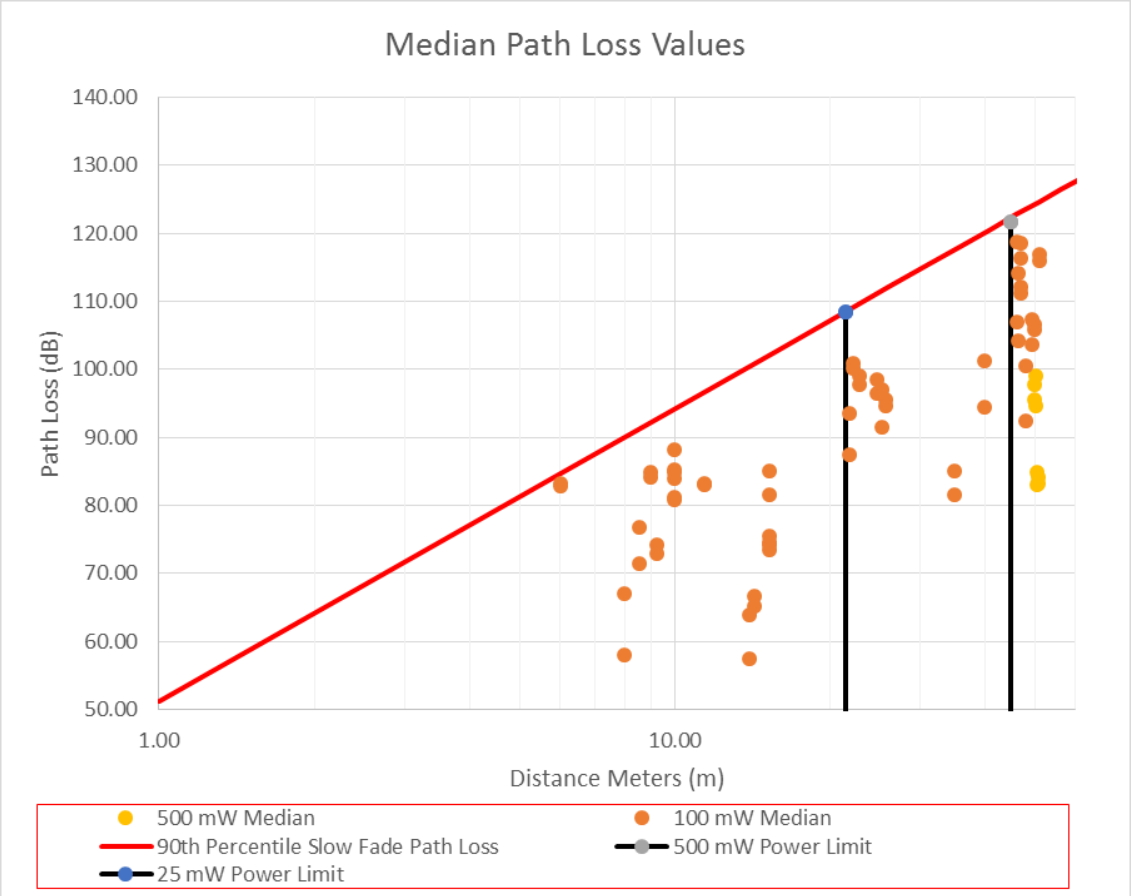


Figure 10 Median Path Loss Measurements

Path loss limit line, 25mW and 500mW power limits on the chart in Figure 10 are derived from the summary of all the data collected on all sites. Details of how these limits are derived and their formulation is contained in the final summary report, to which this document is an Appendix.

An observation can be made in that all values fall within the limits of collated data for all sites. Approximately 90% of all measured median values are within the 25 mW path loss value of 108dB.

Figure 11 Fast Fade Margin shows the average number of points recorded within increasing 1 dB steps from the median values for each multipath fast fading test. 90% of all values are less than 8.5 dB from the median.

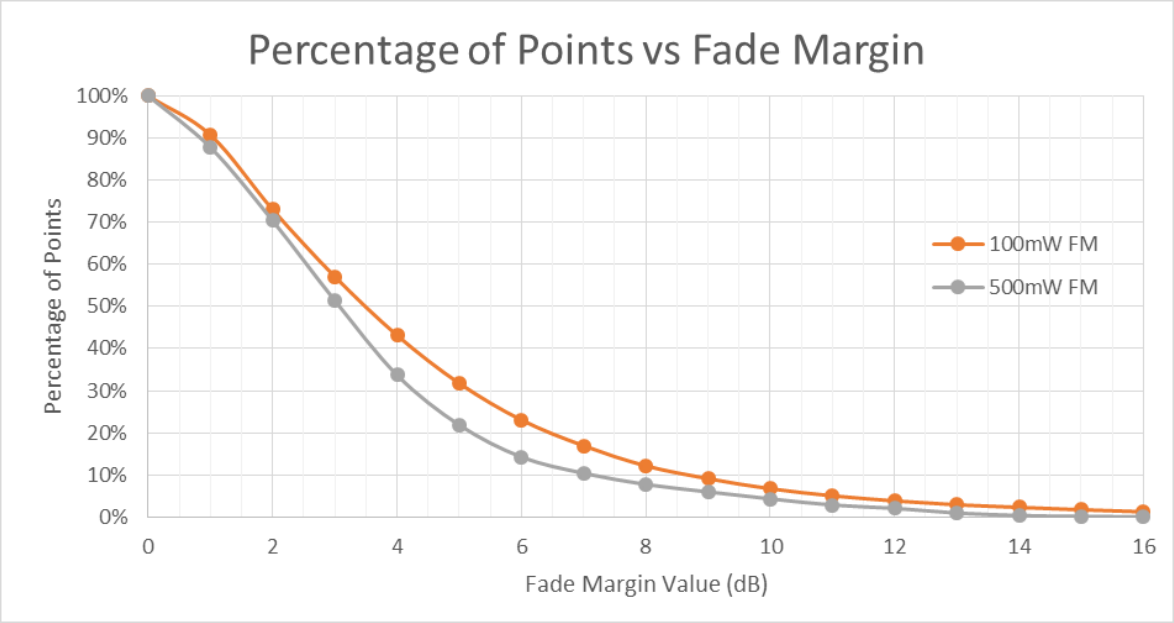


Figure 11 Fast Fade Margin

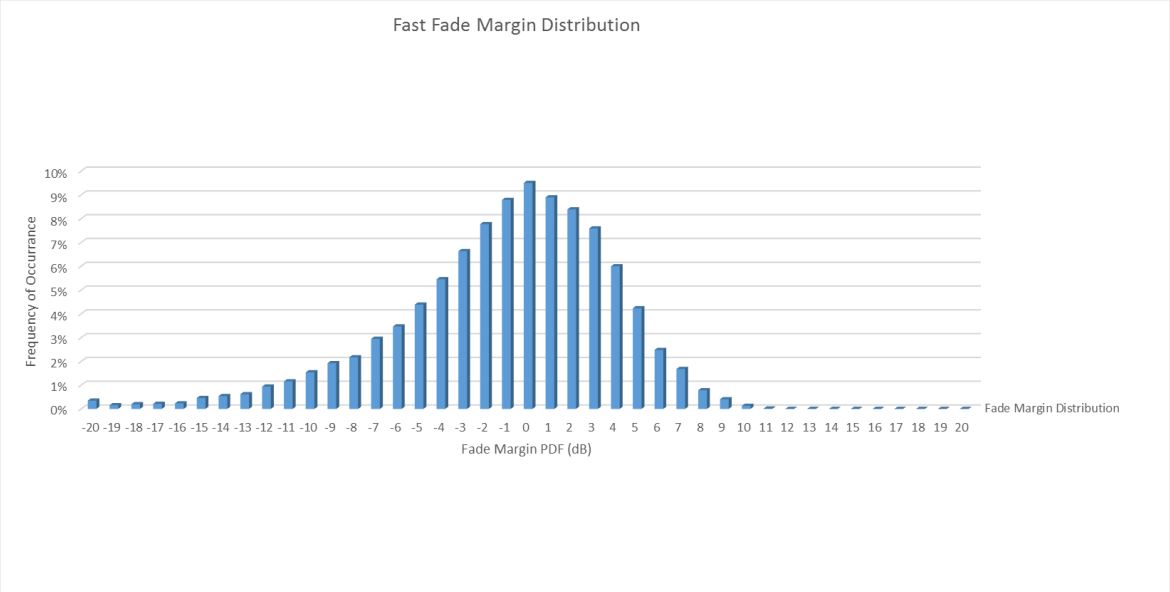
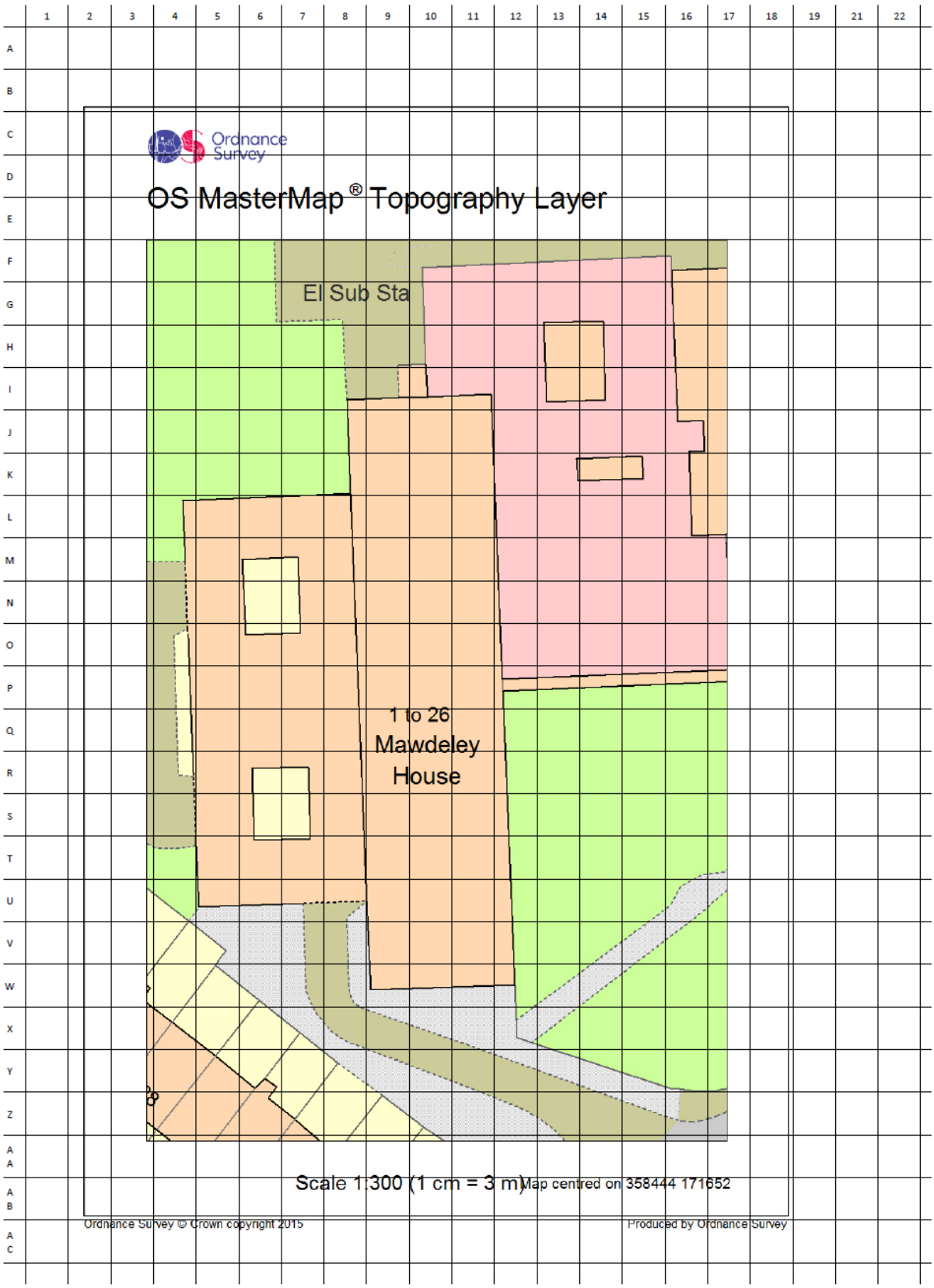


Figure 12 Fast Fading Rayleigh PDF

The fast fade margin PDF in Figure 12 shows that the building has a Rayleigh fast fading characteristic. This is explained in more detail in the main report.

5 Appendix A – Building Plan


Ordnance Survey
OS MasterMap® Topography Layer
El Sub Sta
1 to 26
Mawdeley
House
Scale 1:300 (1 cm = 3 m)
Map centred on 358444 171652
Ordnance Survey © Crown copyright 2015
Produced by Ordnance Survey

6 Appendix B – Test Locations

Team	Test	Floor	Inside/Outside	Grid Reference
-	Tx 1	Ground	Inside	V8
-	Tx 2	Ground	Outside	V9
-	Tx 3	Third	Inside	V9
1	Rx 1	Third	Inside	W10
1	Rx 2	Third	Inside	P10
1	Rx 3	Third	Inside	J10
1	Rx 4	Second	Inside	J10
1	Rx 5	Second	Inside	P10
1	Rx 6	Second	Inside	W10
1	Rx 7	Second	Inside	V11
1	Rx 7	Ground	Inside	I9
1	Rx 7	First	Inside	I9
1	Rx 7	Second	Inside	I9
1	Rx 7	Third	Inside	I9
2	Rx 1	Ground	Inside	I9
2	Rx 2	Ground	Inside	L10
2	Rx 3	Ground	Outside	W10
2	Rx 4	First	Inside	V11
2	Rx 5	First	Inside	P10
2	Rx 6	First	Inside	I10

Spectrum Engineering Services

Smart Meter RF Survey Site Report

Michon Creative

Appendix A.12

Publication Date: 19 October 2015

Version: 1.2

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Document Control

Prepared for:	Department of Energy and Climate Change
Author(s):	Dave Smith
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1.2	19/10/15	DS	Changed Figures

Contents

Section Page

1 Introduction

This document details the results and findings for the DECC smart meter RF survey of multiple dwelling units. The survey was to examine the path loss measurements within different types of multiple dwelling units.

Before reading this report appendix, the main report shall be read, as this contains explanations to the testing procedure, how the data was processed and a description to the results presentation.

On the 24 July 2015, Ofcom engineers conducted a radio propagation survey at the Multiple Dwelling Units (MDU) property described below. This survey is part of the drive by the Department of Energy and Climate Change (DECC) to rollout Smart Meters in every UK home.

As part of this program, DECC is keen to understand how radio frequency signals propagate through the different MDU.

Transmit and receive locations for the test equipment were typical locations where you may find the electricity and gas meters in these types of buildings. These locations were identified with the assistance of energy suppliers.

Table 1 Site Details

Detail	Description
Property Identifier	Michon Creative
Property Type	Converted School/commercial building
Material of Construction	Brick
Type of Exterior Wall	Brick
Property Age	Built in 19th Century
Gas Meter Location	Commercial building
Electricity Meter Location	Commercial building

Figure 1 Typical View Michon Creative Building

Radio frequency path loss measurements were conducted in the 868MHz short range device band, typically used for short range indoor applications.

The measurements were carried out in predefined locations within the building in consultation with the energy suppliers.

2 Path Loss Survey Methodology

A detailed description of the methodology can be found in a separate document.[1]

2.1 Number of Locations Tested

Ofcom tested a combined total of fourteen receive locations within the property and outside, using signals from two different transmitter locations, with a transmit power of 100 mW. The receive antenna was tested in two orientations, vertical and horizontal. A total of 56 test files were recorded for Michon Creative.

The two transmit locations in the MDU used:

1. Indoor electrical cupboard (100 mW).
2. Outside next to wall (100 mW).

2.2 Measurements Recorded

Three types of measurements were carried out during the survey:

1. An interference measurement to determine the activity in the 868MHz SRD band. This was carried out at one location, close to where one of the transmitter antennas was located.
2. Receive signal level measurements using a known transmit signal. The receive signal was measured in both the vertical and horizontal orientation, at various locations throughout the MDU and outside the MDU.

The diagram below shows the typical transmit/receive equipment set up used during the MDU testing.

