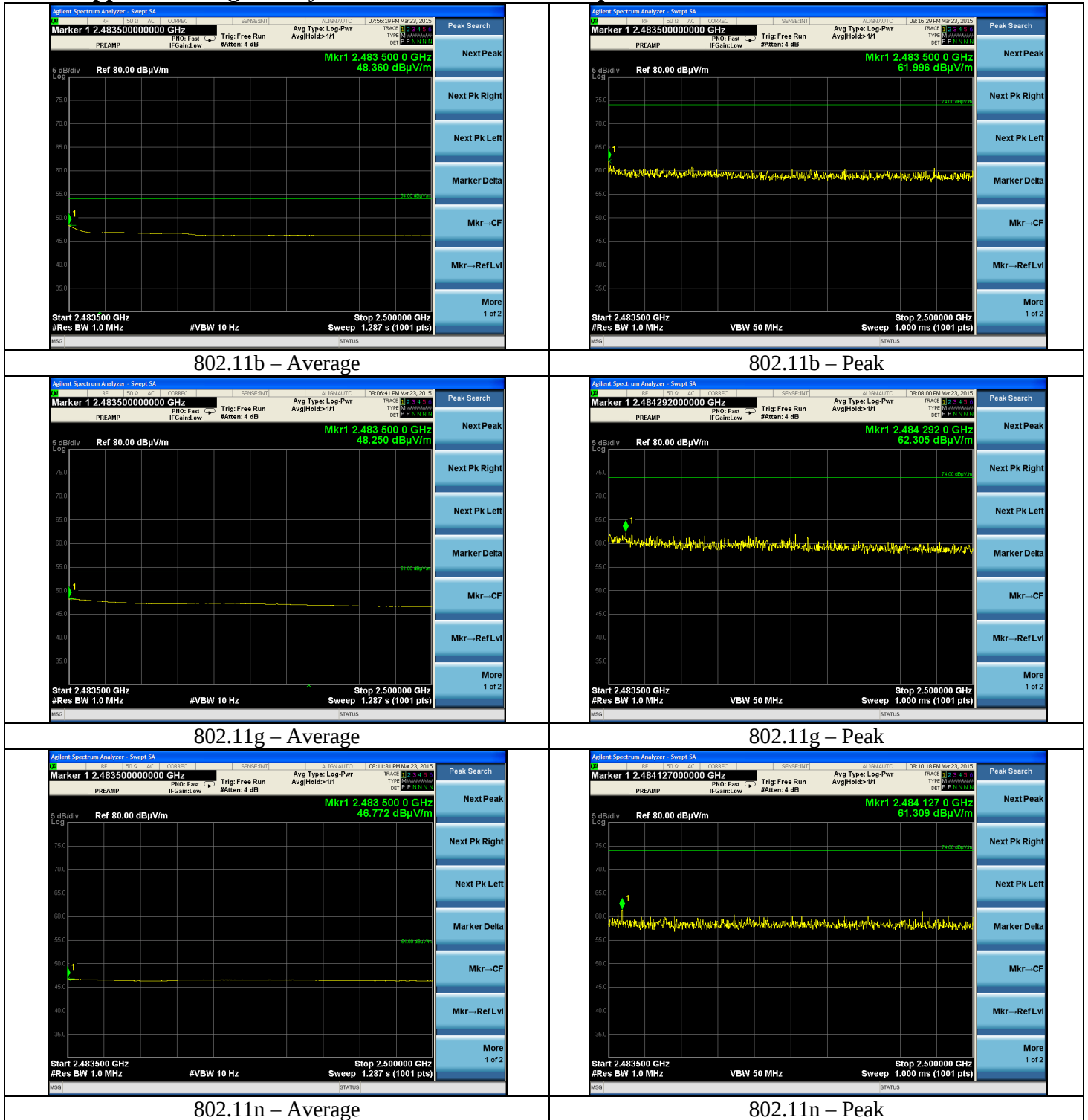


Upper band edge - 4-layer board – Antenna 2 – Chip Antenna



Prepared For: LSR

Report: TR 314413

LSR: C-2114

Name: TiWi-C-W

Model: TiWi-C-W

Serial: See Section 3.1

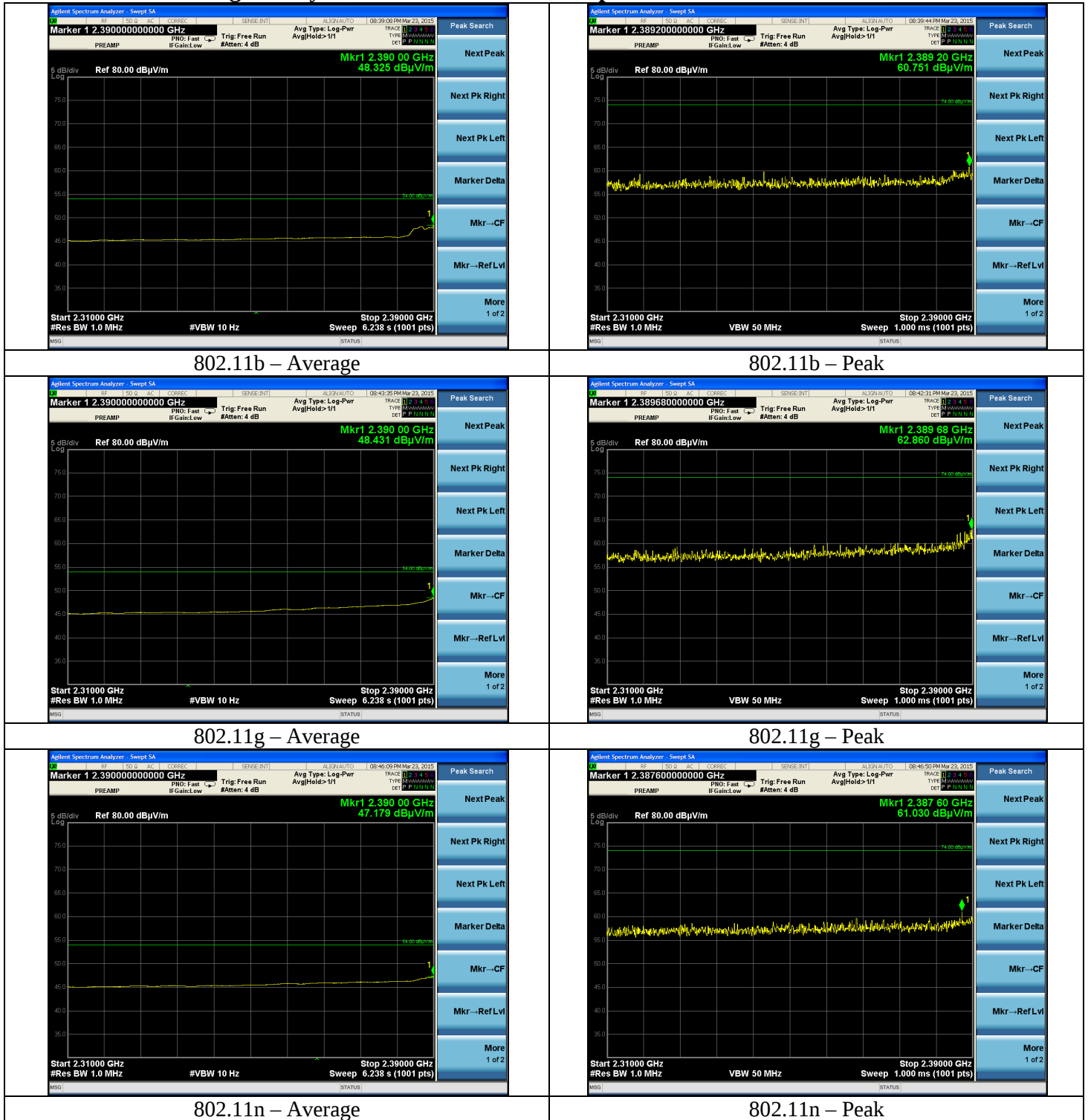
Lower Band-Edge Restricted Band
4-layer board – Antenna 2 – Chip Antenna
Average

Mode (802.11)	Mode (Mbps)	Frequency (GHz)	Average Meas (dBμV/m)	Average Limit (dBμV/m)	Margin
b	1	2.390000	48.325	54	5.7
g	6	2.390000	48.431		5.6
n	MCS 0	2.390000	47.179		6.8

Peak

Mode (802.11)	Mode (Mbps)	Frequency (GHz)	Peak Meas (dBμV/m)	Limit	Margin
b	1	2.3892000	60.751	74	13.2
g	6	2.3896800	62.860		11.1
n	MCS 0	2.3876000	61.030		13.0

Lower band edge - 4-layer board – Antenna 2 – Chip Antenna



Prepared For: LSR

Report: TR 314413

LSR: C-2114

Name: TiWi-C-W

Model: TiWi-C-W

Serial: See Section 3.1

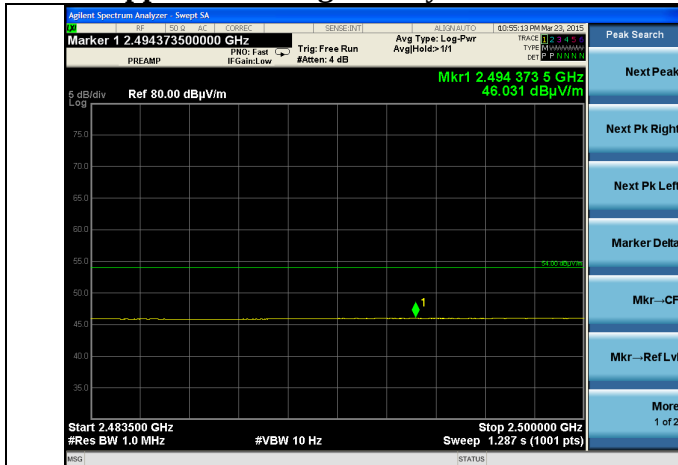
Upper Band-Edge Restricted Band
4-layer board – Antenna 2 – u.fl port with termination
Average

Mode (802.11)	Mode (Mbps)	Frequency (GHz)	Average Meas (dBμV/m)	Average Limit (dBμV/m)	Margin
b	1	2.494374	46.031	54	8.0
g	6	2.497789	46.061	54	7.9
n	MCS 0	2.492889	46.046	54	8.0