[1] Ofcom – Smart Meter RF Survey Methodology, Reference: OFCOM_SES(15)_011 – 868MHz Smart_Test_Method_v2.0

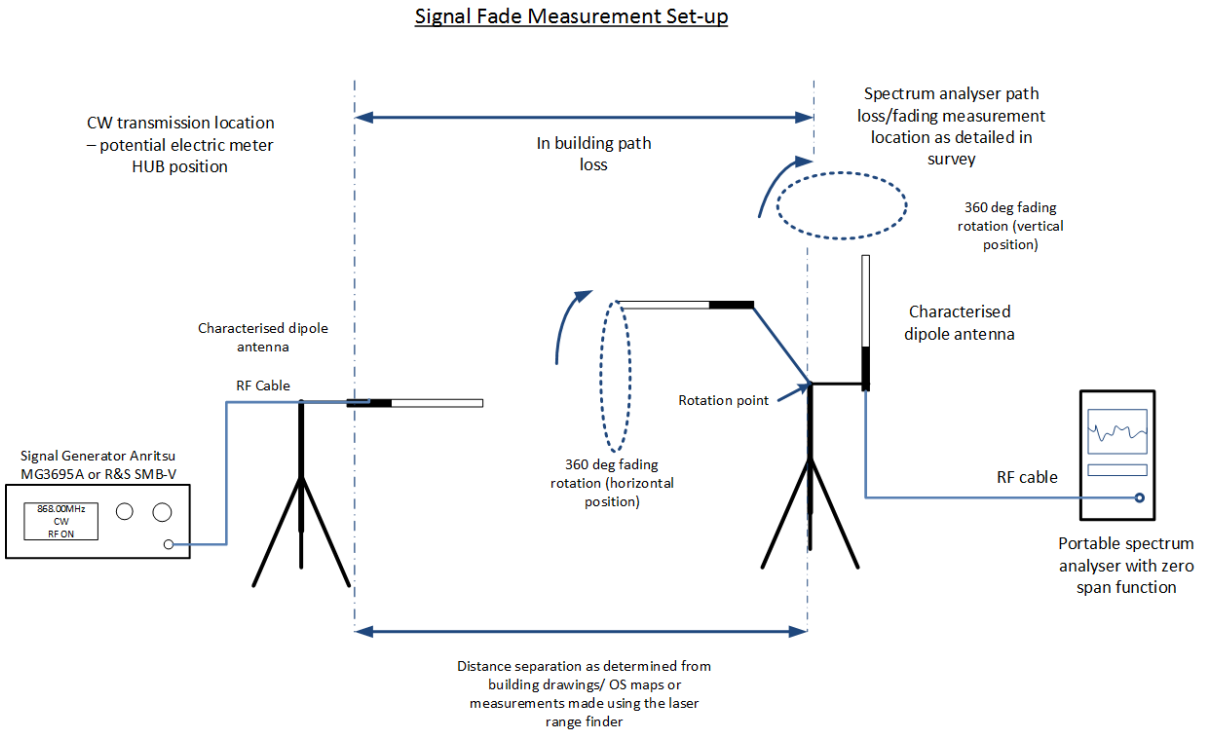


Figure 2 Equipment Set Up

2.3 Test Equipment Details

For traceability the main test equipment components used in the MDU survey are listed below with appropriate tracking details.

Table 2 Test Equipment Details

Item	Make/Model	Serial / Asset Number
Signal Generator 1	R&S SMBV100B	256587 (0471)
Signal Generator 2	Anritsu MG3695A	032006
Power Amplifier	ENI 607l-01	162
Spectrum Analyser 1	R&S FSH8	115160/028
Spectrum Analyser 2	R&S ZVH8	1155159/EJ

Table 3 Test Antenna Details

Item	Make/Model	Serial Number	VSWR
Tx Antenna 1	Radio Structures ENF900	11911	1.43
Tx Antenna 2	Radio Structures ENF900	11883	1.51
Rx Antenna 1	Radio Structures ENF900	11910	1.42
Rx Antenna 2	Radio Structures ENF900	11882	1.62

3 Site Details

3.1 Building Plan and Test Locations

See Appendix A – Building Plan, which contains a plan of the property with a grid used to identify the test locations and contains a table which details the test locations. The grid used in Appendix A represents a 4 meter square and is scaled to the Ordnance Survey plan drawings.

3.2 Test Heights

The test heights are provided in the table below

Table 4 Test Heights

Location	Location Name	Height
Tx 1	Inside electrical cupboard	1.5 m
Tx 2	Outside next to wall	1.5 m

3.3 Photographs of Transmit Locations

Figure 3 Transmit Location 1 Electricity Cupboard

Figure 4 Outside Transmitter Location 2

3.4 Photographs of Receive Test Locations

The following photographs are of typical test locations within Michon Creative. This location is a commercial premises and is used to represent an old building converted to flats.

The figures below show typical test locations within the public areas of the flats.

Figure 5 Sample Test Location 1

Figure 6 Sample Test Location 2

Figure 7 Sample Test Location 3

4 Test Results

This section presents the processed results for the measurements taken at Michon Creative.

4.1 Test Frequencies and Powers

The following interference sweep was carried out to determine the frequencies that could be used for the subsequent testing. Figure 8 shows a sweep of the 868 MHz band and the activity in the band.

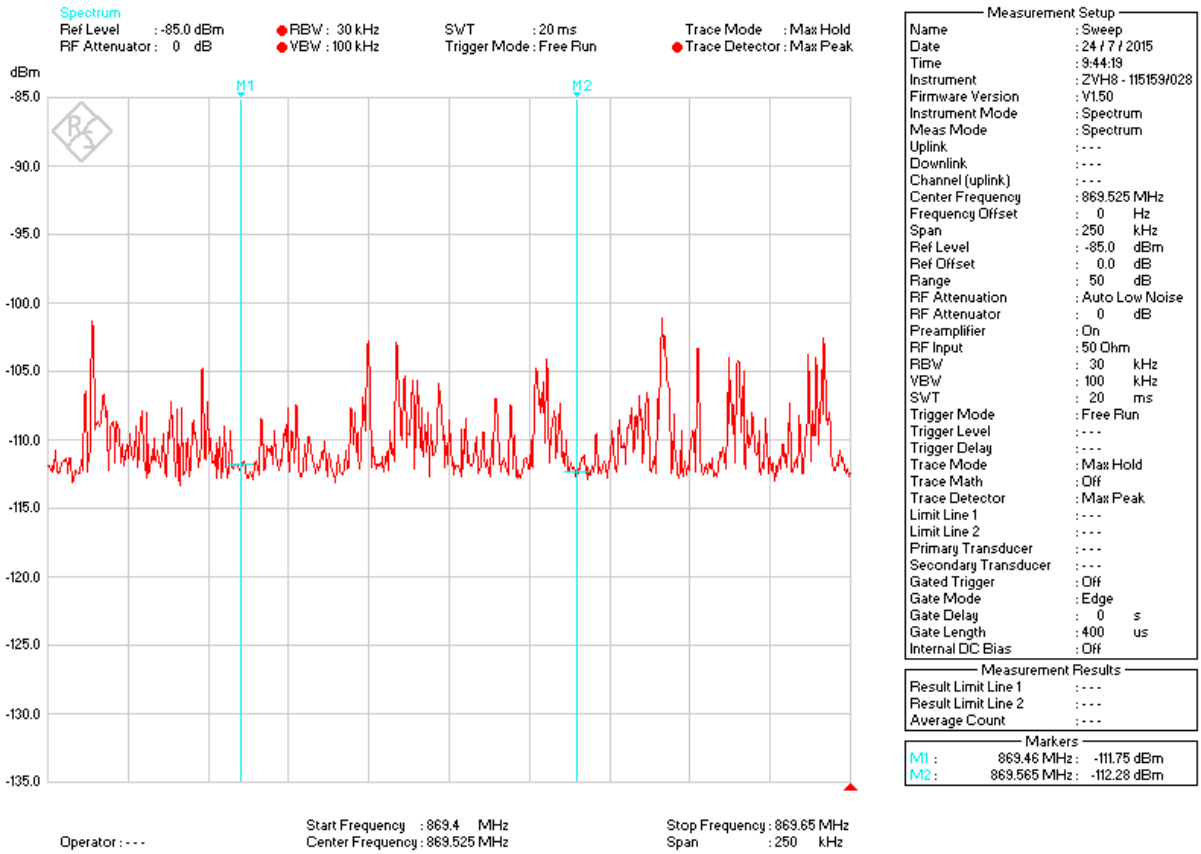


Figure 8 Scan of the 868 MHz Band

The following test frequencies and powers were used in all tests at Michon Creative.

Table 5 Transmit Frequencies and Powers

Transmitter	Frequency	Power
Tx 1	869.460 MHz	100mW
Tx 2	869.565 MHz	100mW

Figure 9 shows the median values for all the measurements taken at Michon Creative for 100 mW.

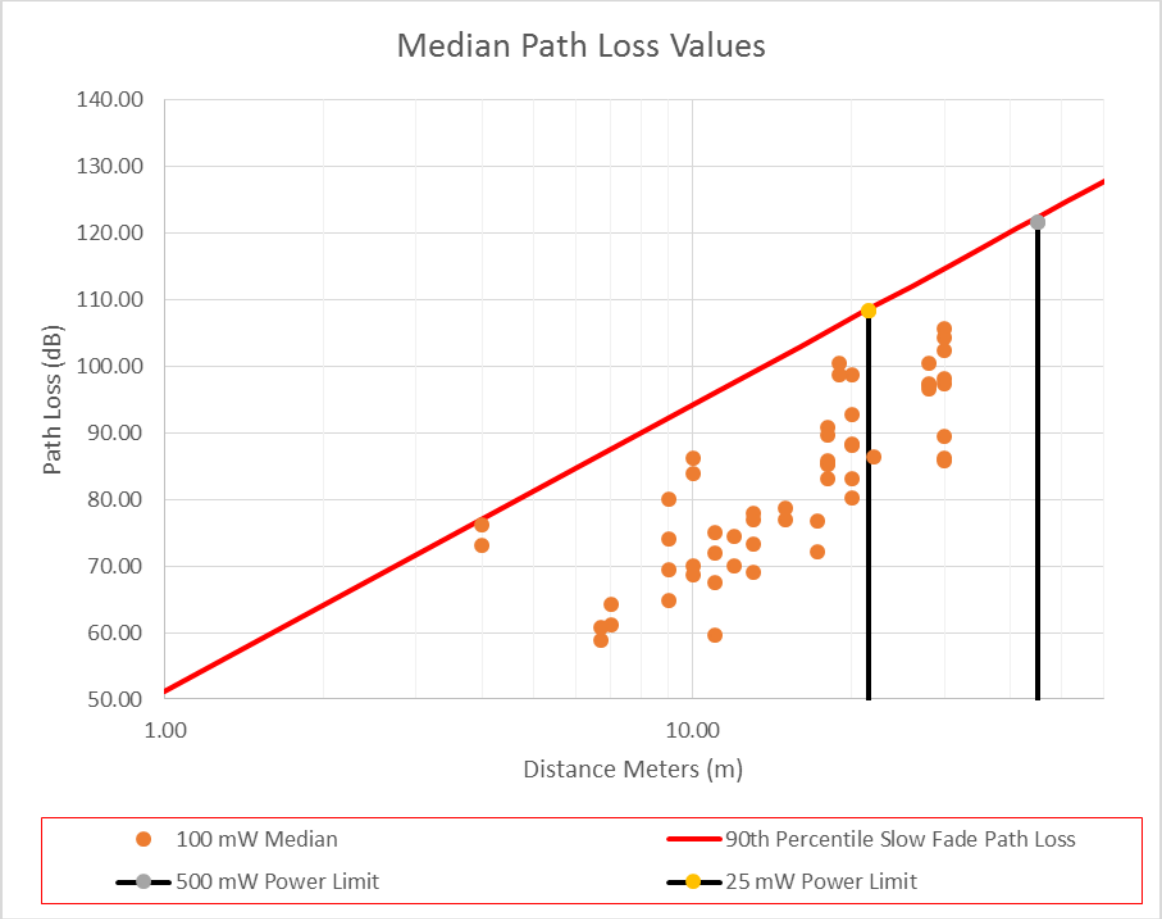


Figure 9 Median Path Loss Measurements

Path loss limit line, 25mW and 500mW power limits on the chart in Figure 9 are derived from the summary of all the data collected on all sites. Details of how these limits are derived and their formulation is contained in the final summary report, to which this document is an Appendix.

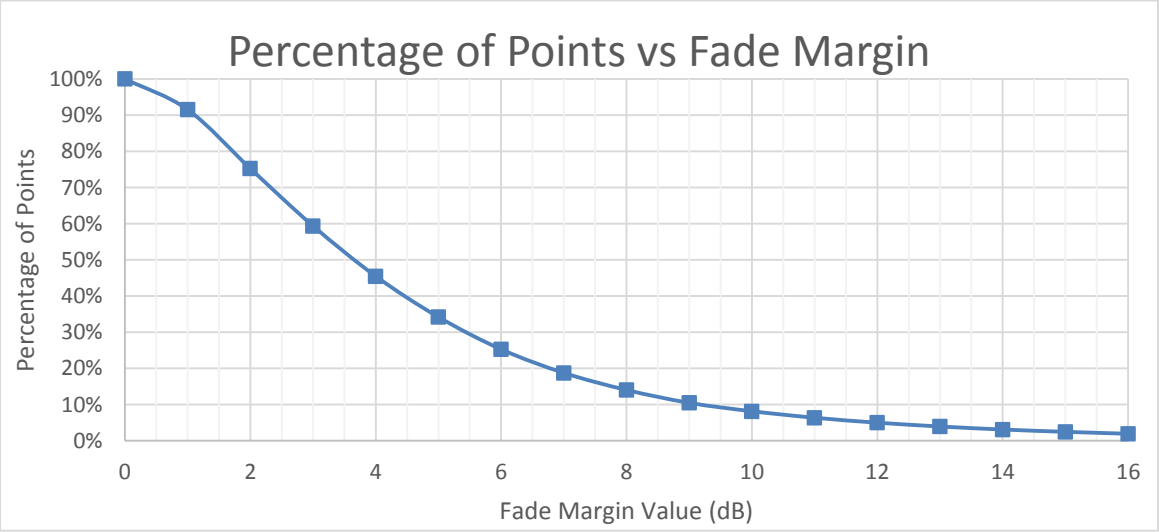


Figure 10 Fast Fade Margin

Figure 10 Fast Fade Margin shows the average number of points recorded within increasing 1 dB steps from the median values for each multipath fast fading test. 90% of all values are less than 9 dB from the median.

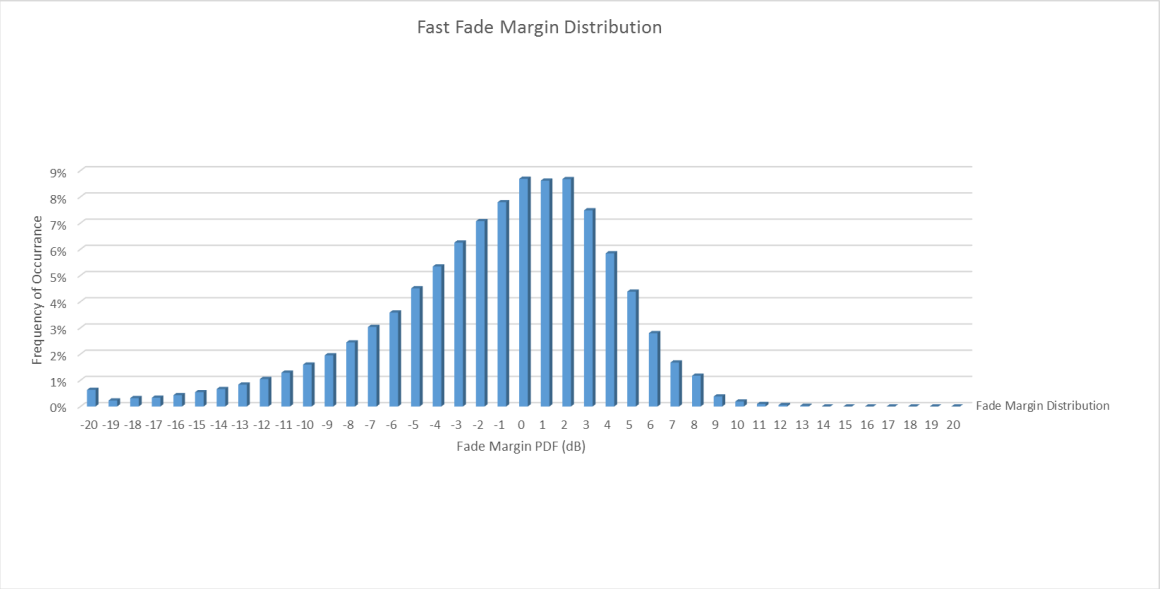
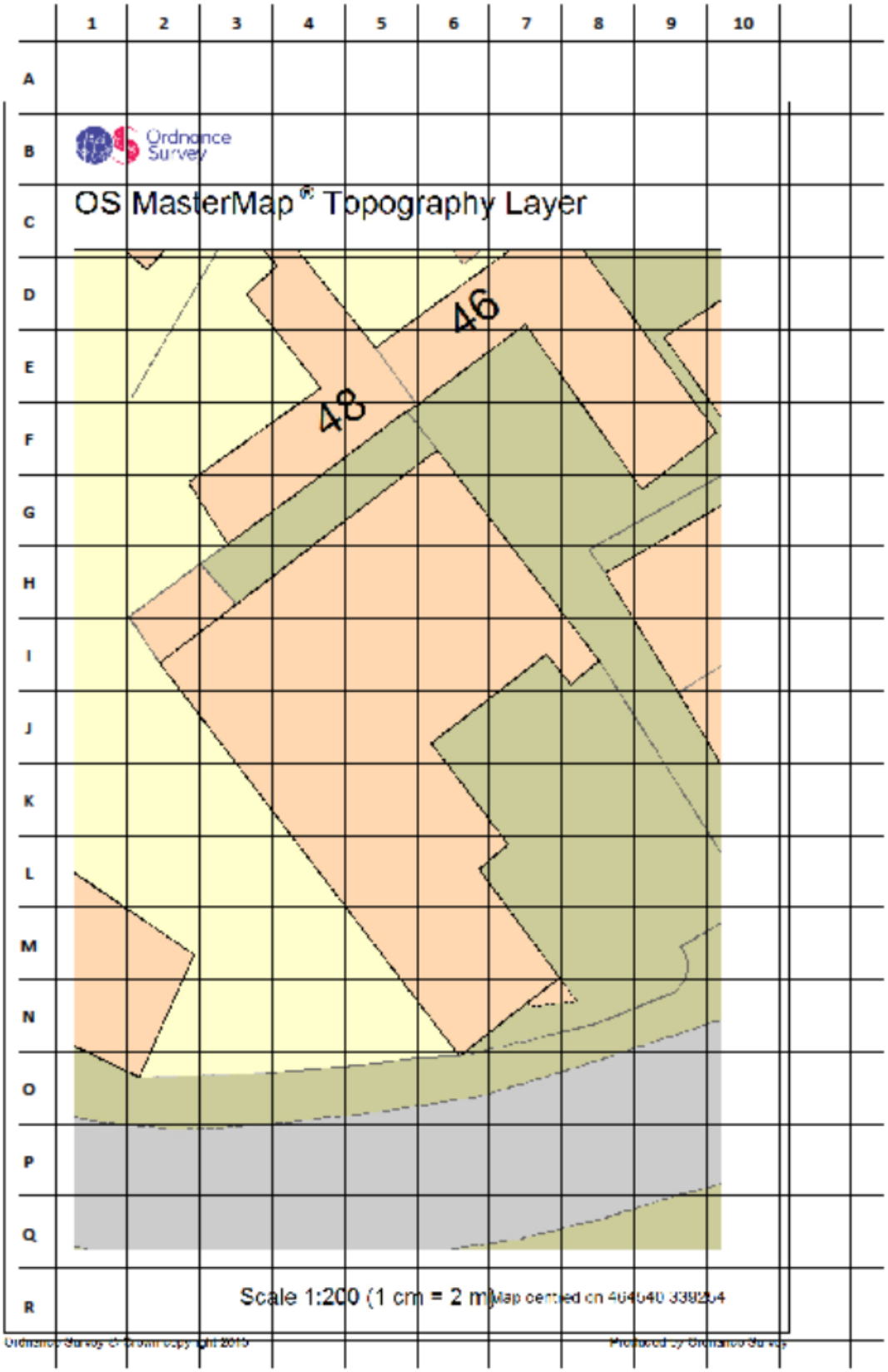


Figure 11 Fast Fading Rayleigh PDF

The fast fade margin PDF in Figure 11 shows that the building has a Rayleigh fast fading characteristic. This is explained in more detail in the main report.