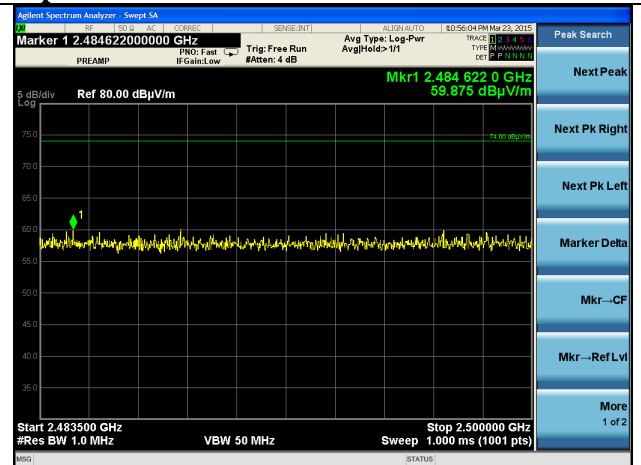
Peak

Mode (802.11)	Mode (Mbps)	Frequency (GHz)	Peak Meas (dBμV/m)	Limit	Margin
b	1	2.4846220	59.875	74	14.1
g	6	2.4910900	61.109	74	12.9
n	MCS 0	2.4951820	59.684	74	14.3

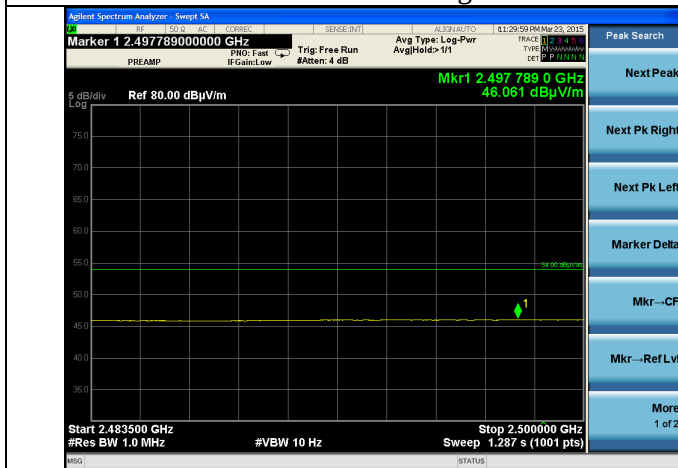
Upper Band Edge - 4-layer board – Antenna 2 – u.fl port with termination



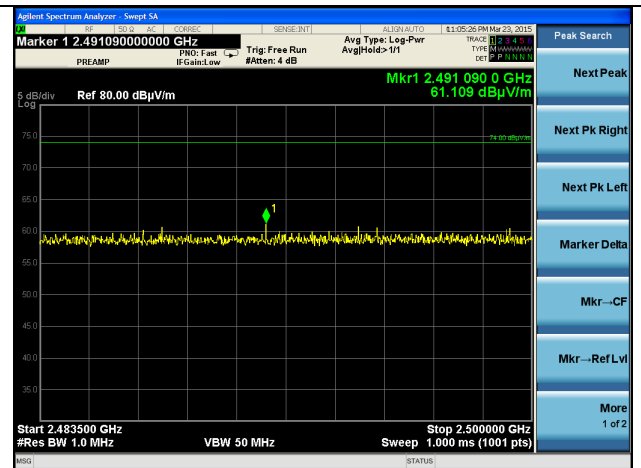
802.11b – Average



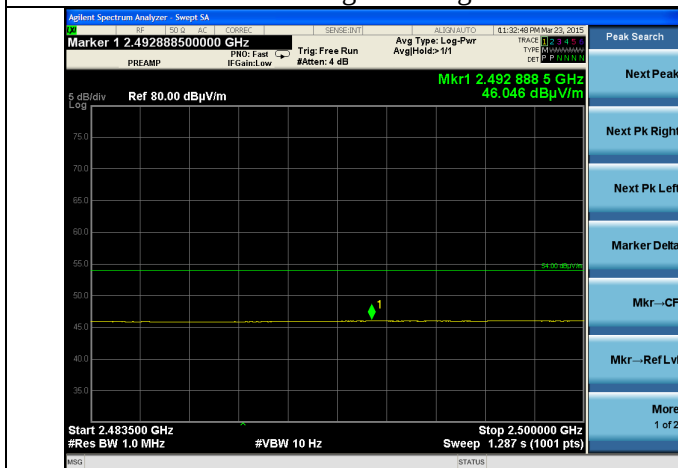
802.11b – Peak



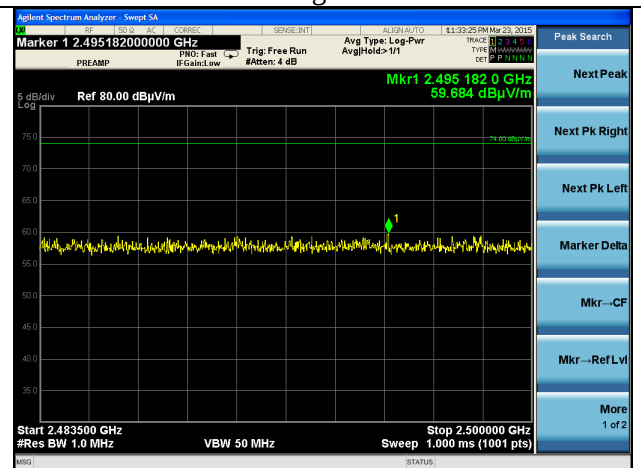
802.11g – Average



802.11g – Peak



802.11n – Average



802.11n – Peak

Prepared For: LSR

Report: TR 314413

LSR: C-2114

Name: TiWi-C-W

Model: TiWi-C-W

Serial: See Section 3.1

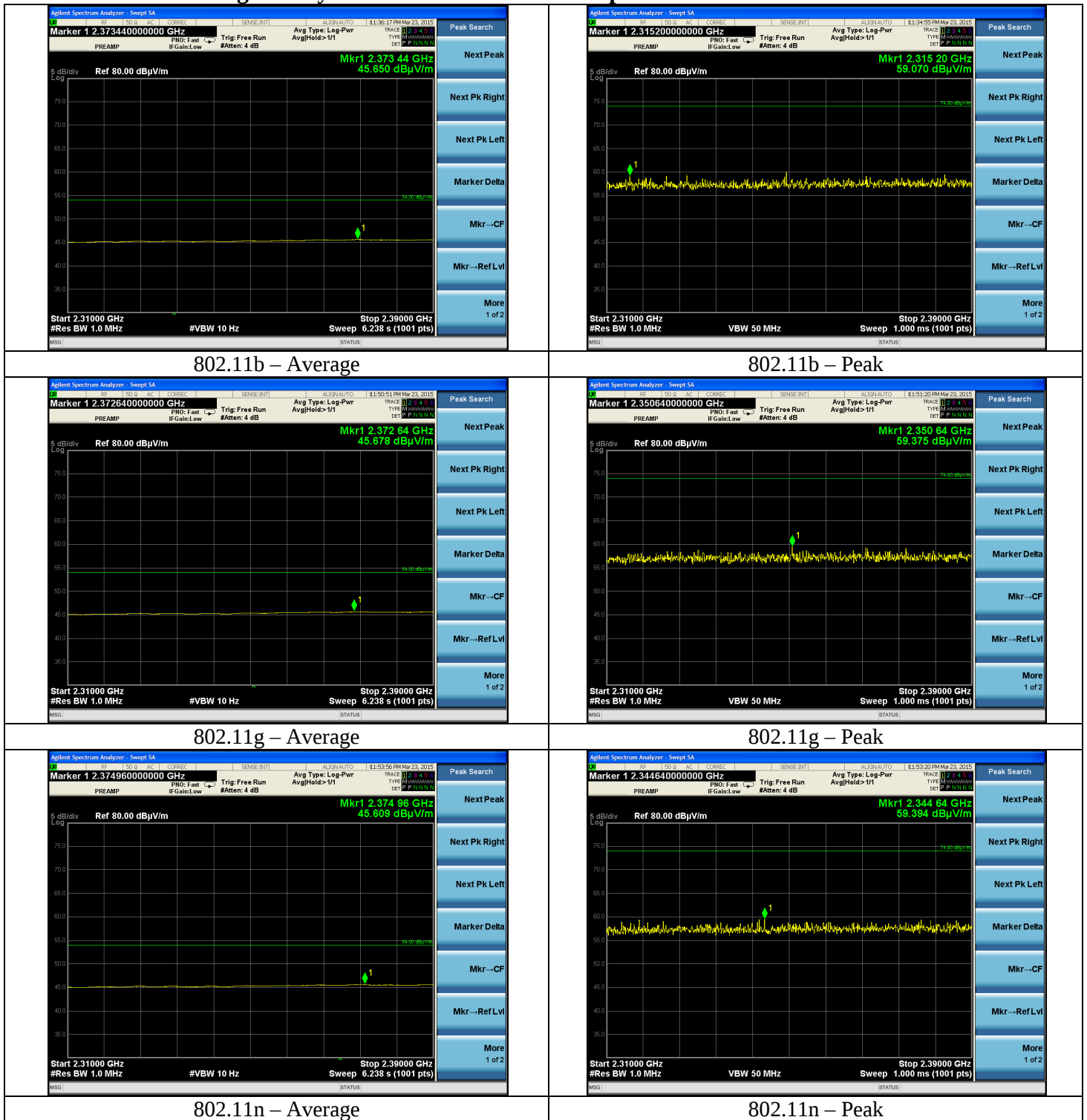
Lower Band-Edge Restricted Band
4-layer board – Antenna 2 – u.fl port with termination
Average

Mode (802.11)	Mode (Mbps)	Frequency (GHz)	Average Meas (dBμV/m)	Average Limit (dBμV/m)	Margin
b	1	2.373440	45.650	54	8.4
g	6	2.372640	45.678		8.3
n	MCS 0	2.374960	45.609		8.4

Peak

Mode (802.11)	Mode (Mbps)	Frequency (GHz)	Peak Meas (dBμV/m)	Limit	Margin
b	1	2.3152000	59.070	74	14.9
g	6	2.3506400	59.375		14.6
n	MCS 0	2.3446400	59.394		14.6

Lower Band Edge - 4-layer board – Antenna 2 – u.fl port with termination



Prepared For: LSR

Report: TR 314413

LSR: C-2114

Name: TiWi-C-W

Model: TiWi-C-W

Serial: See Section 3.1

Upper Band-Edge
2-layer board – Antenna 1
802.11b (worst case mode)