5 Appendix A – Building Plan



6 Appendix B – Test Locations

Team	Test	Floor	Inside/Outside	Grid Reference
-	Tx 1	Ground	Inside	L7
-	Tx 2	Ground	Outside	M7
1	Rx 1	Ground	Outside	N6
1	Rx 2	Ground	Outside	M5
1	Rx 3	Ground	Inside	F6
1	Rx 4	Ground	Inside	H4
1	Rx 5	Ground	Inside	I2
2	Rx 1	Ground	Outside	K4
2	Rx 2	Ground	Outside	I2
2	Rx 3	Ground	Outside	H2
2	Rx 4	Ground	Outside	N7
2	Rx 5	Ground	Inside	N6
2	Rx 6	Ground	Inside	N6
2	Rx 7	Ground	Inside	J2
2	Rx 8	Ground	Inside	H2
2	Rx 9	First	Inside	K5

Spectrum Engineering Services

Smart Meter RF Survey

Norfolk House

Appendix A.13

Publication Date: 19 October 2015

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OFCOM_SES(15)010.A.13

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On the 07 July 2015, Ofcom engineers conducted a radio propagation survey at the Multiple Dwelling Units (MDU) property described below. This survey is part of the drive by the Department of Energy and Climate Change (DECC) to rollout Smart Meters in every UK home.

As part of this program, DECC is keen to understand how radio frequency signals propagate through the different MDU.

Transmit and receive locations for the test equipment were typical locations where you may find the electricity and gas meters in these types of buildings. These locations were identified with the assistance of energy suppliers.

Table 1 Site Details

Detail	Description
Property Identifier	Norfolk House
Property Type	Terrace of five contiguous blocks of flats
Material of Construction	Brick and concreate
Type of Exterior Wall	Brick
Property Age	Built in 1903
Gas Meter Location	In flats
Electricity Meter Location	In flats

Figure 1 Typical Property View

Radio frequency path loss measurements were conducted in the 868MHz short range device band, typically used for short range indoor applications.

The measurements were carried out in predefined locations within the building in consultation with the energy suppliers.

2 Path Loss Survey Methodology

A detailed description of the methodology can be found in a separate document.[1]

2.1 Number of Locations Tested

Ofcom tested a combined total of thirteen receive locations within the property and outside, using signals from two transmitter locations. The receive antenna was tested in two orientations, vertical and horizontal. A total of 69 test files were recorded for Norfolk House.

The two transmit locations used:

1. Outside entrance to flats below ground level (100 mW).
2. Under stairs cupboard on ground floor (100 mW).

2.2 Measurements Recorded

Three types of measurements were carried out during the survey:

1. An interference measurement to determine the activity in the 868MHz SRD band. This was carried out at one location, close to where one of the transmitter antennas was located.
2. Receive signal level measurements using a known transmit signal. The receive signal was measured in both the vertical and horizontal orientation, at various locations throughout the MDU and outside the MDU.

The diagram below shows the typical transmit/receive equipment set up used during the MDU testing.

[1] Ofcom – Smart Meter RF Survey Methodology, Reference: OFCOM_SES(15)_011 – 868MHz Smart_Test_Method_v2.0

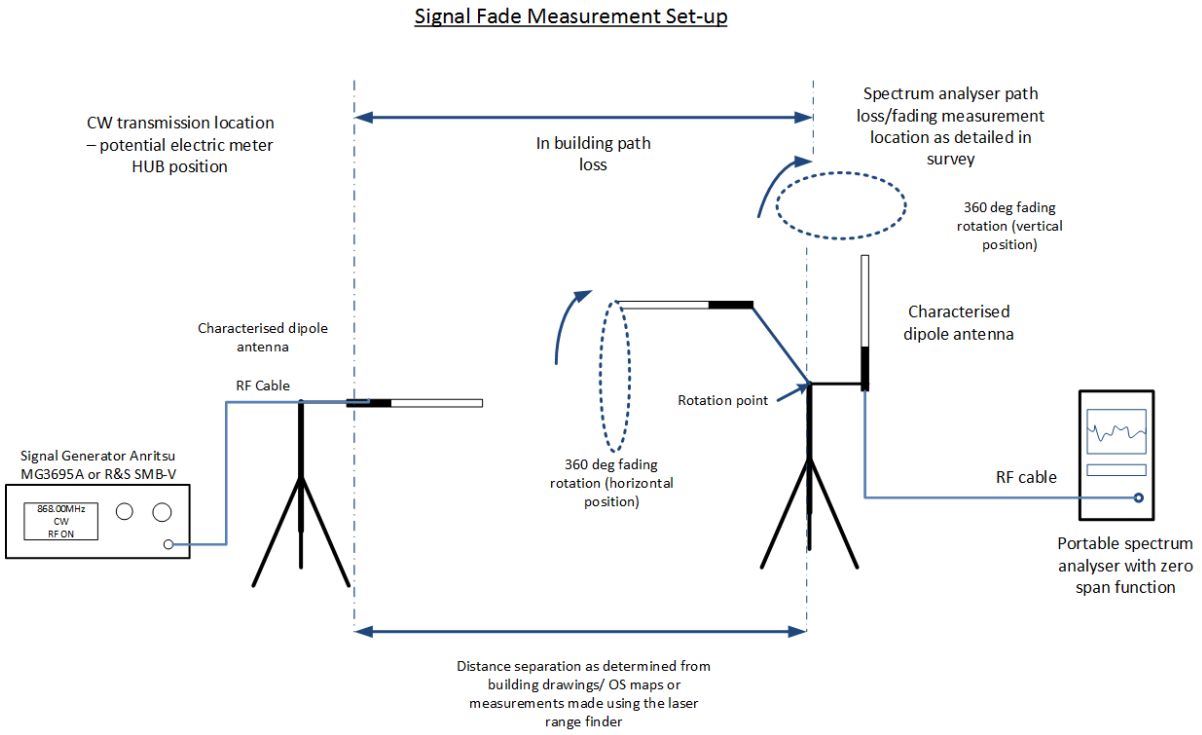

Figure 2 Equipment Set Up

2.3 Test Equipment Details

For traceability the main test equipment components used in the MDU survey are listed below with appropriate tracking details.

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Power Amplifier	ENI 607l-01	162
Spectrum Analyser 1	R&S FSH8	115160/028
Spectrum Analyser 2	R&S ZVH8	1155159/EJ

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Item	Make/Model	Serial Number	VSWR
Tx Antenna 1	Radio Structures ENF900	11911	1.43
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Rx Antenna 1	Radio Structures ENF900	11910	1.42
Rx Antenna 2	Radio Structures ENF900	11882	1.62

3 Site Details

3.1 Building Plan and Test Locations

See, Appendix A – Building Plan which contains a plan of the property with a grid used to identify the test locations and Appendix B – Test Locations contains a table which details the test locations. The grid used in Appendix A represents a 4 meter square and is scaled to the Ordnance Survey plan drawings.

3.2 Test Heights

The test heights are provided in the table below

Table 4 Test Heights

Location	Location Name	Height
Tx1	Outside Front Entrance below ground level	1.5 m
Tx2	Cupboard under stairs	1.5 m

3.3 Photographs of Transmit Locations

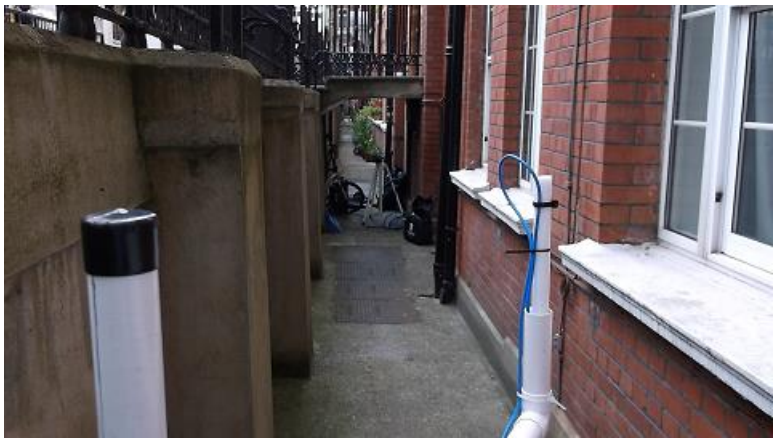

Figure 3 Transmit Location 1

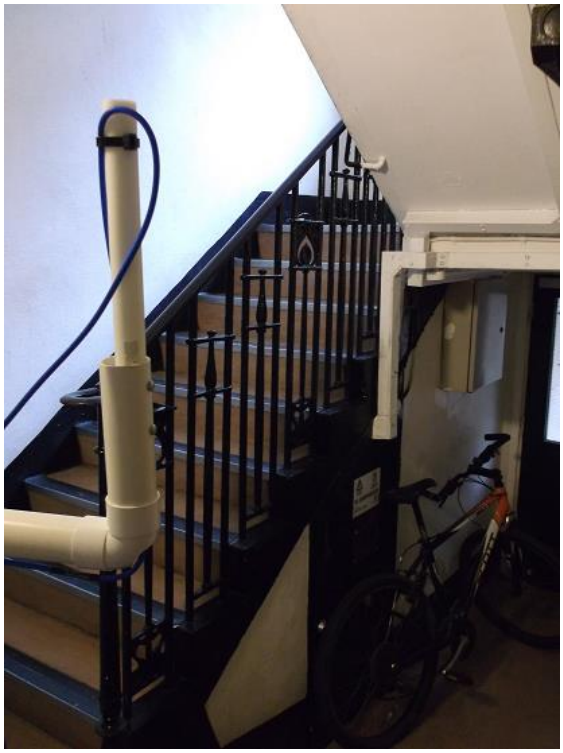

Figure 4 Day 2 Transmit Location 1

3.4 Photographs of Receive Test Locations

The following photographs are of typical test locations within Norfolk House. All flats are entered from a central stair case in each block and the blocks are repeated along the terrace.

Figure 5 Sample Test Location 1

Figure 6 Sample Test Location 2

Figure 7 Sample Test Location 3

Figure 8 Sample Test Location 4

4 Test Results

This section presents the processed results for the measurements taken at Norfolk House.

4.1 Test Frequencies and Powers

The following interference sweep was carried out to determine the frequencies that could be used for the subsequent testing. Figure 9 shows a sweep of the 868 MHz band and the activity in the band.

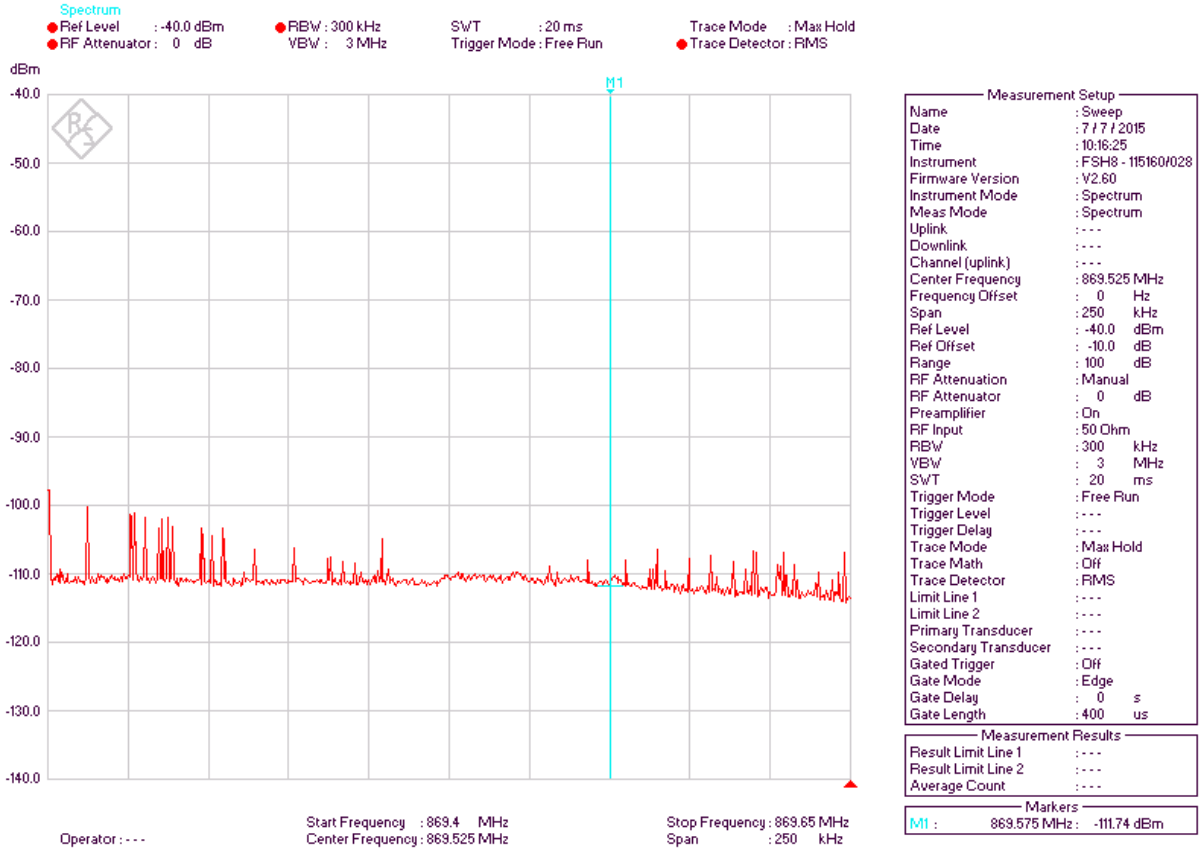

Figure 9 Scan of the 868 MHz Band

The following test frequencies and powers were used in all tests at Norfolk House.

Table 5 Transmit Frequencies and Powers

Transmitter	Frequency	Power
Tx 1	869.470 MHz	100mW
Tx 2	869.575 MHz	100mW

Figure 10 shows the median values for all the measurements taken at Norfolk House at 100 mW.