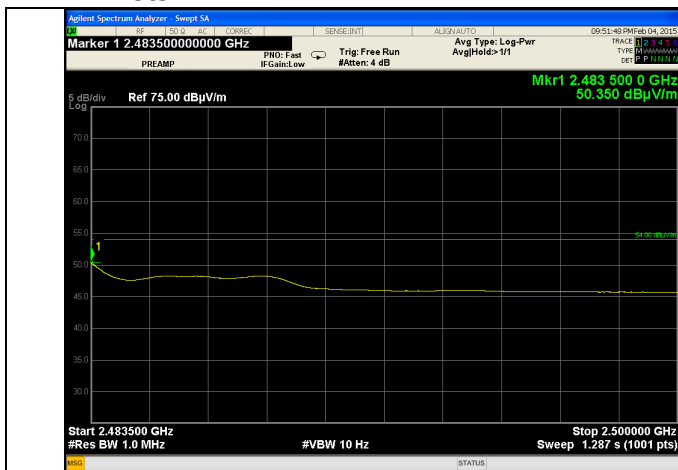
Average

Antenna	Mode (802.11)	Mode (Mbps)	Frequency (GHz)	Average Meas (dBμV/m)	Average Limit (dBμV/m)	Margin
Chip	b	1	2.483500	50.350	54	3.7
U.FL	b	1	2.494258	45.267	54	8.7

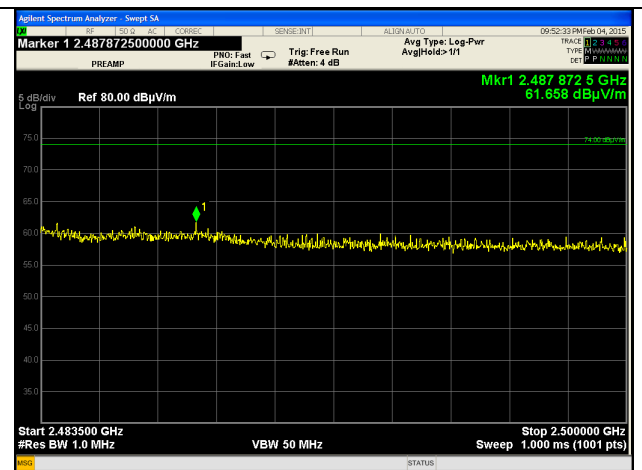
Peak

Antenna	Mode (802.11)	Mode (Mbps)	Frequency (GHz)	Peak Meas (dBμV/m)	Limit	Margin
Chip	b	1	2.4878725	61.658	74	12.3
U.FL	b	1	2.4925585	59.063	74	14.9

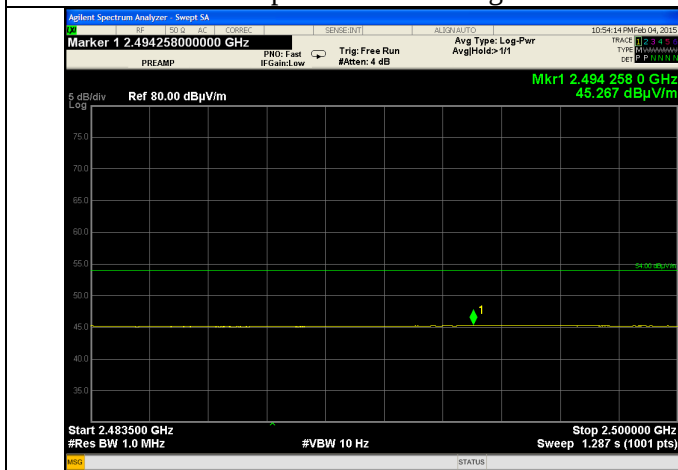
Plots



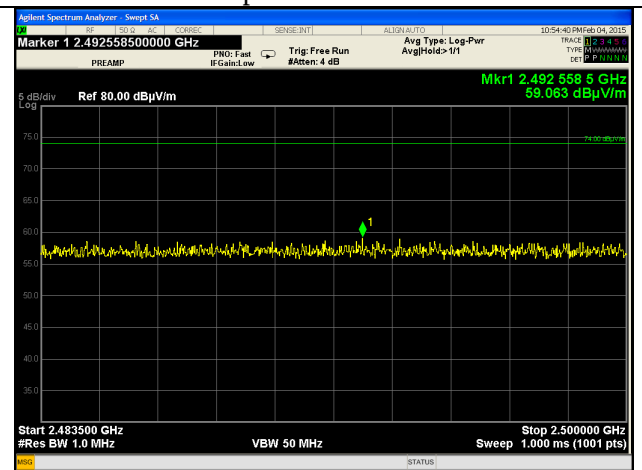
Chip Antenna - Average



Chip Antenna - Peak



U.FL Ant. Port w/ termination - Average



U.FL Ant. Port w/ termination - Peak

Prepared For: LSR

Report: TR 314413

LSR: C-2114

Name: TiWi-C-W

Model: TiWi-C-W

Serial: See Section 3.1

Lower Band-Edge 2-layer – Antenna 1 802.11b (worst case mode)

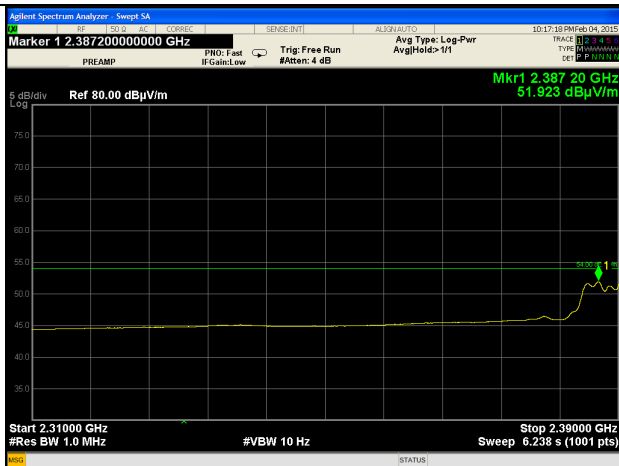
Average

Antenna	Mode (802.11)	Mode (Mbps)	Frequency (GHz)	Average Meas (dBμV/m)	Average Limit (dBμV/m)	Margin
Chip	b	1	2.387200	51.923	54	2.1
U.FL	b	1	2.386320	44.920	54	9.1

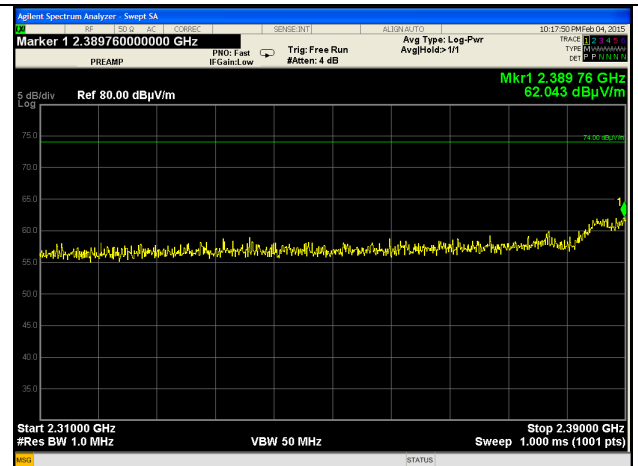
Peak

Antenna	Mode (802.11)	Mode (Mbps)	Frequency (GHz)	Peak Meas (dBμV/m)	Limit	Margin
Chip	b	1	2.3897600	62.043	74	12.0
U.FL	b	1	2.3875200	58.965	74	15.0

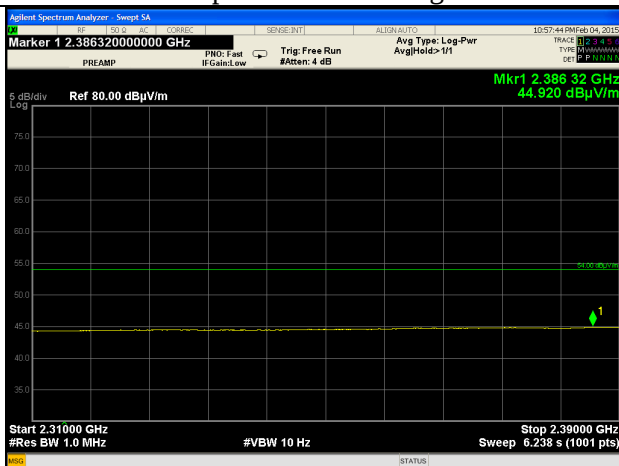
Plots



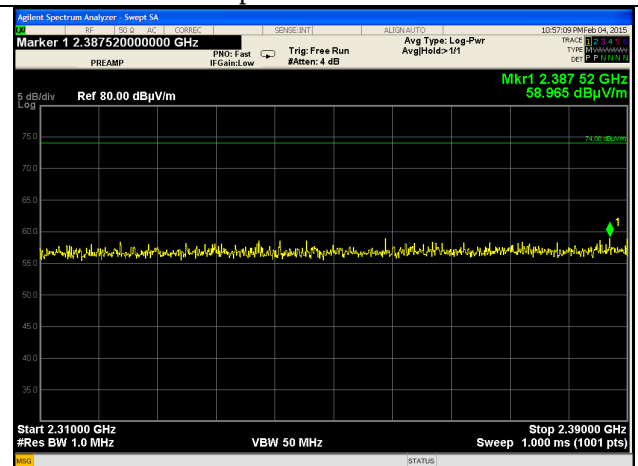
Chip Antenna - Average



Chip Antenna - Peak



U.FL Ant. Port w/ termination - Average



U.FL Ant. Port w/ termination - Peak

Prepared For: LSR

Report: TR 314413

LSR: C-2114

Name: TiWi-C-W

Model: TiWi-C-W

Serial: See Section 3.1

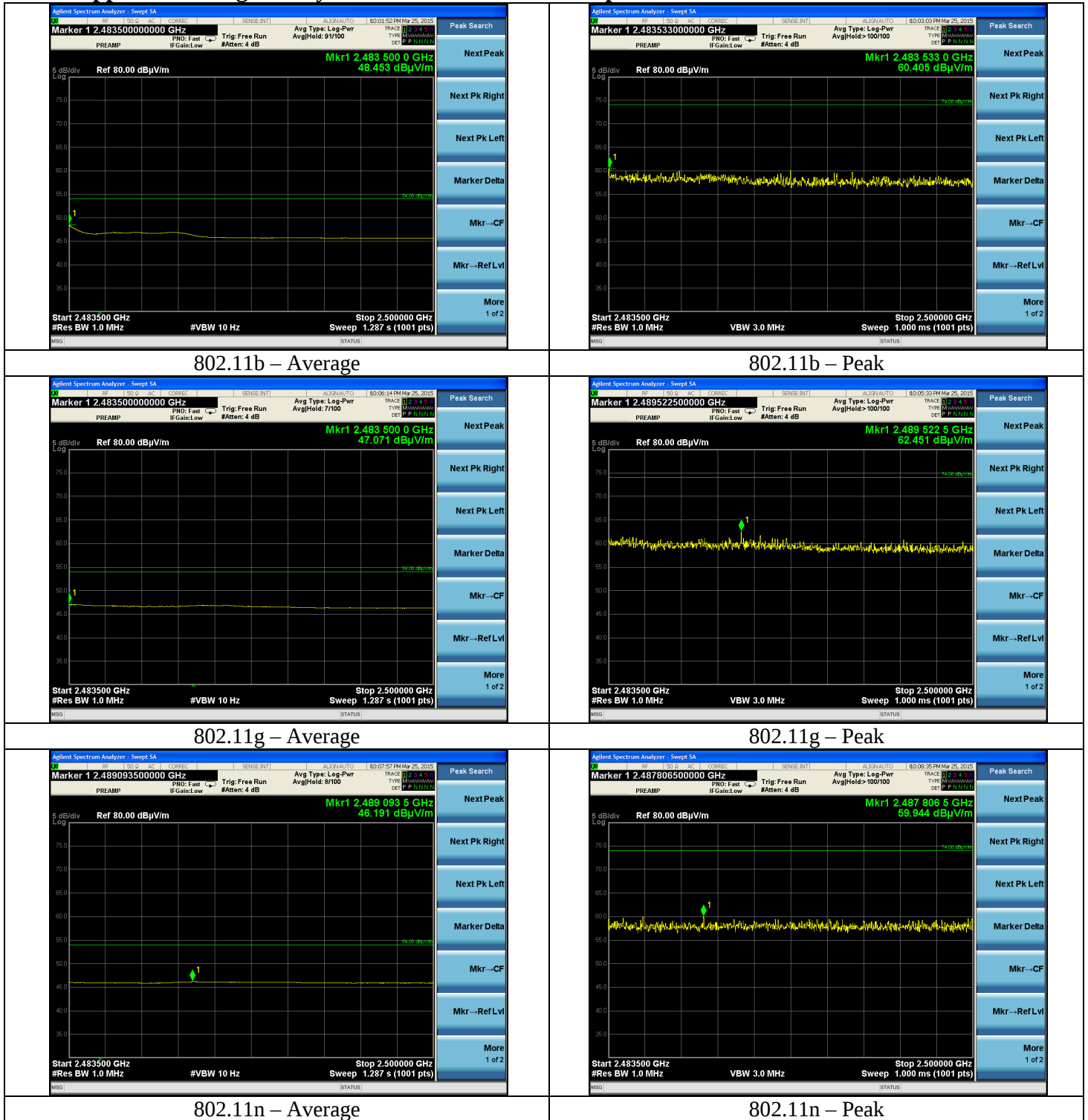
Upper Band-Edge Restricted Band
2-layer board – Antenna 2 – Chip Antenna
Average

Mode (802.11)	Mode (Mbps)	Frequency (GHz)	Average Meas (dBμV/m)	Average Limit (dBμV/m)	Margin
b	1	2.483500	48.453	54	5.5
g	6	2.483500	47.081		6.9
n	MCS 0	2.489094	46.191		7.8

Peak

Mode (802.11)	Mode (Mbps)	Frequency (GHz)	Peak Meas (dBμV/m)	Limit	Margin
b	1	2.4835330	60.606	74	13.4
g	6	2.4895225	62.451		11.5
n	MCS 0	2.4878065	59.944		14.1

Upper Band Edge - 2-layer board – Antenna 2 – Chip Antenna



Prepared For: LSR

Report: TR 314413

LSR: C-2114

Name: TiWi-C-W

Model: TiWi-C-W

Serial: See Section 3.1

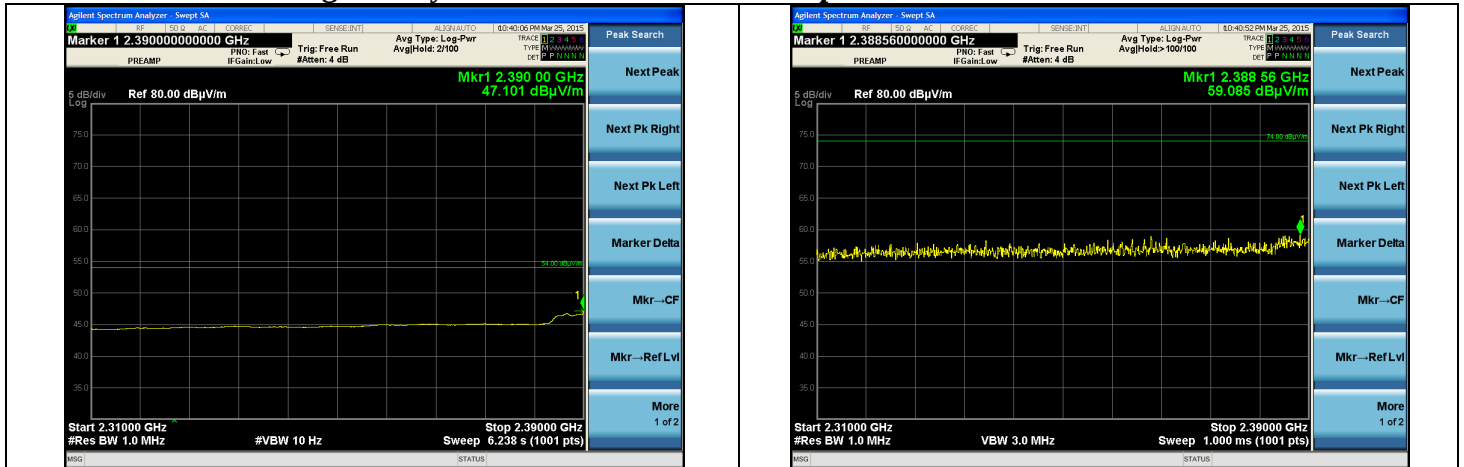
Lower Band-Edge Restricted Band
2-layer board – Antenna 2 – Chip Antenna
Average

Mode (802.11)	Mode (Mbps)	Frequency (GHz)	Average Meas (dBμV/m)	Average Limit (dBμV/m)	Margin
b	1	2.390000	47.147	54	6.9
g	6	2.390000	47.725		6.3
n	MCS 0	2.390000	46.915		7.1

Peak

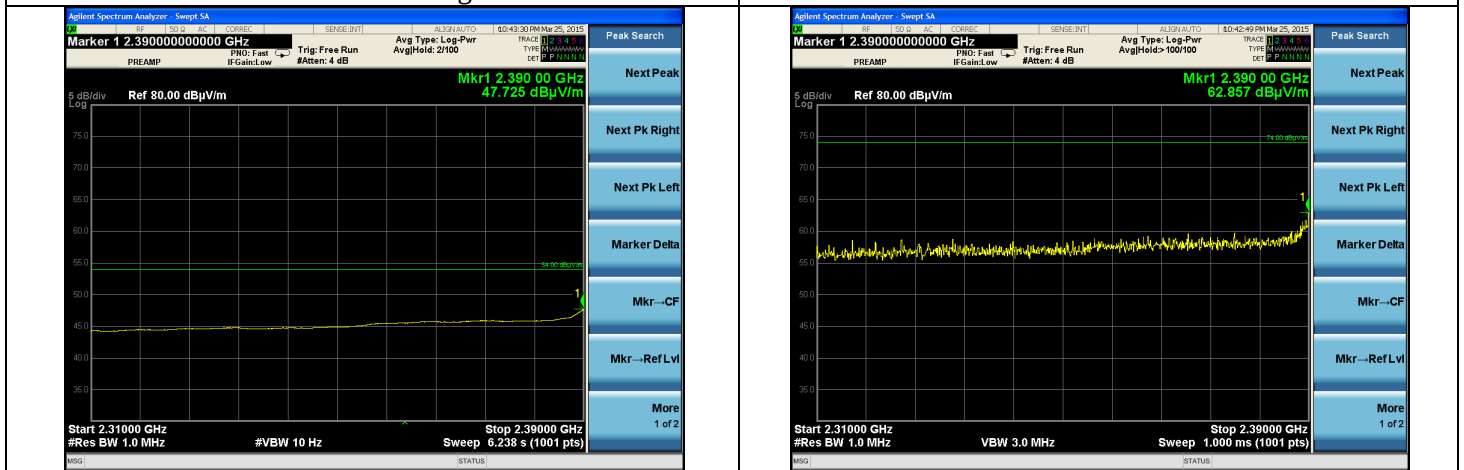
Mode (802.11)	Mode (Mbps)	Frequency (GHz)	Peak Meas (dBμV/m)	Limit	Margin
b	1	2.3885600	59.085	74	14.9
g	6	2.3900000	62.857		11.1
n	MCS 0	2.3879200	60.945		13.1