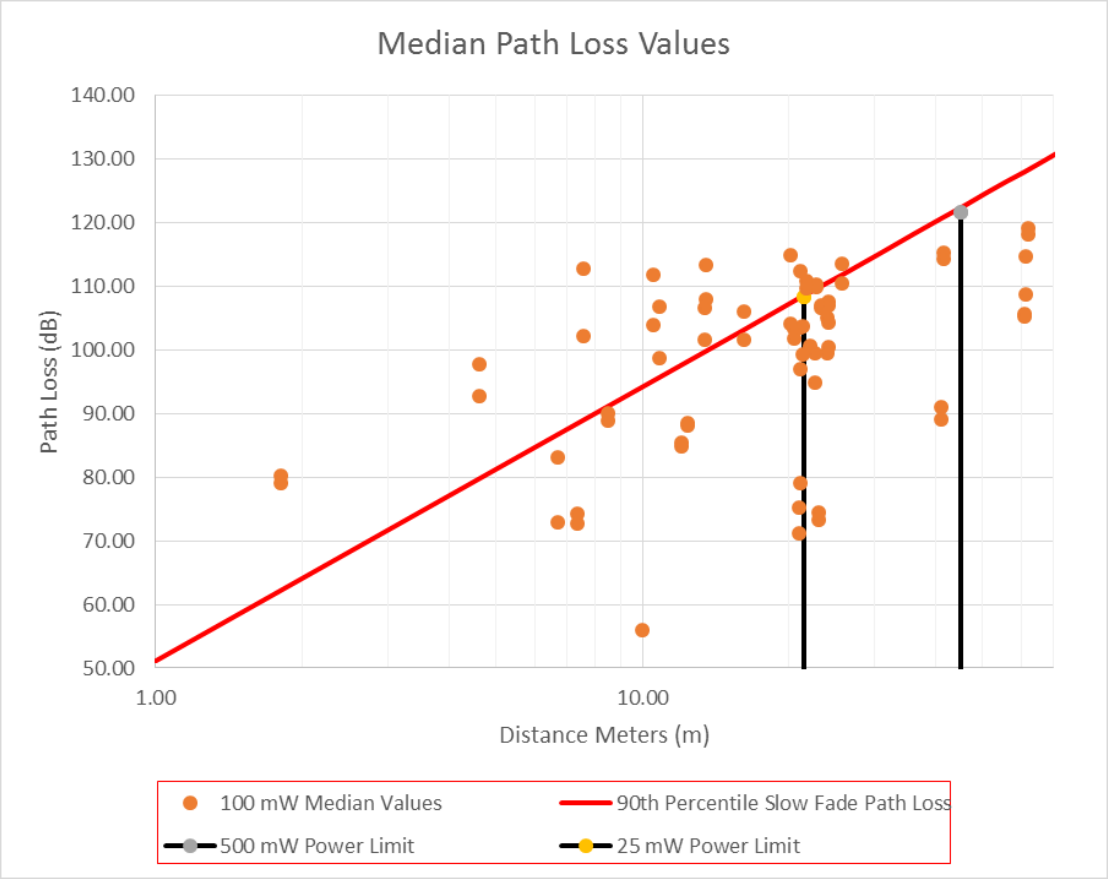

Figure 10 Median Path Loss Measurements

Path loss limit line, 25mW and 500mW power limits on the chart in Figure 10 are derived from the summary of all the data collected on all sites. Details of how these limits are derived and their formulation is contained in the final summary report, to which this document is an Appendix.

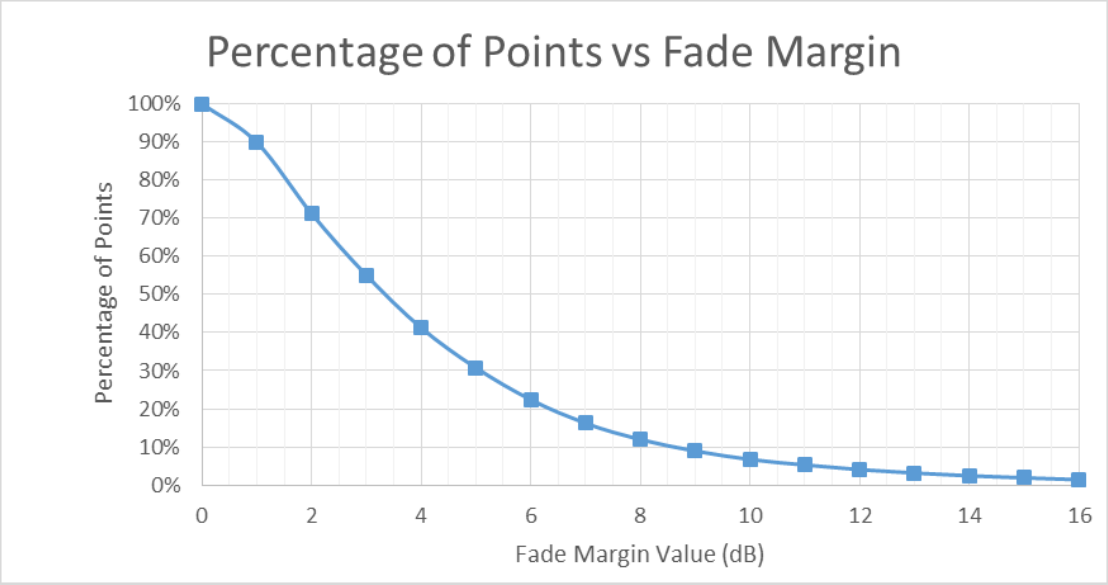

Figure 11 Fast Fade Margin

Figure 11 Fast Fade Margin shows the average number of points recorded within increasing 1 dB steps from the median values for each multipath fast fading test. 90% of all values are less than 9 dB from the median.

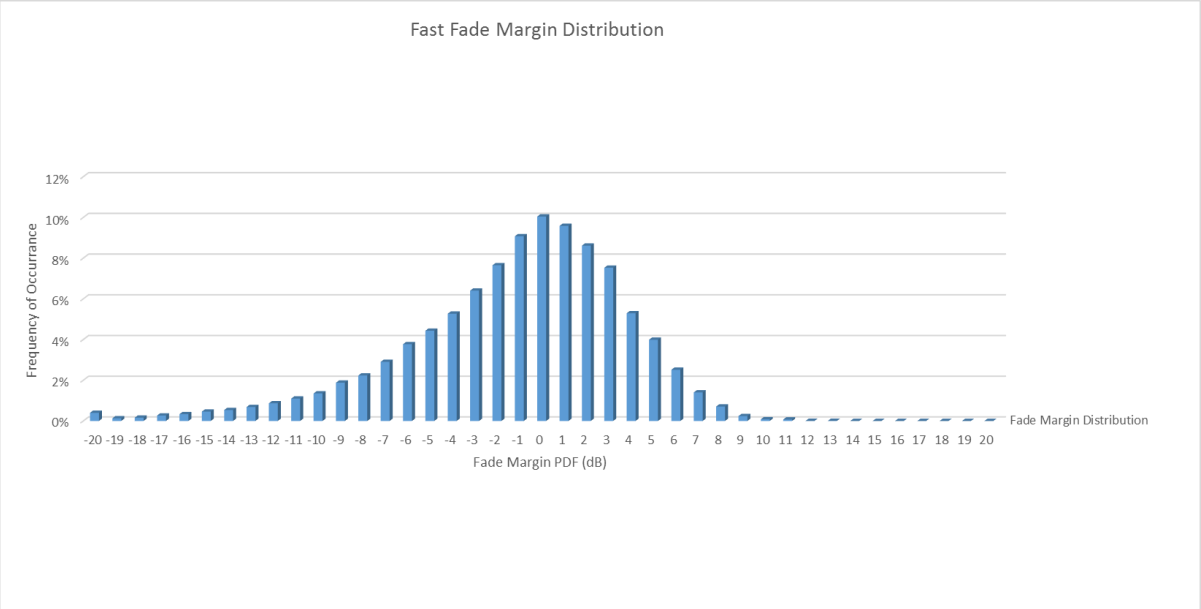

Figure 12 Fast Fading Rayleigh PDF

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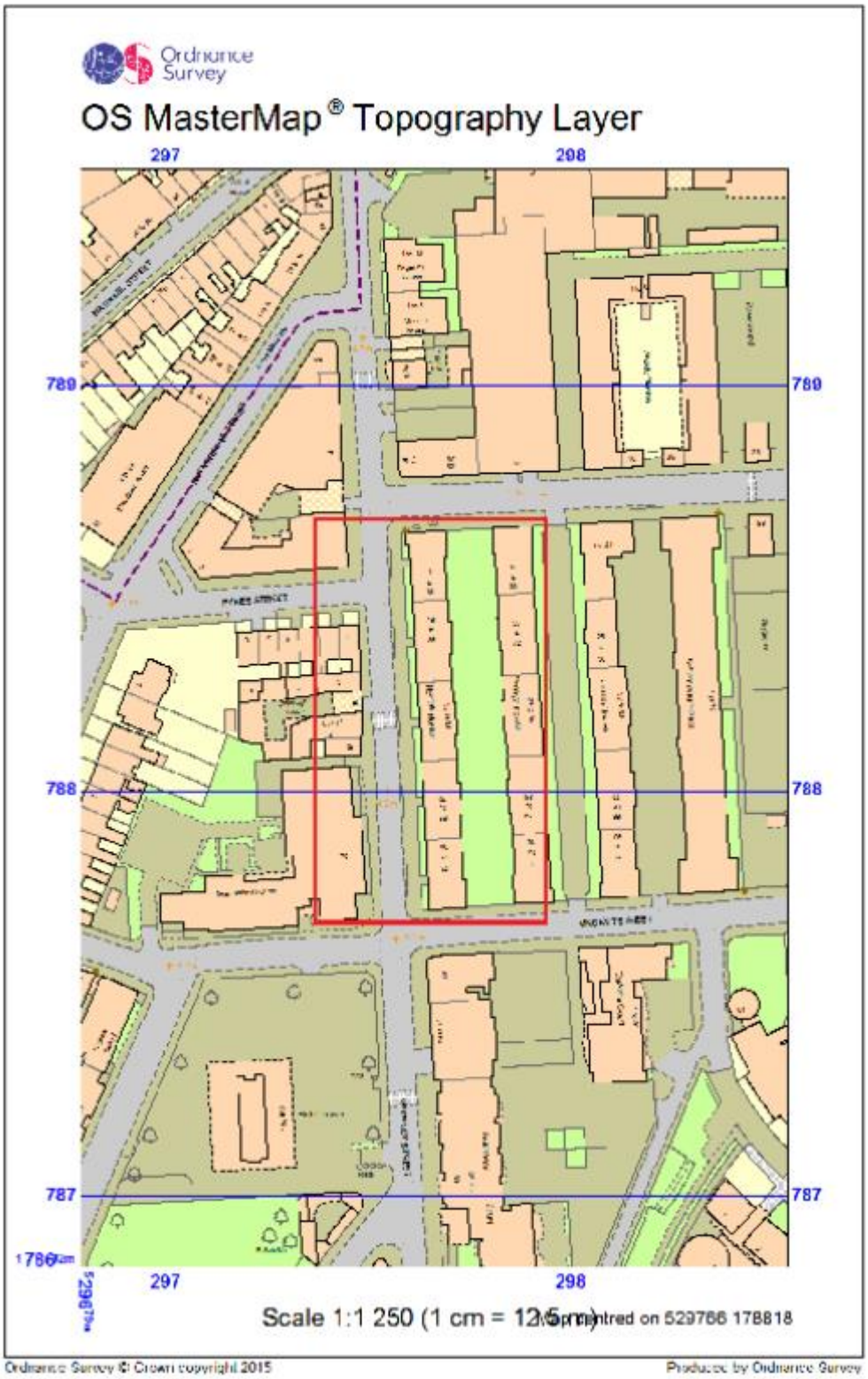
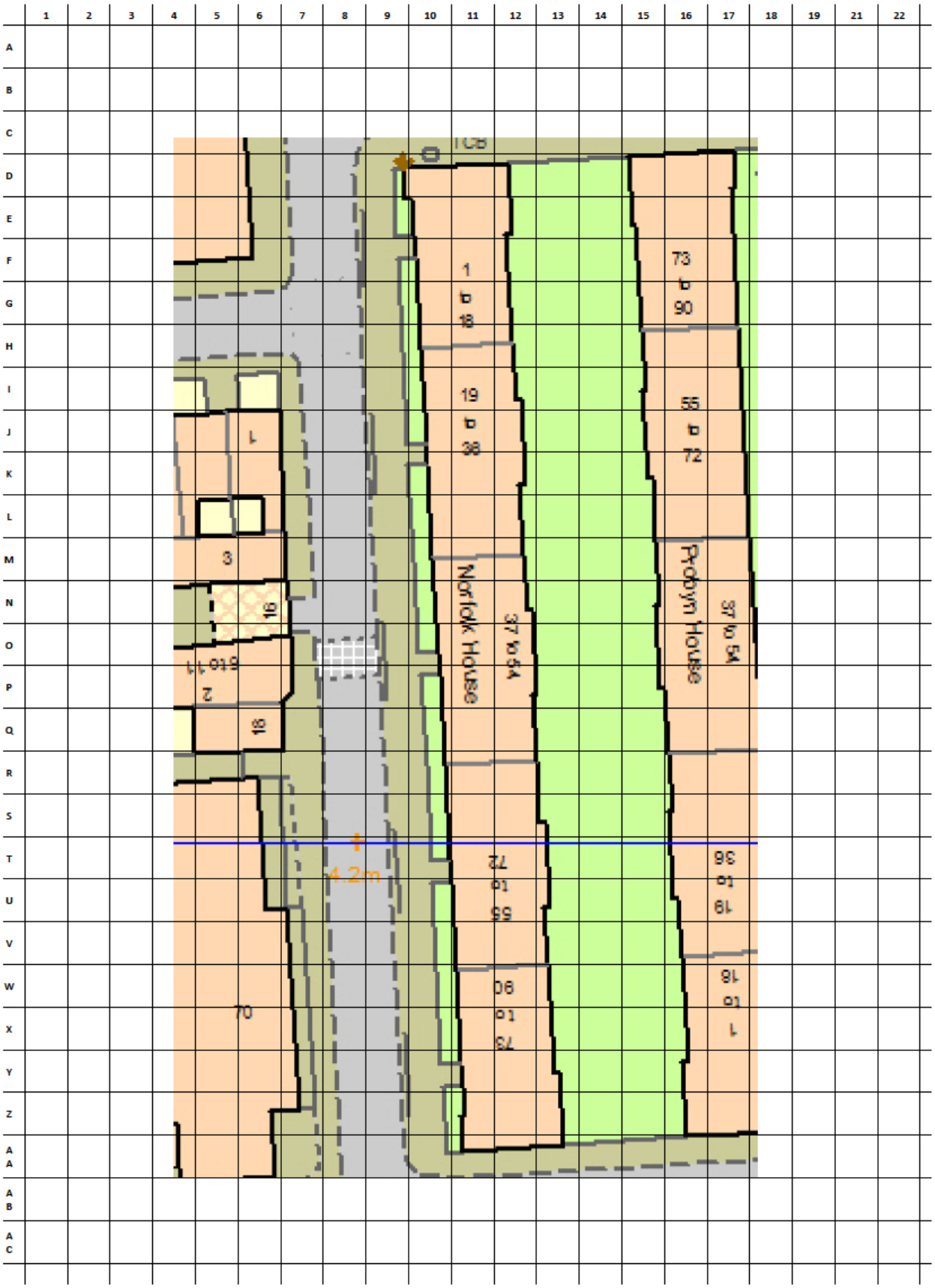
5 Appendix A – Building Plan




1 to 18
19 to 36
73 to 90
55 to 72
37 to 54
Norfolk House
Probyn House
4.2m
3
1
2
18
70

6 Appendix B – Test Locations

Team	Test	Floor	Inside/Outside	Grid Reference
-	Tx 1	Sub-ground	Outside	U10
-	Tx 2	Ground	Inside	T11
1	Rx 1	Fifth	Inside	T12
1	Rx 2	Fourth	Inside	T12
1	Rx 3	Third	Inside	T12
1	Rx 4	Second	Inside	T12
1	Rx 5	First	Inside	T12
1	Rx 6	Ground	Inside	O11
2	Rx 1	Sub-ground	Outside	W10
2	Rx 2	Sub-ground	Outside	Z11
2	Rx 3	Sub-ground	Outside	O10
2	Rx 4	Sub-ground	Outside	J10
2	Rx 5	Sub-ground	Outside	E9
2	Rx 6	Ground	Inside	Z13
2	Rx 7	Ground	Inside	T13
2	Rx 8	Ground	Inside	E12
2	Rx 9	Fifth	Inside	O11
2	Rx 10	Fourth	Inside	O11
2	Rx 11	Third	Inside	O11
2	Rx 12	Second	Inside	O11

Spectrum Engineering Services

Smart Meter RF Survey

Rossie Place

Appendix A.14

Publication Date: 19 October 2015

Version: 1.2

OFCOM_SES(15)010.A.1

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On the 29 July 2015, Ofcom engineers conducted a radio propagation survey at the Multiple Dwelling Units (MDU) property described below. This survey is part of the drive by the Department of Energy and Climate Change (DECC) to rollout Smart Meters in every UK home.

As part of this program, DECC is keen to understand how radio frequency signals propagate through the different MDU.

Transmit and receive locations for the test equipment were typical locations where you may find the electricity and gas meters in these types of buildings. These locations were identified with the assistance of energy suppliers.

Table 1 Site Details

Detail	Description
Property Identifier	Rossie Place
Property Type	Terraced block
Material of Construction	Sand Stone and Tile
Type of Exterior Wall	Sand Stone
Property Age	Built in 19th century
Gas Meter Location	In flat
Electricity Meter Location	In flat

Figure 1 Typical View Rossie Place

Radio frequency path loss measurements were conducted in the 868MHz short range device band, typically used for short range indoor applications.

The measurements were carried out in predefined locations within the building in consultation with the energy suppliers.

2 Path Loss Survey Methodology

A detailed description of the methodology can be found in a separate document.[1]

2.1 Number of Locations Tested

Ofcom tested a combined total of ten receive locations within the property and outside, using signals from two different transmitter locations, with a transmit power of 100 mW. The receive antenna was tested in two orientations, vertical and horizontal. A total of 40 test files were recorded for Rossie Place.

The two transmit locations in the MDU used:

1. Inside passageway (100 mW).
2. Outside rear door (100 mW).

2.2 Measurements Recorded

Three types of measurements were carried out during the survey:

1. An interference measurement to determine the activity in the 868MHz SRD band. This was carried out at one location, close to where one of the transmitter antennas was located.
2. Receive signal level measurements using a known transmit signal. The receive signal was measured in both the vertical and horizontal orientation, at various locations throughout the MDU and outside the MDU.

The diagram below shows the typical transmit/receive equipment set up used during the MDU testing.

[1] Ofcom – Smart Meter RF Survey Methodology, Reference: OFCOM_SES(15)_011 – 868MHz Smart_Test_Method_v2.0

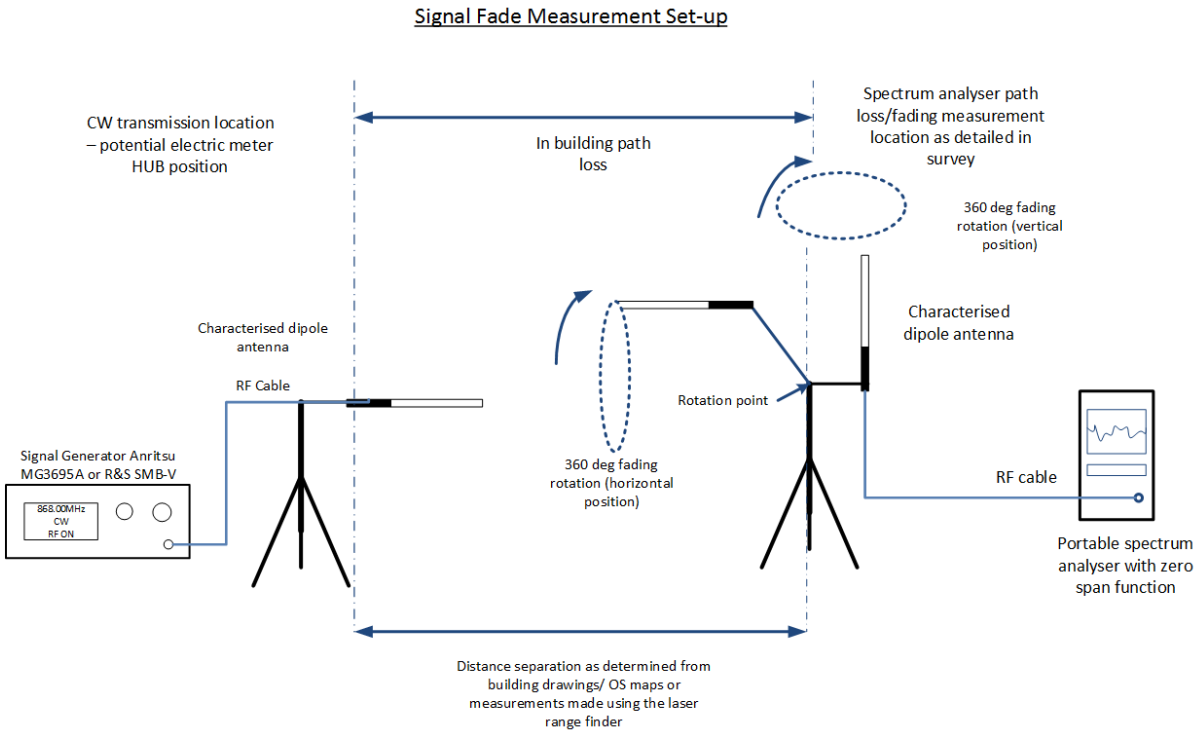


Figure 2 Equipment Set Up

2.3 Test Equipment Details

For traceability the main test equipment components used in the MDU survey are listed below with appropriate tracking details.

Table 2 Test Equipment Details

Item	Make/Model	Serial / Asset Number
Signal Generator 1	R&S SMBV100B	256587 (0471)
Signal Generator 2	Anritsu MG3695A	032006
Power Amplifier	ENI 607l-01	162
Spectrum Analyser 1	R&S FSH8	115160/028
Spectrum Analyser 2	R&S ZVH8	1155159/EJ

Table 3 Test Antenna Details

Item	Make/Model	Serial Number	VSWR
Tx Antenna 1	Radio Structures ENF900	11911	1.43
Tx Antenna 2	Radio Structures ENF900	11883	1.51
Rx Antenna 1	Radio Structures ENF900	11910	1.42
Rx Antenna 2	Radio Structures ENF900	11882	1.62

3 Site Details

3.1 Building Plan and Test Locations

See Appendix A – Building Plan which contains a plan of the property with a grid used to identify the test locations and Appendix B – Test Locations contains a table which details the test locations. The grid used in Appendix A represents a 4 meter square and is scaled to the Ordnance Survey plan drawings.

3.2 Test Heights

The test heights are provided in the table below

Table 4 Test Heights

Location	Location Name	Height
Tx 1	Inside passageway	1.5 m
Tx 2	Outside rear door	1.5 m

3.3 Photographs of Transmit Locations

Figure 3 Transmit Location 1 Indoors

Figure 4 Transmitter Location 2 Outside Rear Entrance

3.4 Photographs of Receive Test Locations

The following photographs are of typical test locations within Rossie Place. The block of flats are part of a terrace.

The figures below show typical test locations within the public areas of the flats.

Figure 5 Sample Test Location 1

Figure 6 Sample Test Location 2

Figure 7 Sample Test Location 3

4 Test Results

This section presents the processed results for the measurements taken at Rossie Place.

4.1 Test Frequencies and Powers

The following interference sweep was carried out to determine the frequencies that could be used for the subsequent testing. Figure 8 shows a sweep of the 868 MHz band and the activity in the band.

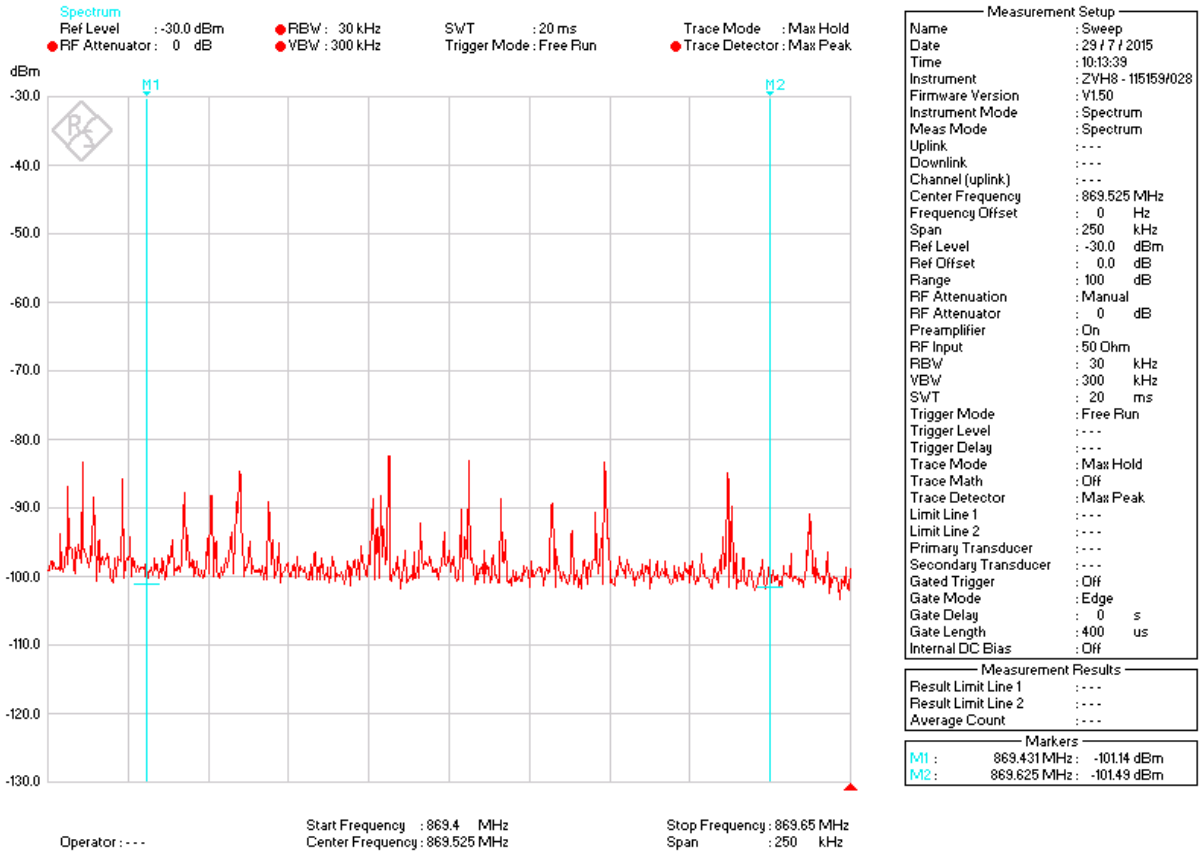


Figure 8 Scan of the 868 MHz Band

The following test frequencies and powers were used in all tests at Rossie Place.

Table 5 Transmit Frequencies and Powers

Transmitter	Frequency	Power
Tx 1	869.625 MHz	100mW
Tx 2	869.431 MHz	100mW

Figure 9 shows the median values for all the measurements taken at Rossie Place for 100 mW.

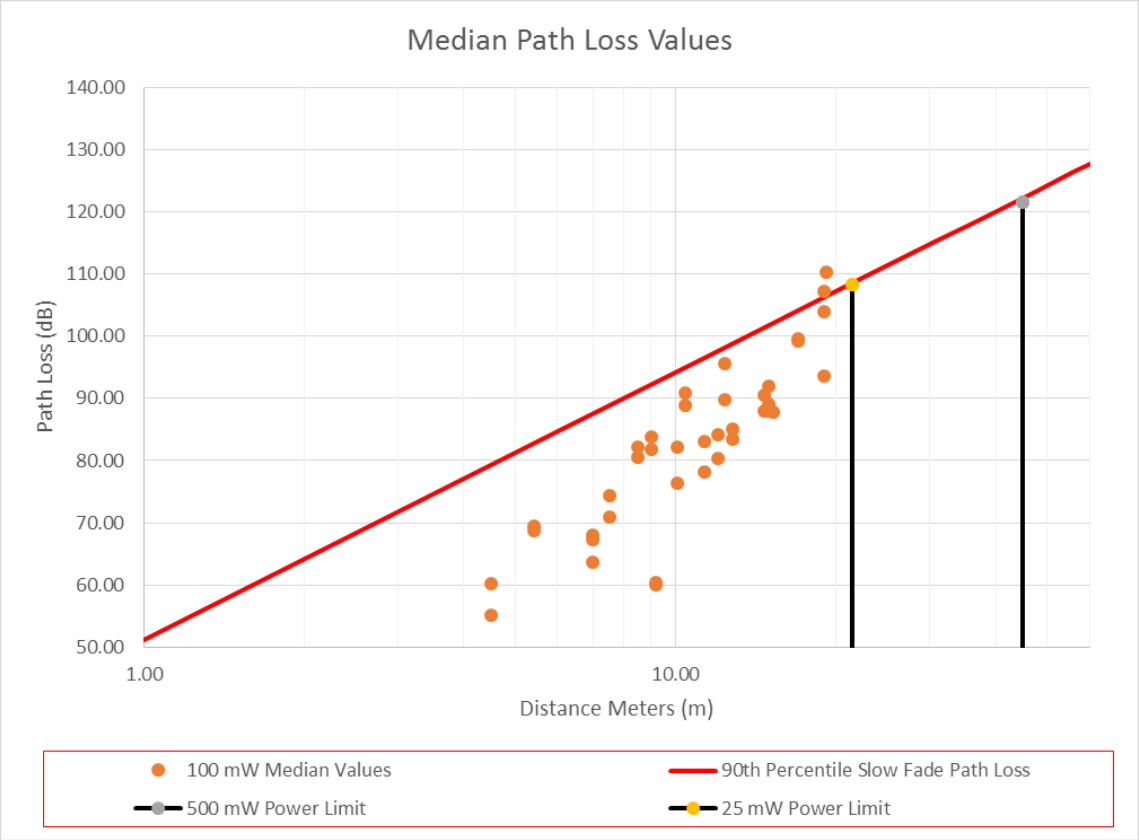


Figure 9 Median Path Loss Measurements

Path loss limit line, 25mW and 500mW power limits on the chart in Figure 9 are derived from the summary of all the data collected on all sites. Details of how these limits are derived and their formulation is contained in the final summary report, to which this document is an Appendix.

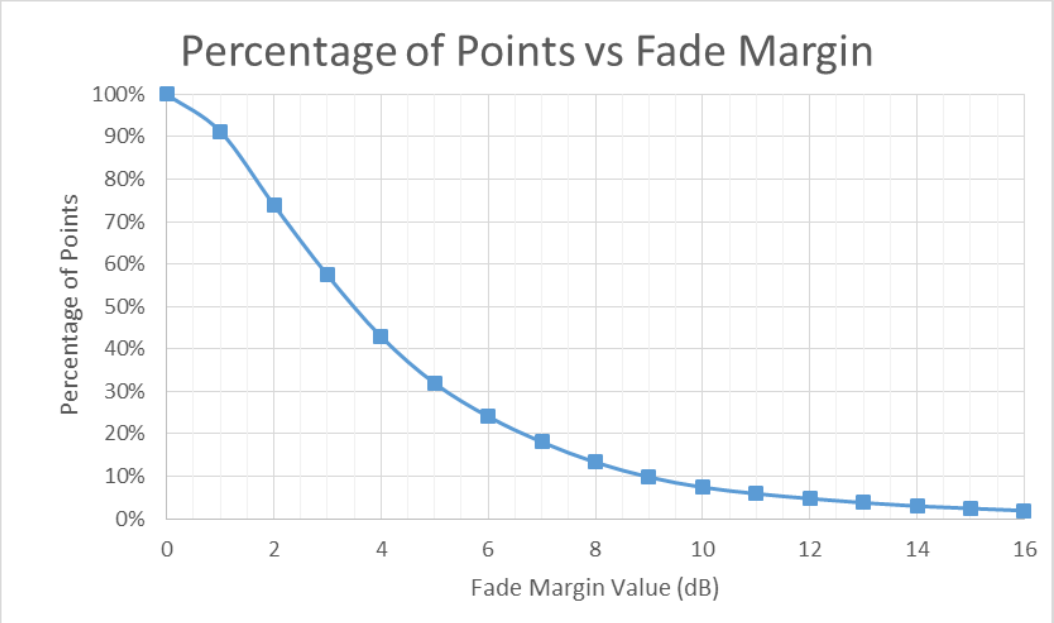


Figure 10 Fast Fade Margin

Figure 10 Fast Fade Margin shows the average number of points recorded within increasing 1 dB steps from the median values for each multipath fast fading test. 90% of all values are less than 9 dB from the median.