Lower Band-Edge - 2-layer board – Antenna 2 – Chip Antenna



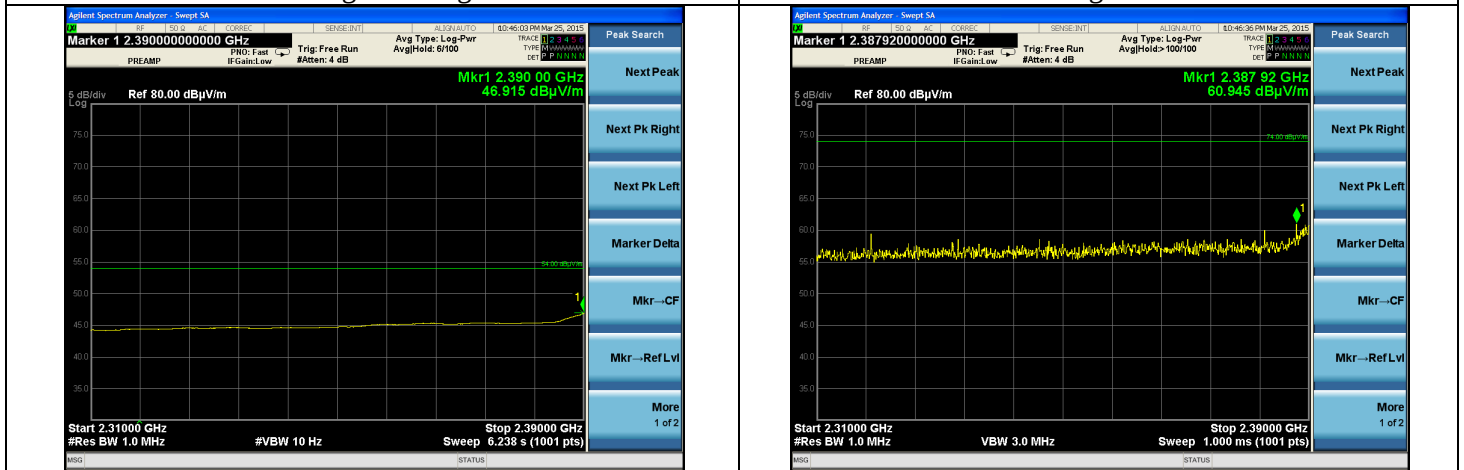
802.11b – Average

802.11b – Peak



802.11g – Average

802.11g – Peak



802.11n – Average

802.11n – Peak

Prepared For: LSR

Report: TR 314413

LSR: C-2114

Name: TiWi-C-W

Model: TiWi-C-W

Serial: See Section 3.1

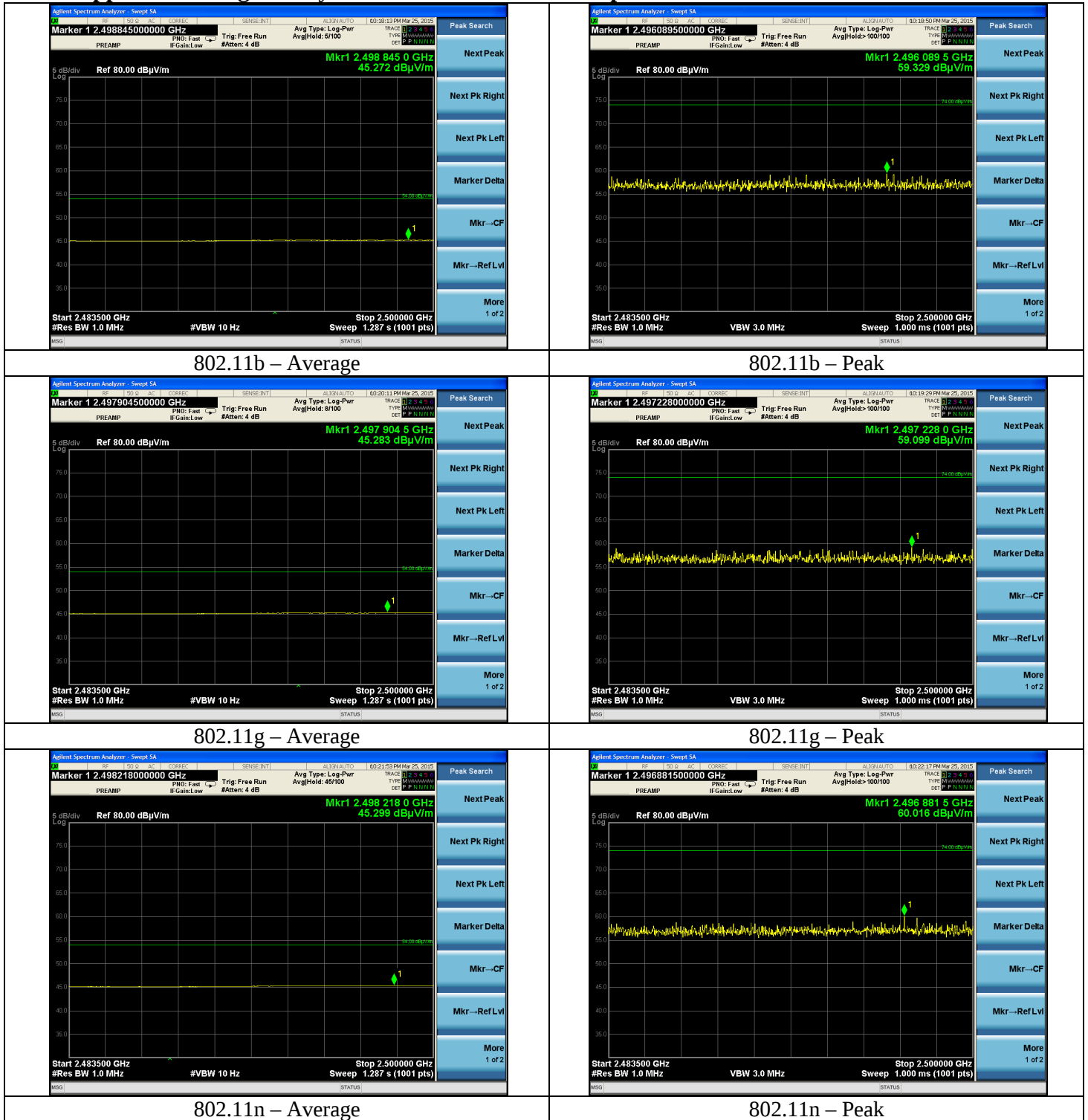
Upper Band-Edge Restricted Band
2-layer board – Antenna 2 – u.fl port with termination
Average

Mode (802.11)	Mode (Mbps)	Frequency (GHz)	Average Meas (dBμV/m)	Average Limit (dBμV/m)	Margin
b	1	2.498845	45.272	54	8.7
g	6	2.497905	45.283	54	8.7
n	MCS 0	2.498218	45.299	54	8.7

Peak

Mode (802.11)	Mode (Mbps)	Frequency (GHz)	Peak Meas (dBμV/m)	Limit	Margin
b	1	2.4960895	59.329	74	14.7
g	6	2.4972280	59.099	74	14.9
n	MCS 0	2.4968810	60.016	74	14.0

Upper Band-Edge - 2-layer board – Antenna 2 – u.fl port with termination



Prepared For: LSR

Report: TR 314413

LSR: C-2114

Name: TiWi-C-W

Model: TiWi-C-W

Serial: See Section 3.1

Lower Band-Edge Restricted Band

2-layer board – Antenna 2 – u.fl port with termination

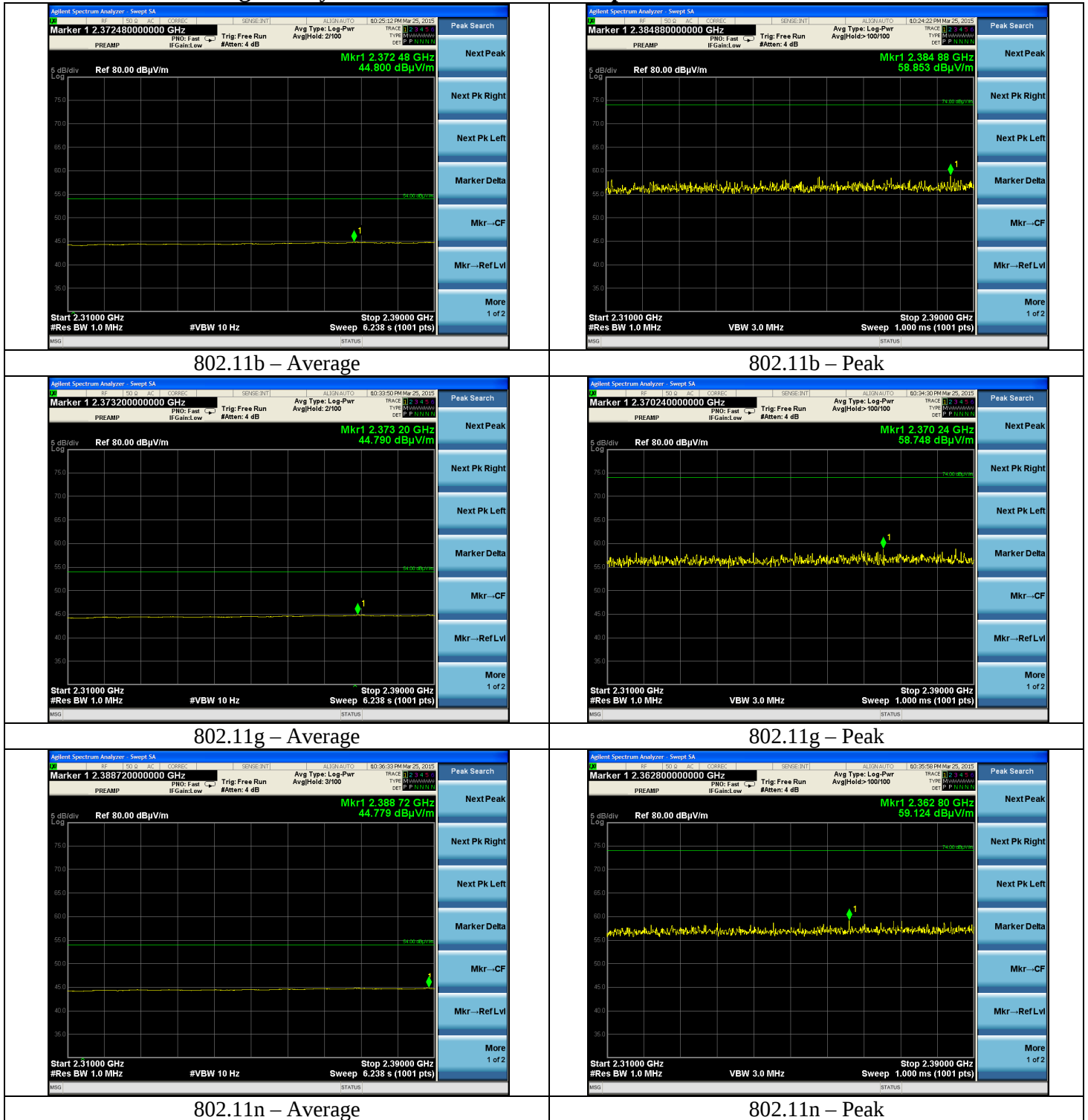
Average

Mode (802.11)	Mode (Mbps)	Frequency (GHz)	Average Meas (dBμV/m)	Average Limit (dBμV/m)	Margin
b	1	2.372480	44.800	54	9.2
g	6	2.373200	44.790		9.2
n	MCS 0	2.388720	44.779		9.2

Peak

Mode (802.11)	Mode (Mbps)	Frequency (GHz)	Peak Meas (dBμV/m)	Limit	Margin
b	1	2.3848800	58.853	74	15.1
g	6	2.3702400	58.748		15.3
n	MCS 0	2.3628000	59.124		14.9

Lower Band-Edge - 2-layer board – Antenna 2 – u.fl port with termination



Prepared For: LSR

Report: TR 314413

LSR: C-2114

Name: TiWi-C-W

Model: TiWi-C-W

Serial: See Section 3.1

B.2.2 – Transmitter Radiated Spurious Emissions in Restricted Bands

Manufacturer	LSR
Date	12-4-2014 and 1-20, 1-21, 2-3, 3-18, 3-24, 3-25 2015
Operator	Adam A
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Rule Part	15.247/ 15.205 / 15.209
Measurement Procedure	ANSI C63.4 - 2009 ANSI C63.10 - 2009 FCC KDB 558074 v03r02 Section 12.2.7 Radiated spurious emission test
Test Distance	3 meter 4-18 GHz, 1 meter 18-25 GHz
EUT Placement	80 cm height non-conductive table centered on turn-table, EUT rotated in three orientations
Detectors	Peak; RBW 1 MHz Average VBW (10Hz)
Additional Notes	1) Tested in continuous transmit modulated mode (worst case 1 Mbps) with EUT in three orientations. 2) U.FL Antenna port terminated with matching 50 ohm termination and chip antenna tested <u>all</u> frequency ranges. 3) 4-layer and 2-layer designs tested 4) Antenna 1 and Antenna 2 tested 5) No emissions found above system noise floor 30-1000 MHz for any configuration during exploratory emissions measurements.