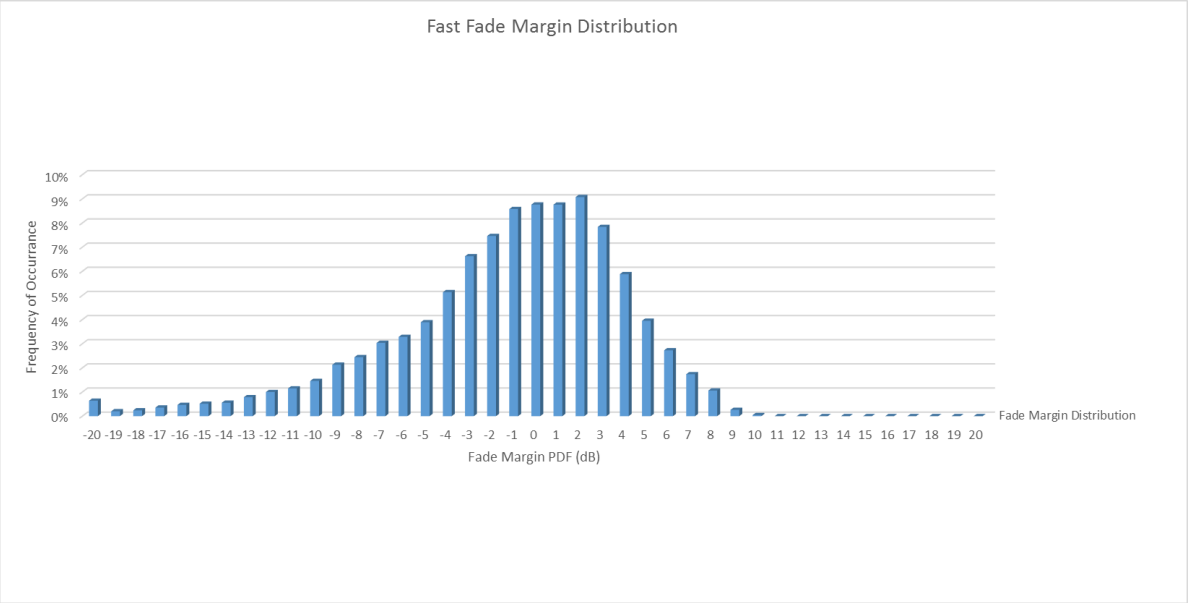
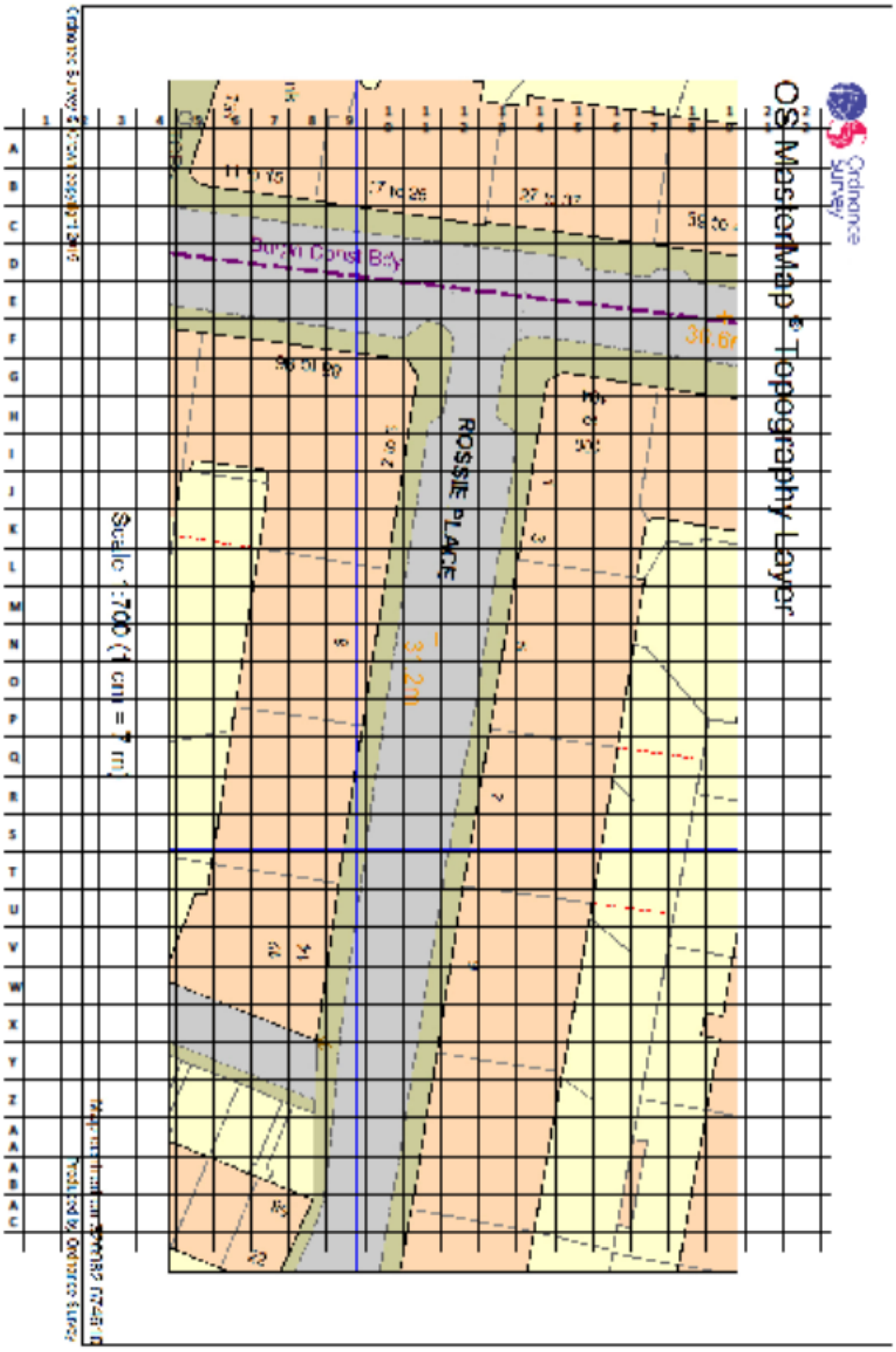


Figure 11 Fast Fading Rayleigh PDF

The fast fade margin PDF in Figure 11 shows that the building has a Rayleigh fast fading characteristic. This is explained in more detail in the main report.

5 Appendix A – Building Plan



6 Appendix B – Test Locations

Team	Test	Floor	Inside/Outside	Grid Reference
-	Tx 1	Ground	Inside	R14
-	Tx 2	Ground	Outside	R17
1	Rx 1	Ground	Inside	R13
1	Rx 2	First	Inside	R13
1	Rx 3	Second	Inside	R13
1	Rx 4	Third	Inside	R13
1	Rx 5	Ground	Outside	S12
1	Rx 6	Ground	Outside	P13
1	Rx 7	Ground	Outside	U16
1	Rx 8	Ground	Outside	R17
1	Rx 9	Forth	Inside	R13
1	Rx 10	Ground	Outside	T12

Spectrum Engineering Services

Smart Meter RF Survey Site Report

Tothill House

Appendix A.15

Publication Date: 19 October 2015

Version: 1.2

OFCOM_SES(15)010.A.15

Document Control

Prepared for:	Department of Energy and Climate Change
Author(s):	Dave Smith
Checked by:	Alistair Abington
Report Initiated:	10 Aug 2015
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Version No.:	1.2
Contact Details:	Office of Communications Baldock Radio Station, Royston Road, Baldock. SG7 6SH. Tel: 01462 428500

Change History

Version	Date	Author	Change
0.1	10/08/15	DS	Internal Draft
1.0	11/09/15	DS	Update and Issue
1.1	30/09/15	DS	Changes to Fade Margin
1.2	19/10/15	DS	Changed Figures

Contents

Section Page

1 Introduction

This document details the results and findings for the DECC smart meter RF survey of multiple dwelling units. The survey was to examine the path loss measurements within different types of multiple dwelling units.

Before reading this report appendix, the main report shall be read, as this contains explanations to the testing procedure, how the data was processed and a description to the results presentation.

On the 30 July 2015, Ofcom engineers conducted a radio propagation survey at the Multiple Dwelling Units (MDU) property described below. This survey is part of the drive by the Department of Energy and Climate Change (DECC) to rollout Smart Meters in every UK home.

As part of this program, DECC is keen to understand how radio frequency signals propagate through the different MDU.

Transmit and receive locations for the test equipment were typical locations where you may find the electricity and gas meters in these types of buildings. These locations were identified with the assistance of energy suppliers.

Table 1 Site Details

Detail	Description
Property Identifier	Tothill House, London
Property Type	Elongated Block
Material of Construction	Render and concrete
Type of Exterior Wall	Concrete
Property Age	Built in 1928
Gas Meter Location	Assumed in flats
Electricity Meter Location	Assumed in flats

Figure 1 External View Tothill House

Radio frequency path loss measurements were conducted in the 868MHz short range device band, typically used for short range indoor applications.

The measurements were carried out in predefined locations within the building in consultation with the energy suppliers.

2 Survey Methodology

A detailed description of the methodology can be found in a separate document.[1]

2.1 Number of Locations Tested

Ofcom tested a combined total of 14 receive locations within the property and outside, using a signal from a single transmitter locations. The receive antenna was tested in two orientations, vertical and horizontal. A total of 29 test files were recorded for Tothill House.

The transmit location in the MDU used the stairwell to upper floors (100 mW).

2.2 Measurements Recorded

Three types of measurements were carried out during the survey:

1. An interference measurement to determine the activity in the 868MHz SRD band. This was carried out at one location, close to where one of the transmitter antennas was located.

[1] Ofcom – Smart Meter RF Survey Methodology, Reference: OFCOM_SES(15)_011 – 868MHz Smart_Test_Method_v2.0

2. Receive signal level measurements using a known transmit signal. The receive signal was measured in both the vertical and horizontal orientation, at various locations throughout the MDU and outside the MDU.

The diagram below shows the typical transmit/receive equipment set up used during the MDU testing.

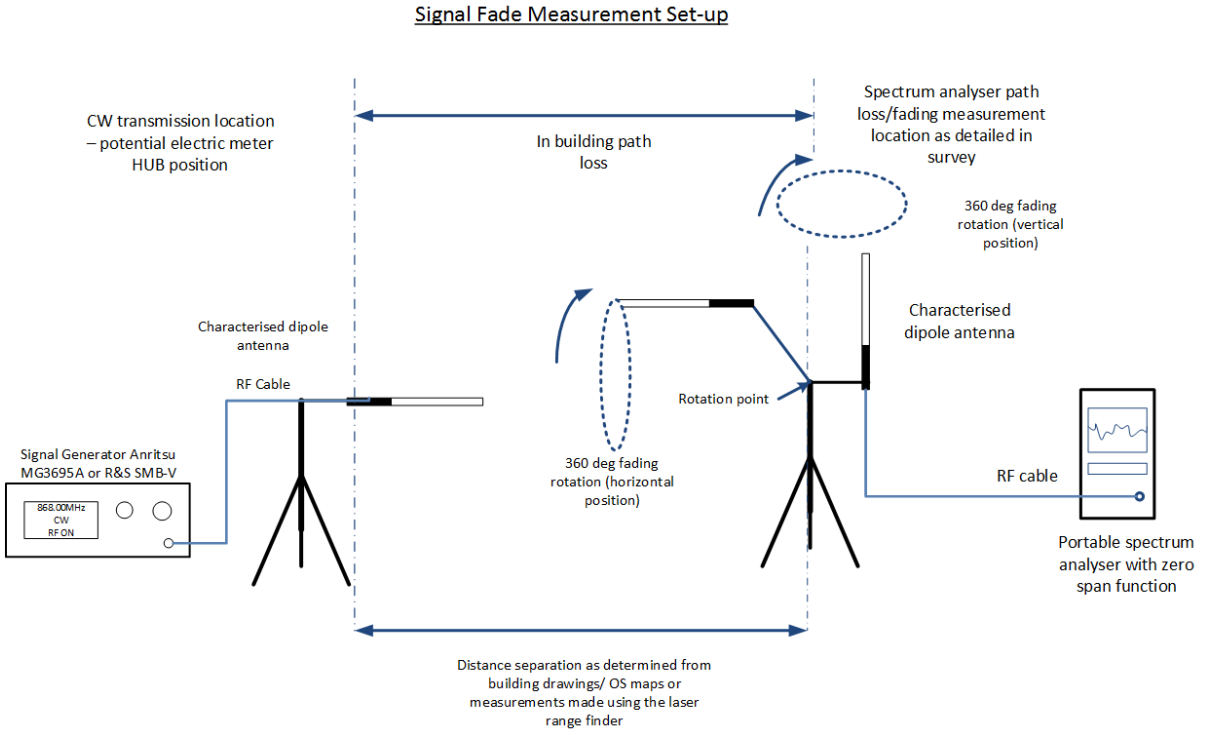

Figure 2 Equipment Set Up

2.3 Test Equipment Details

For traceability the main test equipment components used in the MDU survey are listed below with appropriate tracking details.

Table 2 Test Equipment Details

Item	Make/Model	Serial / Asset Number
Signal Generator 1	R&S SMBV100B	256587 (0471)
Signal Generator 2	Anritsu MG3695A	032006
Power Amplifier	ENI 607l-01	162
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Tx Antenna 1	Radio Structures ENF900	11911	1.43
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Rx Antenna 2	Radio Structures ENF900	11882	1.62

3 Site Details

3.1 Building Plan and Test Location

Appendix A – Building Plan which contains a plan of the property with a grid used to identify the test locations and Appendix B – Test Locations contains a table which details the test locations.

3.2 Test Heights

The test heights are provided in the table below

Table 4 Test Heights

Location	Location Name	Height
Tx1	Internal stairwell	1.5 m

3.3 Photographs of Transmit Locations

Figure 3 Transmit Location 1

3.4 Photographs of Receive Test Locations

The following photographs are of typical test locations within Tothill House. This is a large block of flats spread in the horizontal, with balcony walkways outside the front of the flats.

The balconies are accessed from a number of stairways. The figures below show typical test locations within the public areas of the flats.

Figure 4 Sample Test Location 1

Figure 5 Sample Test Location 2

Figure 6 Sample Test Location 3

4 Test Results

This section presents the processed results for the measurements taken at Tothill House.

4.1 Test Frequencies and Powers

The following interference sweep was carried out to determine the frequencies that could be used for the subsequent testing. Figure 7 shows a sweep of the 868 MHz band and the activity in the band.

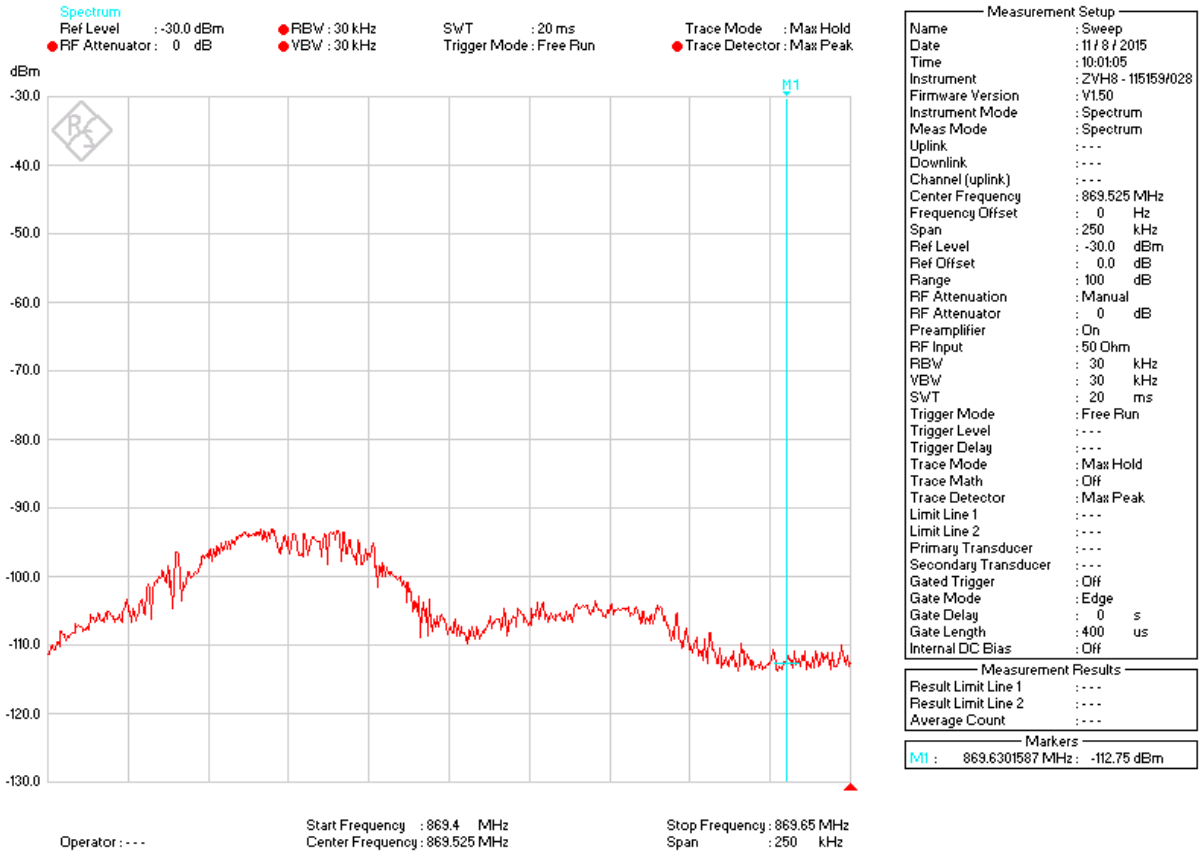

Figure 7 Scan of the 868 MHz Band

The following test frequencies and powers were used in all tests at Tothill House.

Table 5 Transmit Frequencies and Powers

Transmitter	Frequency	Power
Tx 1	869.630 MHz	100mW

Figure 8 shows the median values for all the measurements taken at Tothill House using 100 mW.

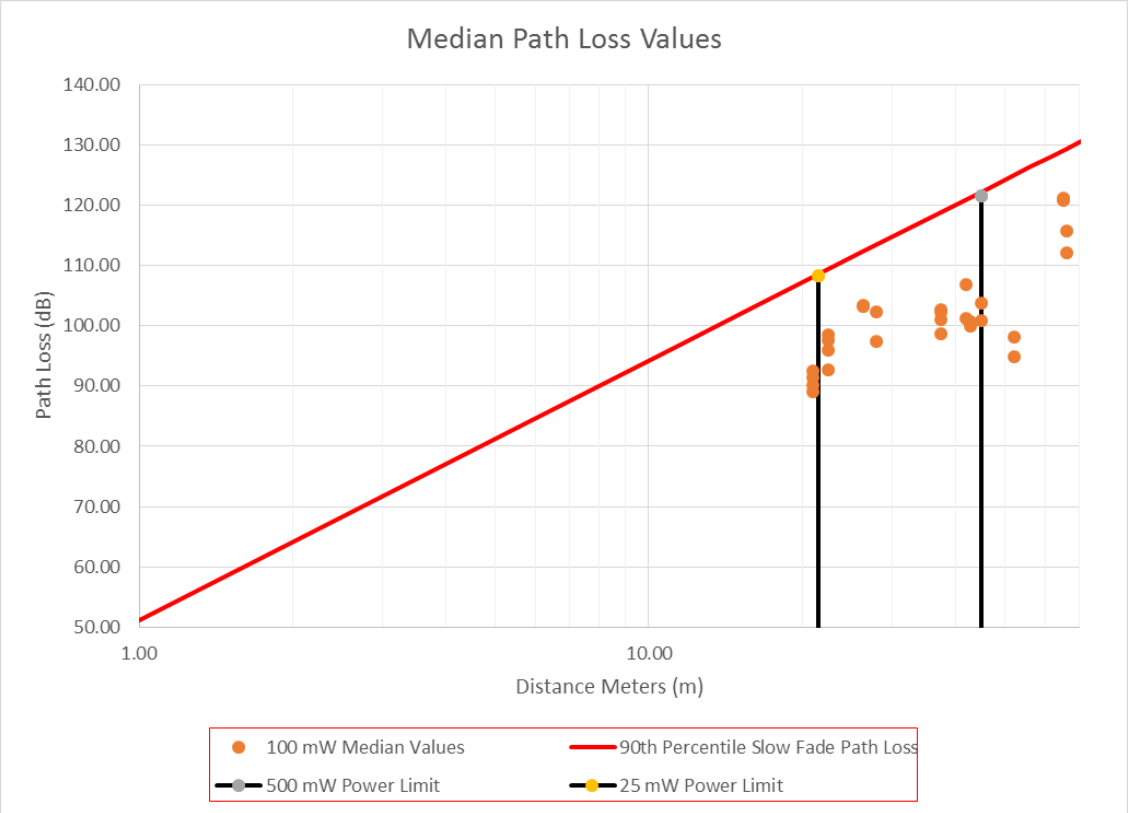

Figure 8 Median Path Loss Measurements

Path loss limit line, 25mW and 500mW power limits on the chart in Figure 8 are derived from the summary of all the data collected on all sites. Details of how these limits are derived and their formulation is contained in the final summary report, to which this document is an Appendix.