Example Calculation:

FCC 15.209 Average Limit @ 3 meter (dBμV/m) – Average Reading (dBμV/m) = Margin

FCC 15.209 Peak Limit @ 3 meter (dBμV/m) – Peak Reading (dBμV/m) = Margin

Prepared For: LSR	Name: TiWi-C-W
Report: TR 314413	Model: TiWi-C-W
LSR: C-2114	Serial: See Section 3.1

U.FL Antenna Port with termination (4-layer board – Antenna 1)

EUT Channel	Frequency (MHz)	EUT orientation	Antenna Polarity	Azimuth (degree)	Height (cm)	Average Reading (dBμV/m)	Peak Reading (dBμV/m)	Average Limit (dBμV/m)	Average Margin (dB)	Peak Limit (dBμV/m)	Peak Margin (dB)
6	7311	Vertical	Vertical	75	111	43.77	49.73	54	10.2	74	24.3
			Horizontal	130	156	52.22	55.86		1.8		18.1
		Horizontal	Vertical	70	198	49.90	53.92		4.1		20.1
			Horizontal	125	194	50.88	54.80		3.1		19.2
		Flat	Vertical	198	136	49.56	53.60		4.4		20.4
			Horizontal	202	125	47.70	52.56		6.3		21.4

EUT Channel	Frequency (MHz)	EUT orientation	Antenna Polarity	Azimuth (degree)	Height (cm)	Average Reading (dBμV/m)	Peak Reading (dBμV/m)	Average Limit (dBμV/m)	Average Margin (dB)	Peak Limit (dBμV/m)	Peak Margin (dB)
11	7386	Vertical	Vertical	69	112	43.95	50.56	54	10.1	74	23.4
			Horizontal	130	154	50.79	55.15		3.2		18.9
		Horizontal	Vertical	74	206	49.28	53.67		4.7		20.3
			Horizontal	133	227	49.63	54.60		4.4		19.4
		Flat	Vertical	45	136	48.09	53.17		5.9		20.8
			Horizontal	203	125	46.13	51.86		7.9		22.1

Chip Antenna (4-layer board – Antenna 1)

EUT Channel	Frequency (MHz)	EUT orientation	Antenna Polarity	Azimuth (degree)	Height (cm)	Average Reading (dBμV/m)	Peak Reading (dBμV/m)	Average Limit (dBμV/m)	Average Margin (dB)	Peak Limit (dBμV/m)	Peak Margin (dB)
6	7311	Vertical	Vertical	193	192	48.30	52.80	54	5.7	74	21.2
			Horizontal	134	153	52.18	55.75		1.8		18.3
		Horizontal	Vertical	79	192	50.19	54.19		3.8		19.8
			Horizontal	134	228	49.15	53.24		4.8		20.8
		Flat	Vertical	179	196	51.61	55.18		2.4		18.8
			Horizontal	199	138	49.09	52.97		4.9		21.0

EUT Channel	Frequency (MHz)	EUT orientation	Antenna Polarity	Azimuth (degree)	Height (cm)	Average Reading (dBμV/m)	Peak Reading (dBμV/m)	Average Limit (dBμV/m)	Average Margin (dB)	Peak Limit (dBμV/m)	Peak Margin (dB)
11	7386	Vertical	Vertical	182	240	44.91	50.65	54	9.1	74	23.4
			Horizontal	130	160	48.60	53.69		5.4		20.3
		Horizontal	Vertical	69	177	46.50	52.13		7.5		21.9
			Horizontal	128	231	45.69	51.81		8.3		22.2
		Flat	Vertical	175	186	46.97	52.82		7.0		21.2
			Horizontal	195	140	45.06	50.68		8.9		23.3

Prepared For: LSR

Name: TiWi-C-W

Report: TR 314413

Model: TiWi-C-W

LSR: C-2114

Serial: See Section 3.1

U.FL Antenna Port with termination (4-layer board – Antenna 2)

EUT Channel	Frequency (MHz)	EUT orientation	Antenna Polarity	Azimuth (degree)	Height (cm)	Average Reading (dBμV/m)	Peak Reading (dBμV/m)	Average Limit (dBμV/m)	Average Margin (dB)	Peak Limit (dBμV/m)	Peak Margin (dB)
6	7311	Vertical	Vertical	193	215	46.53	52.37	54	7.5	74	21.6
			Horizontal	130	161	51.83	56.76		2.2		17.2
		Horizontal	Vertical	355	193	50.00	55.08		4.0		18.9
			Horizontal	44	196	49.70	54.74		4.3		19.3
		Flat	Vertical	181	229	51.56	56.31		2.4		17.7
			Horizontal	201	152	48.66	53.99		5.3		20.0

EUT Channel	Frequency (MHz)	EUT orientation	Antenna Polarity	Azimuth (degree)	Height (cm)	Average Reading (dBμV/m)	Peak Reading (dBμV/m)	Average Limit (dBμV/m)	Average Margin (dB)	Peak Limit (dBμV/m)	Peak Margin (dB)
11	7386	Vertical	Vertical	199	215	45.46	51.99	54	8.5	74	22.0
			Horizontal	131	160	51.16	56.47		2.8		17.5
		Horizontal	Vertical	354	210	48.59	54.27		5.4		19.7
			Horizontal	42	198	49.01	54.59		5.0		19.4
		Flat	Vertical	181	210	49.92	54.98		4.1		19.0
			Horizontal	200	124	47.58	53.37		6.4		20.6

Chip Antenna (4-layer board – Antenna 2)

EUT Channel	Frequency (MHz)	EUT orientation	Antenna Polarity	Azimuth (degree)	Height (cm)	Average Reading (dBμV/m)	Peak Reading (dBμV/m)	Average Limit (dBμV/m)	Average Margin (dB)	Peak Limit (dBμV/m)	Peak Margin (dB)
6	7311	Vertical	Vertical	183	207	43.89	49.92	54	10.1	74	24.1
			Horizontal	129	139	48.88	54.17		5.1		19.8
		Horizontal	Vertical	0	219	47.67	53.20		6.3		20.8
			Horizontal	47	258	44.84	51.14		9.2		22.9
		Flat	Vertical	176	209	48.73	53.70		5.3		20.3
			Horizontal	193	153	44.65	51.22		9.4		22.8

EUT Channel	Frequency (MHz)	EUT orientation	Antenna Polarity	Azimuth (degree)	Height (cm)	Average Reading (dBμV/m)	Peak Reading (dBμV/m)	Average Limit (dBμV/m)	Average Margin (dB)	Peak Limit (dBμV/m)	Peak Margin (dB)
11	7386	Vertical	Vertical	191	206	41.28	49.12	54	12.7	74	24.9
			Horizontal	131	155	45.67	52.08		8.3		21.9
		Horizontal	Vertical	0	211	44.23	50.67		9.8		23.3
			Horizontal	37	280	41.80	49.17		12.2		24.8
		Flat	Vertical	180	205	45.15	52.00		8.9		22.0
			Horizontal	197	137	41.56	49.26		12.4		24.7

Prepared For: LSR	Name: TiWi-C-W
Report: TR 314413	Model: TiWi-C-W
LSR: C-2114	Serial: See Section 3.1

U.FL Antenna Port with termination (2-layer board – Antenna 1)

EUT Channel	Frequency (MHz)	EUT orientation	Antenna Polarity	Azimuth (degree)	Height (cm)	Average Reading (dBμV/m)	Peak Reading (dBμV/m)	Average Limit (dBμV/m)	Average Margin (dB)	Peak Limit (dBμV/m)	Peak Margin (dB)
6	7311	Vertical	Vertical	111	216	50.71	55.30	54	3.3	74	18.7
			Horizontal	117	196	47.10	52.59		6.9		21.4
		Horizontal	Vertical	93	253	46.78	52.02		7.2		22.0
			Horizontal	70	226	51.53	56.11		2.5		17.9
		Flat	Vertical	268	163	48.27	53.09		5.7		20.9
			Horizontal	321	172	45.19	51.47		8.8		22.5

EUT Channel	Frequency (MHz)	EUT orientation	Antenna Polarity	Azimuth (degree)	Height (cm)	Average Reading (dBμV/m)	Peak Reading (dBμV/m)	Average Limit (dBμV/m)	Average Margin (dB)	Peak Limit (dBμV/m)	Peak Margin (dB)
11	7386	Vertical	Vertical	86	235	47.65	52.75	54	6.4	74	21.3
			Horizontal	124	202	44.05	50.45		10.0		23.6
		Horizontal	Vertical	83	273	41.98	49.08		12.0		24.9
			Horizontal	57	249	47.38	52.41		6.6		21.6
		Flat	Vertical	273	269	45.27	51.48		8.7		22.5
			Horizontal	0	170	41.07	47.80		12.9		26.2

Chip Antenna (2-layer board – Antenna 1)

EUT Channel	Frequency (MHz)	EUT orientation	Antenna Polarity	Azimuth (degree)	Height (cm)	Average Reading (dBμV/m)	Peak Reading (dBμV/m)	Average Limit (dBμV/m)	Average Margin (dB)	Peak Limit (dBμV/m)	Peak Margin (dB)
6	7311	Vertical	Vertical	82	252	51.45	55.87	54	2.5	74	18.1
			Horizontal	47	159	46.95	52.73		7.1		21.3
		Horizontal	Vertical	89	249	46.96	53.32		7.0		20.7
			Horizontal	121	142	52.00	56.21		2.0		17.8
		Flat	Vertical	96	225	49.68	54.17		4.3		19.8
			Horizontal	33	163	49.25	53.58		4.8		20.4

EUT Channel	Frequency (MHz)	EUT orientation	Antenna Polarity	Azimuth (degree)	Height (cm)	Average Reading (dBμV/m)	Peak Reading (dBμV/m)	Average Limit (dBμV/m)	Average Margin (dB)	Peak Limit (dBμV/m)	Peak Margin (dB)
11	7386	Vertical	Vertical	76	195	48.31	53.30	54	5.7	74	20.7
			Horizontal	122	195	44.35	49.98		9.7		24.0
		Horizontal	Vertical	98	244	44.55	50.24		9.5		23.8
			Horizontal	130	155	46.95	52.35		7.1		21.7
		Flat	Vertical	104	272	46.48	52.17		7.5		21.8
			Horizontal	34	167	44.89	50.96		9.1		23.0

Prepared For: LSR

Name: TiWi-C-W

Report: TR 314413

Model: TiWi-C-W

LSR: C-2114

Serial: See Section 3.1

U.FL Antenna Port with termination (2-layer board – Antenna 2)