An observation can be made from Figure 8 Median Path Loss Measurements, which approximate to 90% of all measurements lying within the 25 mW maximum path loss value of 108dB.

Error! Reference source not found. Fade Margin shows the average number of points recorded within increasing 1 dB steps from the median values for each multipath fast fading test. 90% of all values are less than 9 dB from the median.

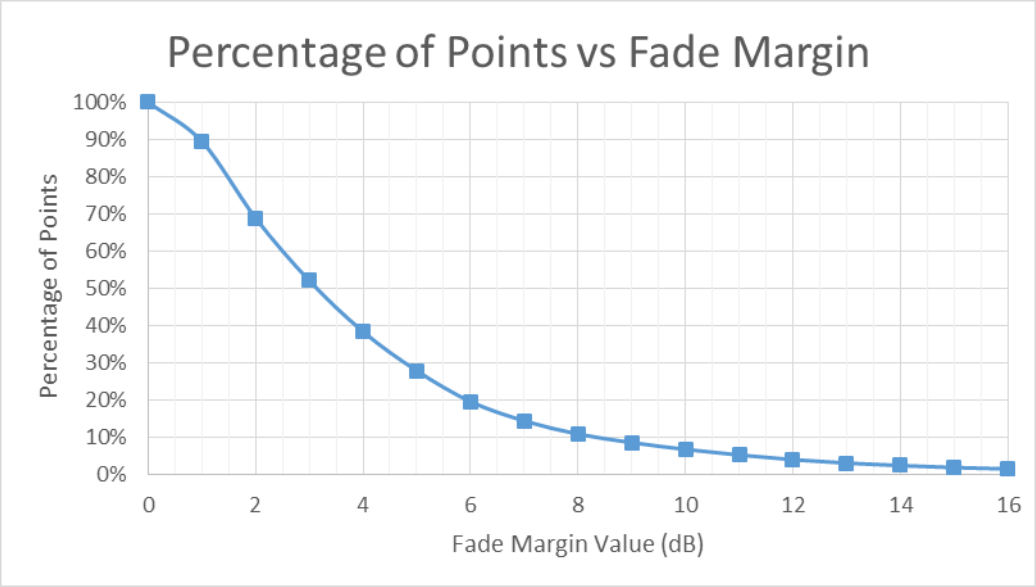

Figure 9 Fast Fade Margin

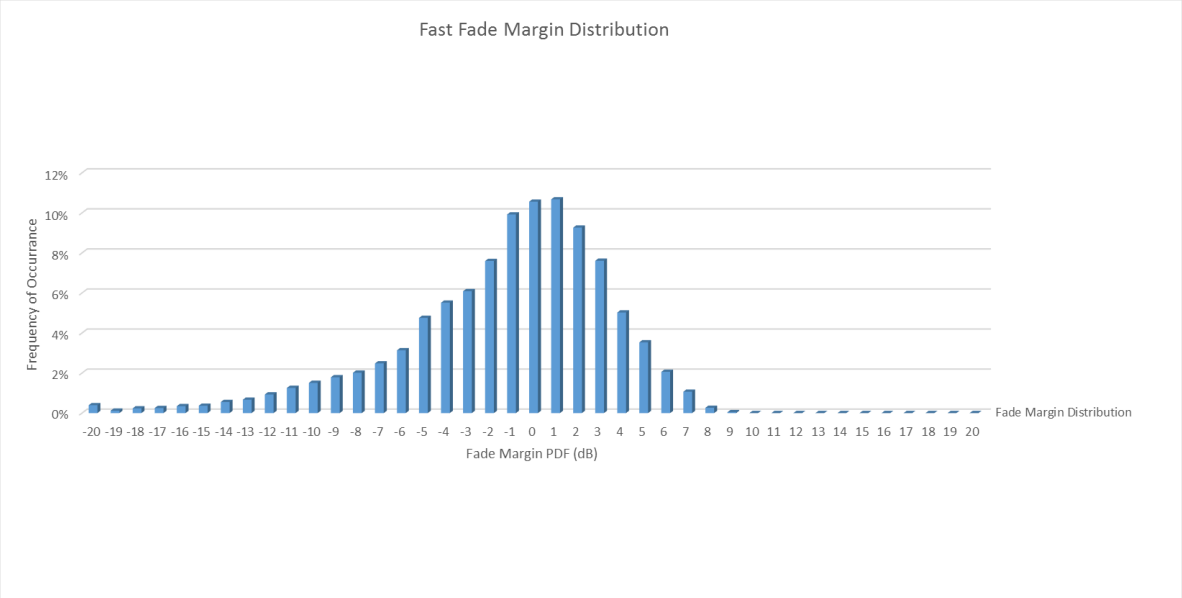

Figure 10 Fast Fading Rayleigh PDF

The fast fade margin PDF in Figure 10 shows that the building has a Rayleigh fast fading characteristic. This is explained in more detail in the main report.

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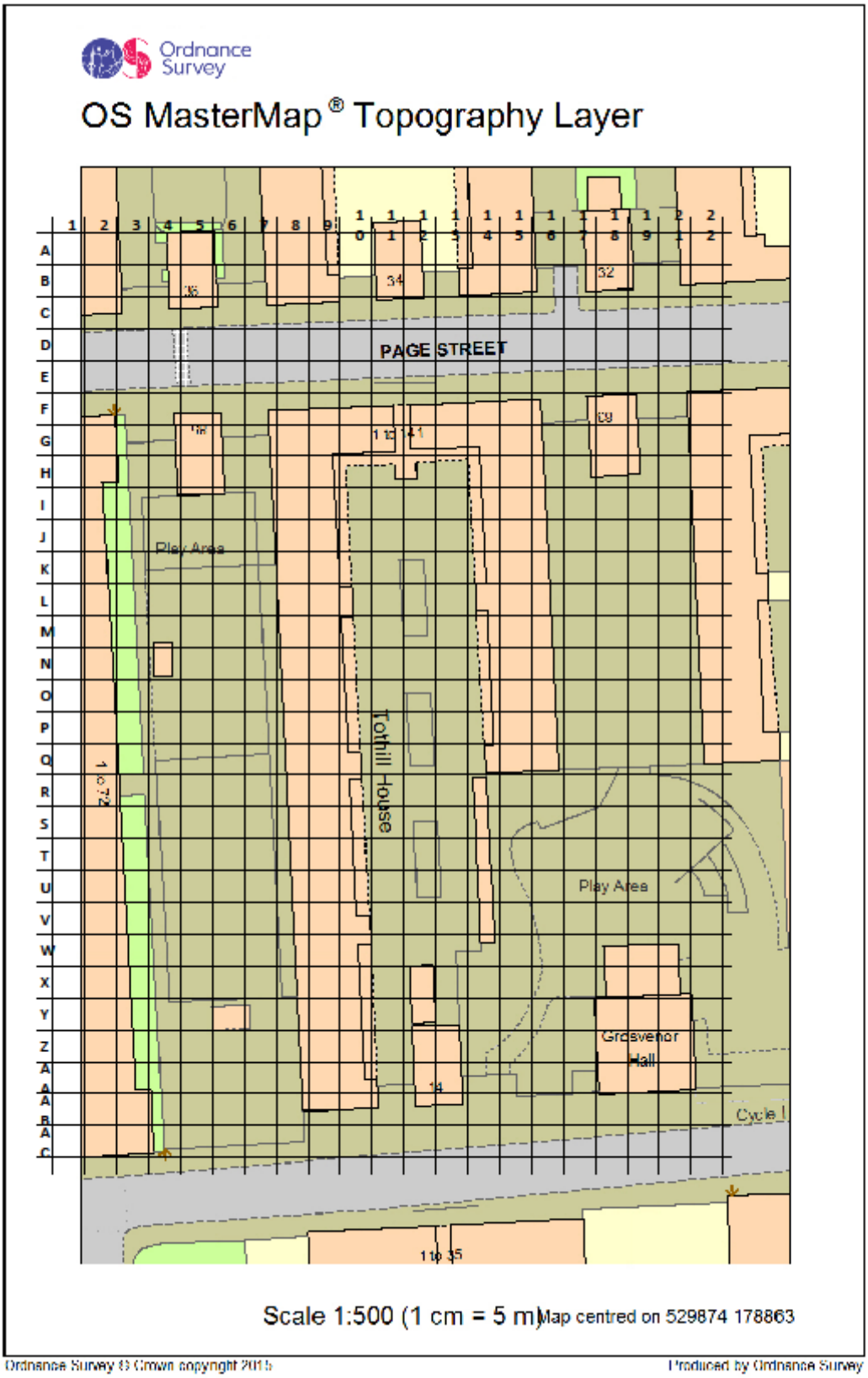
5 Appendix A – Building Plan



6 Appendix B – Test Locations

Team	Test	Floor	Inside/Outside	Grid Reference
-	Tx 1	Ground	Inside	V10
1	Rx 1	Ground	Outside	AB11
1	Rx 2	Ground	Outside	Q10
1	Rx 3	Ground	Outside	H10
1	Rx 4	Ground	Outside	AB8
1	Rx 5	Ground	Outside	F7
1	Rx 6	Ground	Outside	F10
1	Rx 7	Second	Outside	H10
1	Rx 8	Second	Outside	R10
1	Rx 9	Second	Outside	AA10
1	Rx 10	Fourth	Outside	AA10
1	Rx 11	Fourth	Outside	R10
1	Rx 12	Fourth	Outside	H10
1	Rx 12	Fifth	Outside	H10
1	Rx 12	Fifth	Outside	R10

Spectrum Engineering Services

Smart Meter RF Survey Site Report

William Bancroft

Appendix A.16

Publication Date: 19 October 2015

Version: 1.2

OFCOM_SES(15)010.A.16

Document Control

Prepared for:	Department of Energy and Climate Change
Author(s):	Dave Smith
Checked by:	Alistair Abington
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Version No.:	1.2
Contact Details:	Office of Communications Baldock Radio Station, Royston Road, Baldock. SG7 6SH. Tel: 01462 428500

Change History

Version	Date	Author	Change
0.1	10/08/15	DS	Internal Draft
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This document details the results and findings for the DECC smart meter RF survey of multiple dwelling units. The survey was to examine the path loss measurements within different types of multiple dwelling units.

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On the 23 July 2015, Ofcom engineers conducted a radio propagation survey at the Multiple Dwelling Units (MDU) property described below. This survey is part of the drive by the Department of Energy and Climate Change (DECC) to rollout Smart Meters in every UK home.

As part of this program, DECC is keen to understand how radio frequency signals propagate through the different MDU.

Transmit and receive locations for the test equipment were typical locations where you may find the electricity and gas meters in these types of buildings. These locations were identified with the assistance of energy suppliers.

Table 1 Site Details

Detail	Description
Property Identifier	William Bancroft
Property Type	Converted Building
Material of Construction	Brick and Concrete
Type of Exterior Wall	Brick
Property Age	Built in 19th century
Gas Meter Location	Basement meter room
Electricity Meter Location	Basement meter room

Figure 1 Typical View William Bancroft Building

Radio frequency path loss measurements were conducted in the 868MHz short range device band, typically used for short range indoor applications.

The measurements were carried out in predefined locations within the building in consultation with the energy suppliers.

2 Path Loss Survey Methodology

A detailed description of the methodology can be found in a separate document.[1]

2.1 Number of Locations Tested

Ofcom tested a combined total of twenty receive locations within the property and outside, using signals from two different transmitter locations, with a transmit power of 100 mW. The receive antenna was tested in two orientations, vertical and horizontal. A total of 80 test files were recorded for William Bancroft.

The two transmit locations in the MDU used:

1. Indoor basement next to gas meters (100 mW).
2. Outside next to wall (100 mW).

2.2 Measurements Recorded

Three types of measurements were carried out during the survey:

1. An interference measurement to determine the activity in the 868MHz SRD band. This was carried out at one location, close to where one of the transmitter antennas was located.
2. Receive signal level measurements using a known transmit signal. The receive signal was measured in both the vertical and horizontal orientation, at various locations throughout the MDU and outside the MDU.

The diagram below shows the typical transmit/receive equipment set up used during the MDU testing.

[1] Ofcom – Smart Meter RF Survey Methodology, Reference: OFCOM_SES(15)_011 – 868MHz Smart_Test_Method_v2.0

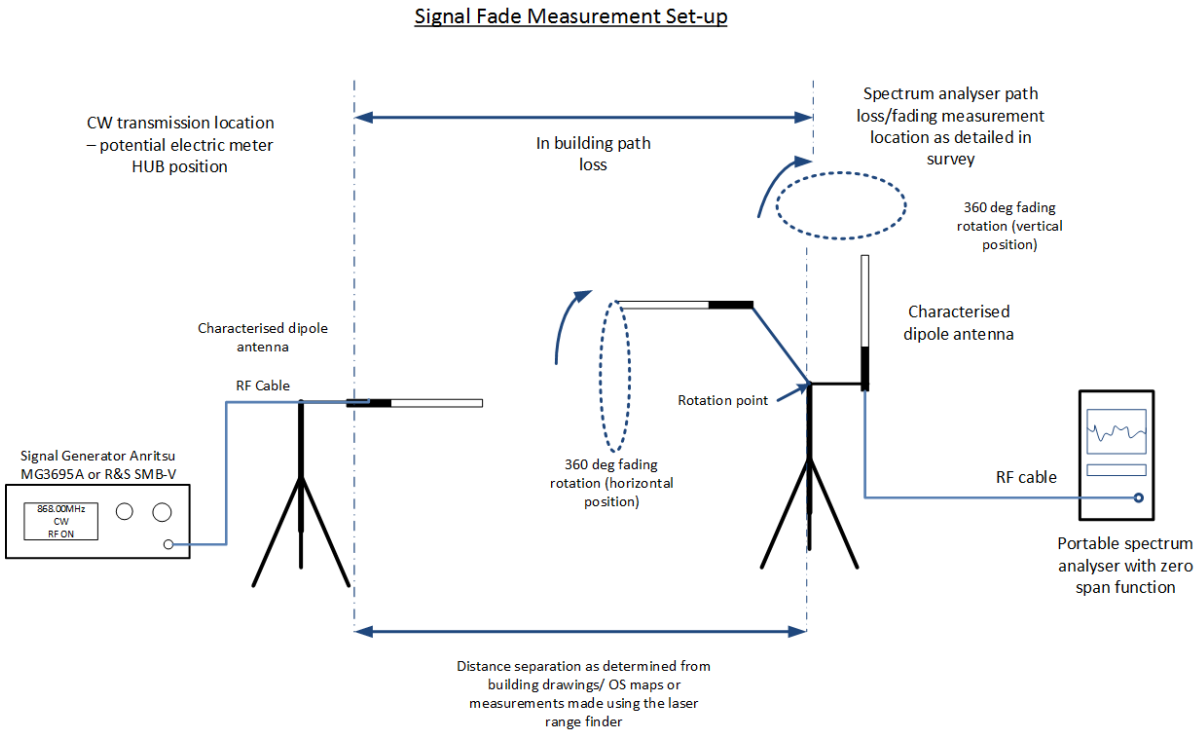

Figure 2 Equipment Set Up

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3 Site Details

3.1 Building Plan and Test Locations

See Appendix A – Building Plan, which contains a plan of the property with a grid used to identify the test locations and Appendix B – Test Locations contains a table which details the test locations. The grid used in Appendix A represents a 4 meter square and is scaled to the Ordnance Survey plan drawings.

3.2 Test Heights

The test heights are provided in the table below

Table 4 Test Heights

Location	Location Name	Height
Tx 1	Inside basement next to gas meters	1.5 m
Tx 2	Outside next to wall	1.5 m

3.3 Photographs of Transmit Locations

Figure 3 Transmit Location 1 Electricity Cupboard

Figure 4 Outside Transmitter Location 2

3.4 Photographs of Receive Test Locations

The following photographs are of typical test locations within William Bancroft. This location is an old building which has been converted to flats.