EUT Channel	Frequency (MHz)	EUT orientation	Antenna Polarity	Azimuth (degree)	Height (cm)	Average Reading (dBμV/m)	Peak Reading (dBμV/m)	Average Limit (dBμV/m)	Average Margin (dB)	Peak Limit (dBμV/m)	Peak Margin (dB)
6	7311	Vertical	Vertical	109	235	50.29	55.13	54	3.7	74	18.9
			Horizontal	139	214	45.35	51.56		8.7		22.4
		Horizontal	Vertical	0	272	42.90	49.93		11.1		24.1
			Horizontal	331	226	51.02	55.82		3.0		18.2
		Flat	Vertical	264	182	47.96	53.48		6.0		20.5
			Horizontal	320	173	42.81	49.99		11.2		24.0

EUT Channel	Frequency (MHz)	EUT orientation	Antenna Polarity	Azimuth (degree)	Height (cm)	Average Reading (dBμV/m)	Peak Reading (dBμV/m)	Average Limit (dBμV/m)	Average Margin (dB)	Peak Limit (dBμV/m)	Peak Margin (dB)
11	7386	Vertical	Vertical	113	263	49.22	53.31	54	4.8	74	20.7
			Horizontal	135	214	44.44	50.45		9.6		23.6
		Horizontal	Vertical	356	269	41.88	48.31		12.1		25.7
			Horizontal	332	200	50.39	55.75		3.6		18.3
		Flat	Vertical	265	185	46.78	52.14		7.2		21.9
			Horizontal	321	174	41.18	48.87		12.8		25.1

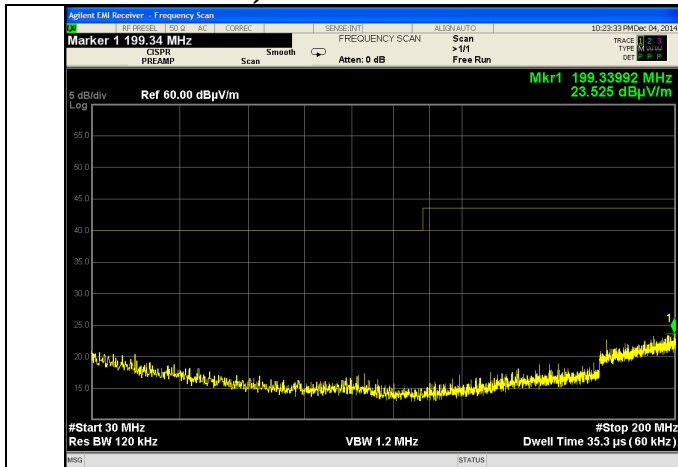
Chip Antenna (2-layer board – Antenna 2)

EUT Channel	Frequency (MHz)	EUT orientation	Antenna Polarity	Azimuth (degree)	Height (cm)	Average Reading (dBμV/m)	Peak Reading (dBμV/m)	Average Limit (dBμV/m)	Average Margin (dB)	Peak Limit (dBμV/m)	Peak Margin (dB)
6	7311	Vertical	Vertical	109	217	49.69	55.20	54	4.3	74	18.8
			Horizontal	117	197	45.56	52.09		8.4		21.9
		Horizontal	Vertical	0	272	43.72	50.48		10.3		23.5
			Horizontal	332	239	50.14	55.32		3.9		18.7
		Flat	Vertical	228	263	48.73	54.03		5.3		20.0
			Horizontal	177	171	42.21	49.50		11.8		24.5

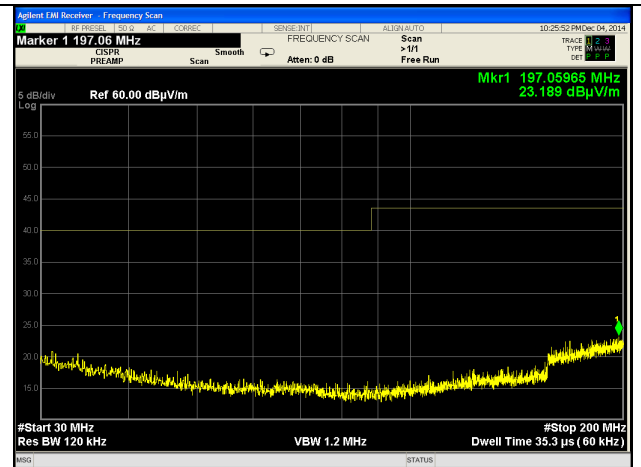
EUT Channel	Frequency (MHz)	EUT orientation	Antenna Polarity	Azimuth (degree)	Height (cm)	Average Reading (dBμV/m)	Peak Reading (dBμV/m)	Average Limit (dBμV/m)	Average Margin (dB)	Peak Limit (dBμV/m)	Peak Margin (dB)
11	7386	Vertical	Vertical	111	220	47.96	53.02	54	6.0	74	21.0
			Horizontal	115	195	43.65	50.90		10.4		23.1
		Horizontal	Vertical	0	280	41.60	48.86		12.4		25.1
			Horizontal	335	222	48.59	54.15		5.4		19.9
		Flat	Vertical	229	264	46.37	51.30		7.6		22.7
			Horizontal	172	172	40.12	47.05		13.9		27.0

Prepared For: LSR	Name: TiWi-C-W
Report: TR 314413	Model: TiWi-C-W
LSR: C-2114	Serial: See Section 3.1

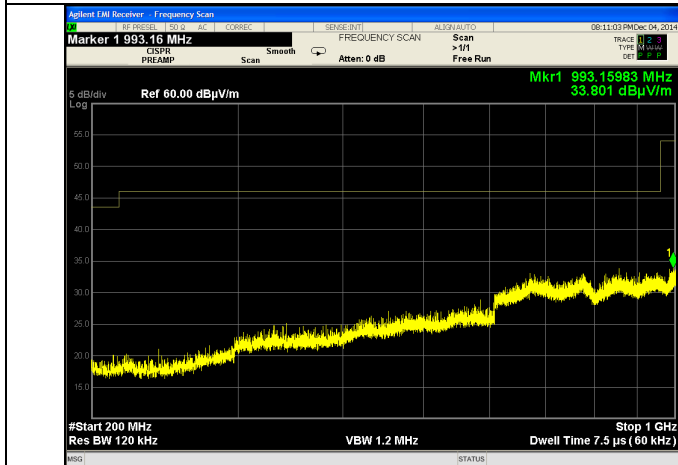
Plots (representative of 2-layer, 4-layer, antenna 1 and antenna 2 with chip and u.fl terminated)



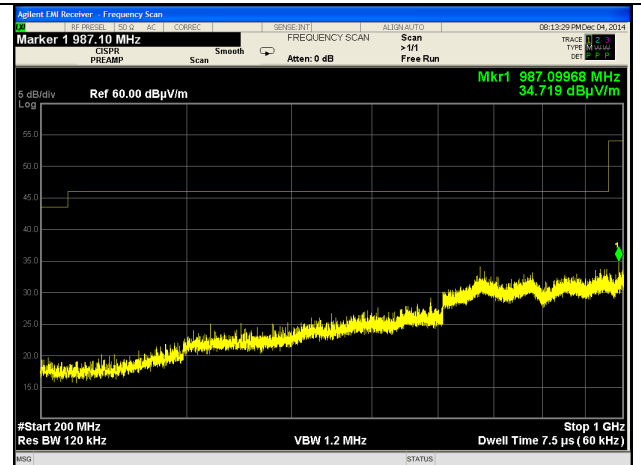
30-200 MHz – Vertical Ant



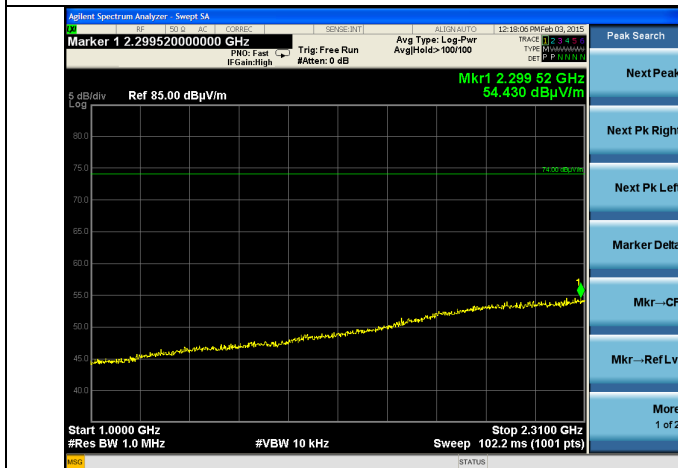
30-200 MHz – Horizontal Ant



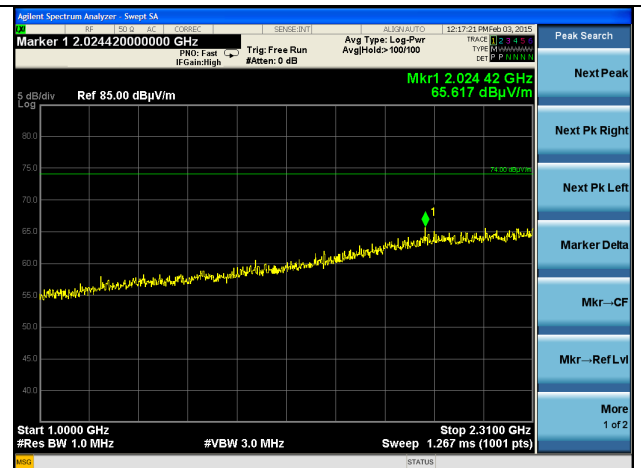
200-1000 MHz – Vertical Ant



200-1000 MHz – Horizontal Ant



1-2.31 GHz (Average)



1-2.31 GHz (Peak)

Prepared For: LSR

Report: TR 314413

LSR: C-2114

Name: TiWi-C-W

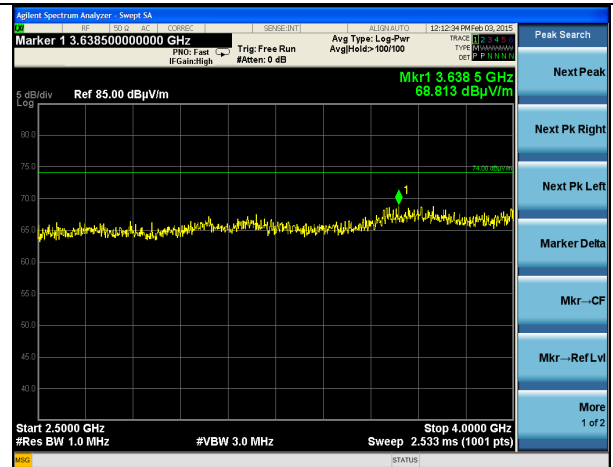
Model: TiWi-C-W

Serial: See Section 3.1

Plots



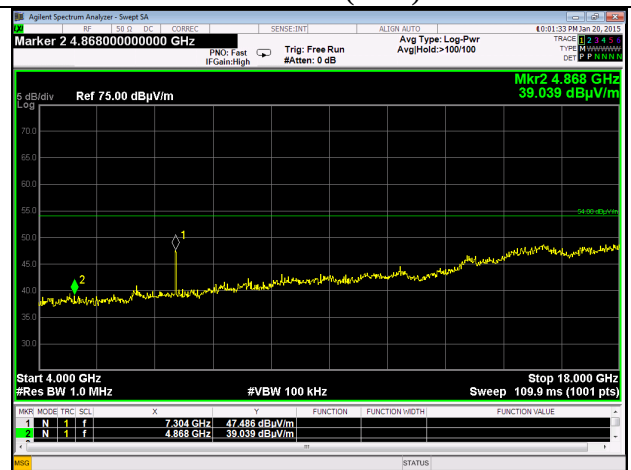
2.5-4 GHz (Average)