The figures below show typical test locations within the flat real estate.

Figure 5 Sample Test Location 1

Figure 6 Sample Test Location 2

Figure 7 Sample Test Location 3

4 Test Results

This section presents the processed results for the measurements taken at William Bancroft.

4.1 Test Frequencies and Powers

The following interference sweep was carried out to determine the frequencies that could be used for the subsequent testing. Figure 8 shows a sweep of the 868 MHz band and the activity in the band.

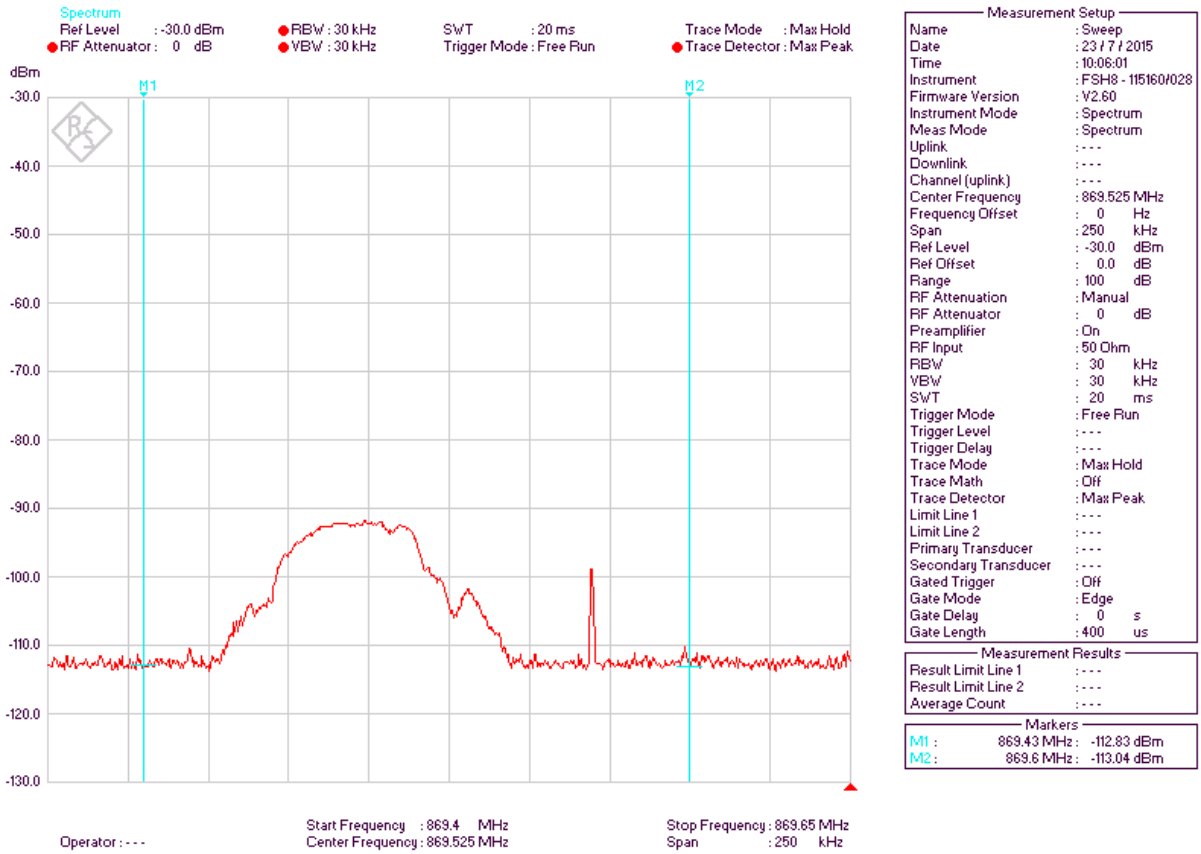

Figure 8 Scan of the 868 MHz Band

The following test frequencies and powers were used in all tests at William Bancroft.

Table 5 Transmit Frequencies and Powers

Transmitter	Frequency	Power
Tx 1	869.430 MHz	100mW
Tx 2	869.600 MHz	100mW

Figure 9 shows the median values for all the measurements taken at William Bancroft for 100 mW.

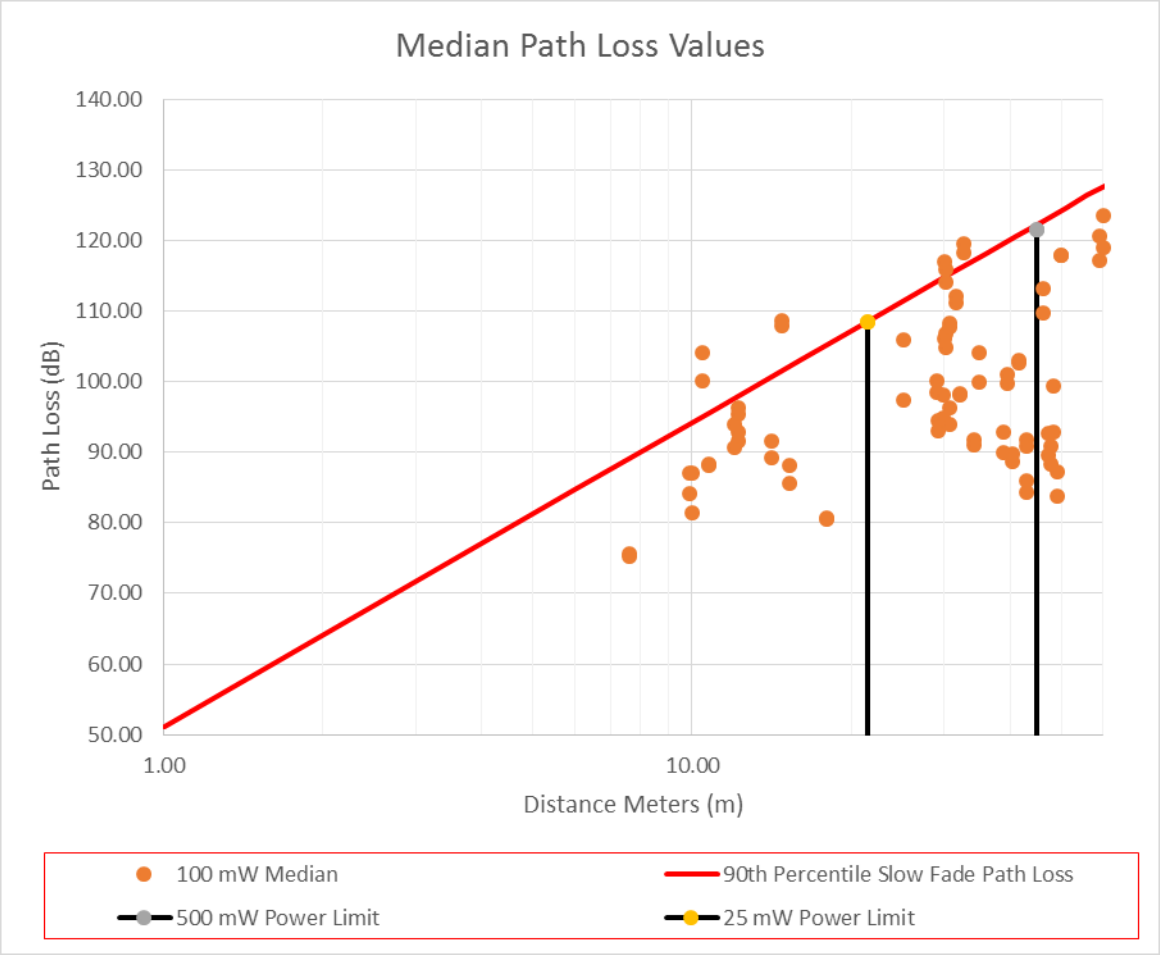

Figure 9 Median Path Loss Measurements

Path loss limit line, 25mW and 500mW power limits on the chart in Figure 9 are derived from the summary of all the data collected on all sites. Details of how these limits are derived and their formulation is contained in the final summary report, to which this document is an Appendix.

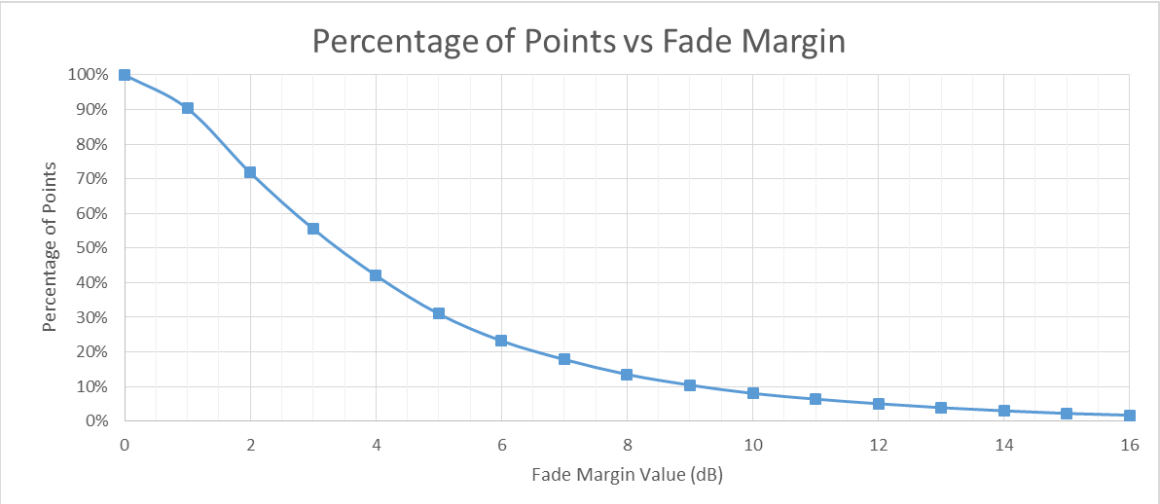

Figure 10 Fast Fade Margin

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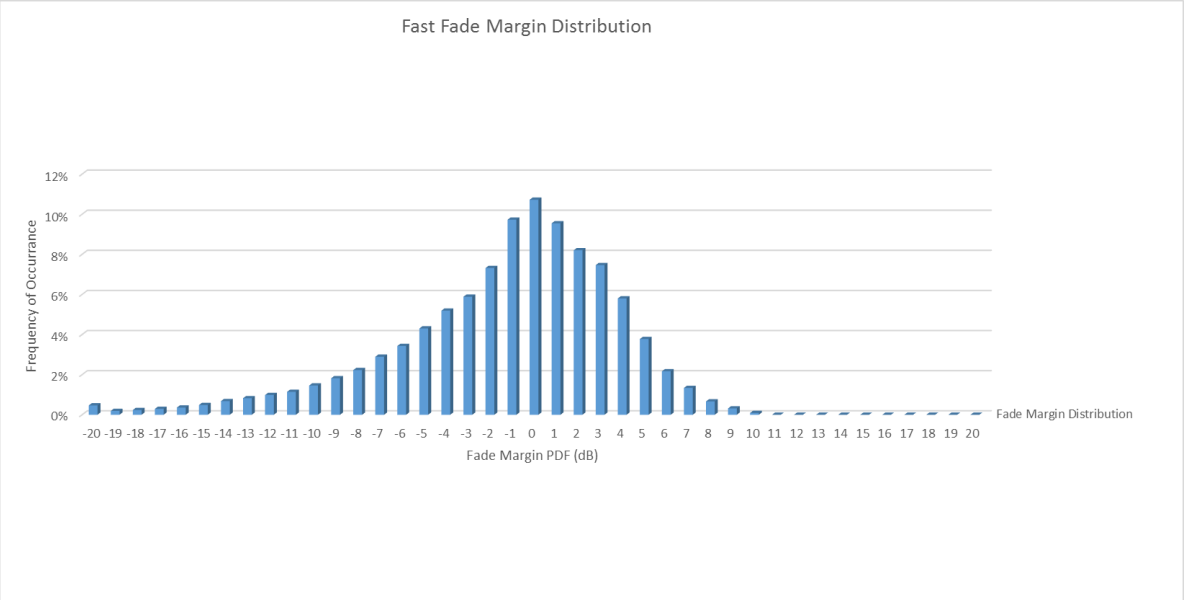
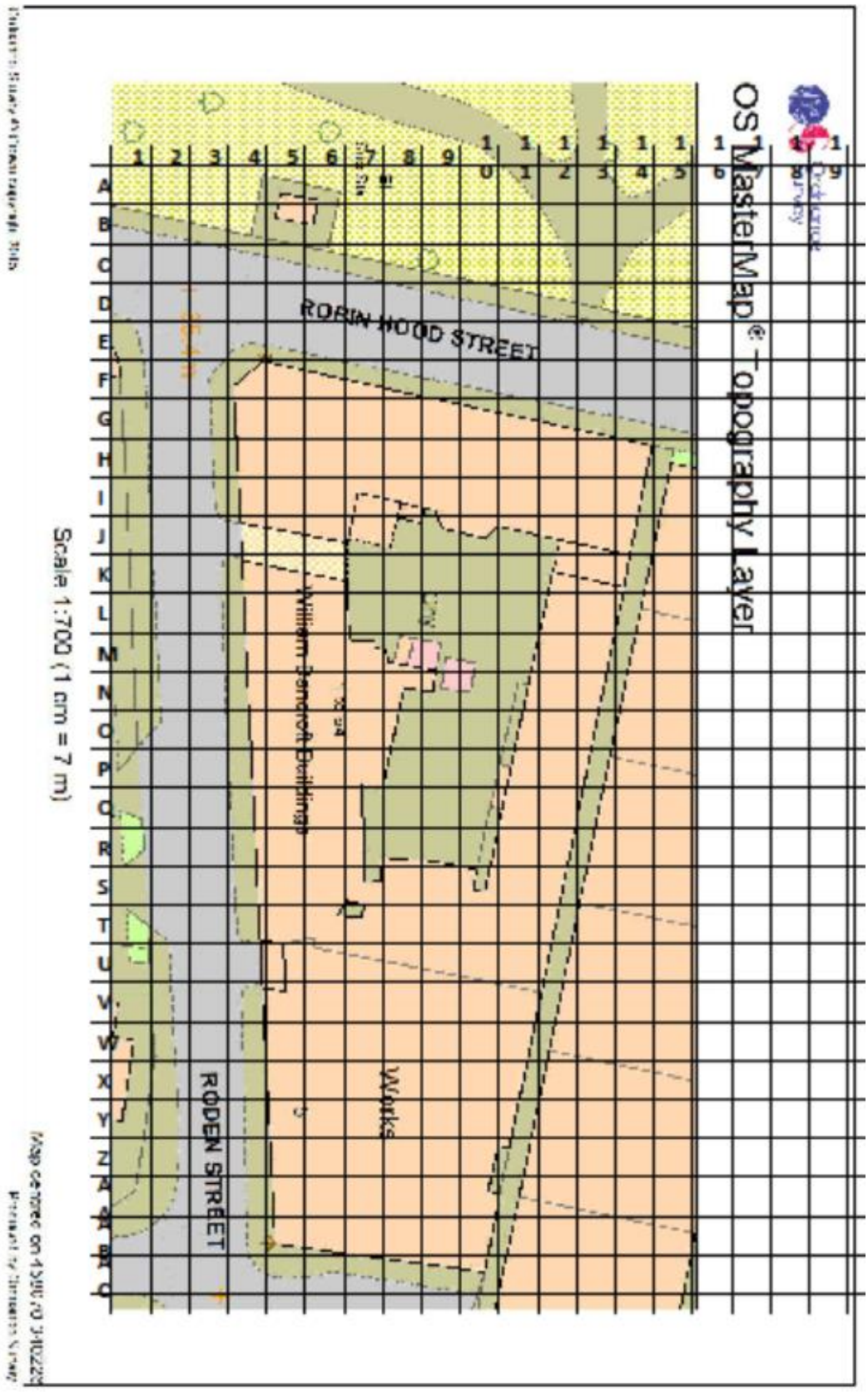


Figure 11 Fast Fading Rayleigh PDF

The fast fade margin PDF in Figure 11 shows that the building has a Rayleigh fast fading characteristic. This is explained in more detail in the main report.

5 Appendix A – Building Plan



6 Appendix B – Test Locations

Team	Test	Floor	Inside/Outside	Grid Reference
-	Tx 1	Basement	Inside	K4
-	Tx 2	Ground	Outside	S7
1	Rx 1	Ground	Inside	T4
1	Rx 2	First	Inside	T5
1	Rx 3	Second	Inside	T5
1	Rx 4	Third	Inside	T5
1	Rx 5	Ground	Inside	M7
1	Rx 6	First	Inside	M7
1	Rx 7	Second	Inside	M7
1	Rx 8	Third	Inside	M7
1	Rx 9	Basement	Inside	S4
2	Rx 1	Ground	Outside	P11
2	Rx 2	Ground	Outside	K13
2	Rx 3	Ground	Outside	J8
2	Rx 4	Ground	Outside	U4
2	Rx 5	Ground	Outside	F4
2	Rx 6	Ground	Outside	G14
2	Rx 15	Fourth	Inside	K14
2	Rx 16	Third	Inside	K14
2	Rx 17	Second	Inside	K14
2	Rx 18	First	Inside	K14
2	Rx 19	Basement	Inside	I12