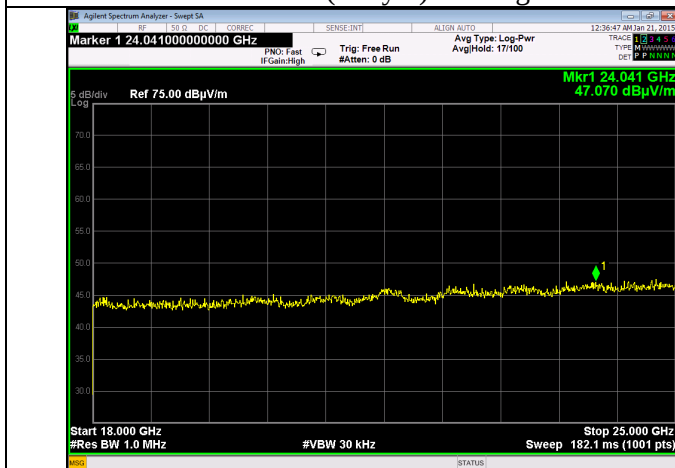
2.5-4 GHz (Peak)



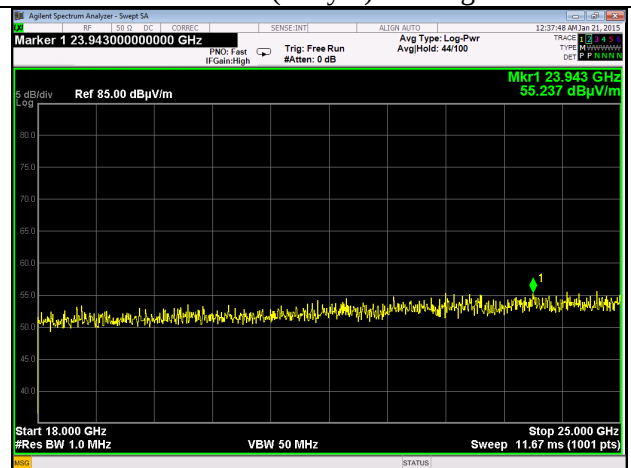
4-18 GHz (4-layer) Average



4-18 GHz (2-layer) Average



18-25 GHz Average



18-25 GHz Peak

Prepared For: LSR

Report: TR 314413

LSR: C-2114

Name: TiWi-C-W

Model: TiWi-C-W

Serial: See Section 3.1

B.2.3 – Radiated Emissions Receive Mode

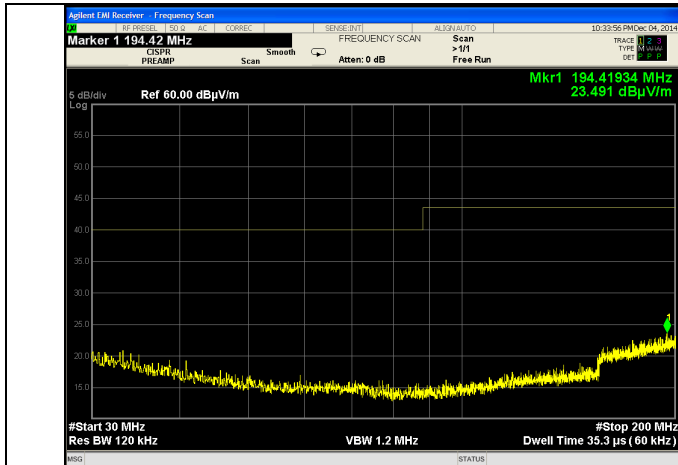
Manufacturer	LSR
Date	12-2, 12-4 2014 and 1-21, 1-30 2015
Operator	Adam A
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Rule Part	15.109 / RSS-GEN
Measurement Procedure	ANSI C63.4 - 2009 ANSI C63.10 - 2009
Test Distance	3 meter 4-18 GHz, 1 meter 18-25 GHz
EUT Placement	80 cm height non-conductive table centered on turn-table, EUT rotated in three orientations
Detectors	Peak; RBW 1 MHz
Additional Notes	1) Continuous receive mode on low, middle, high channels. 2) 4-layer board and 2-layer board 3) Antenna 1 and Antenna 2 4) Emissions not effected by channel receive antenna selection. 5) NO emissions found above system noise floor. 6) Emissions greater than 15 dB below limit.

Example Calculation:

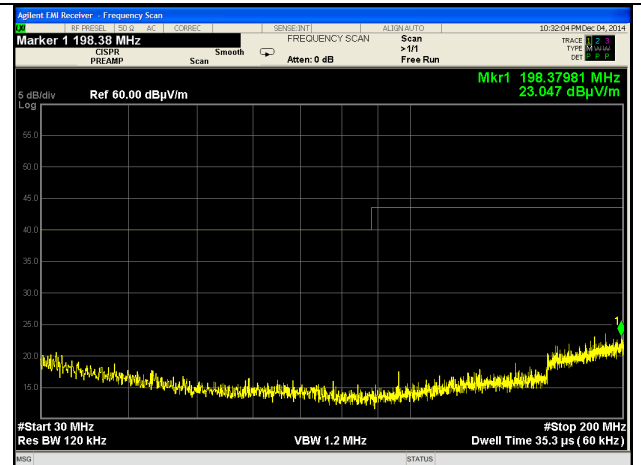
Limit (dBμV/m) – Reading (dBμV/m) = Margin

Prepared For: LSR	Name: TiWi-C-W
Report: TR 314413	Model: TiWi-C-W
LSR: C-2114	Serial: See Section 3.1

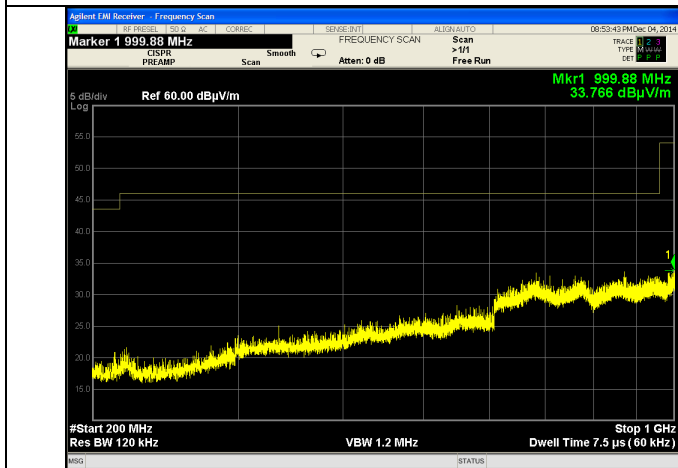
Plots



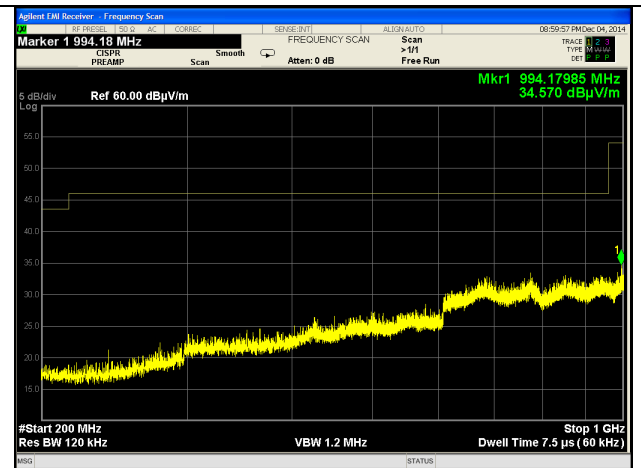
30-200 MHz – Vertical Ant



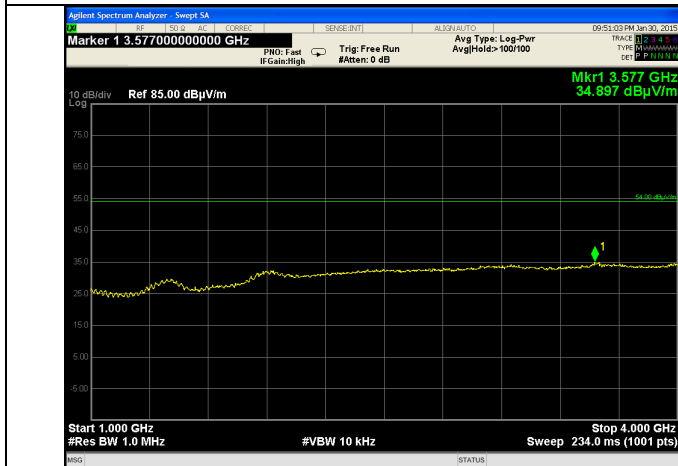
30-200 MHz – Horizontal Ant



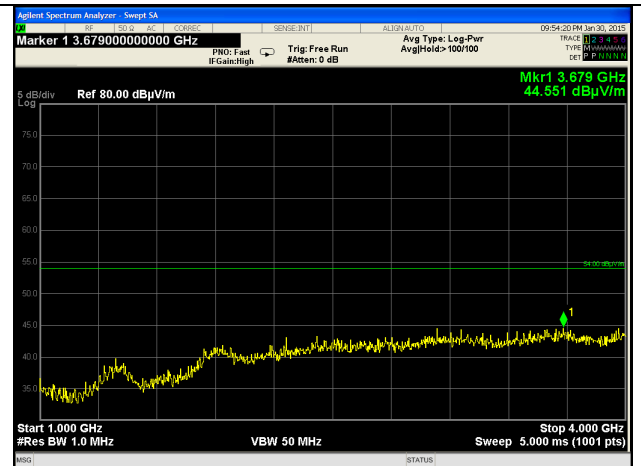
200-1000 MHz – Vertical Ant



200-1000 MHz – Horizontal Ant



1-4 GHz Average



1-4 GHz Peak

Prepared For: LSR

Report: TR 314413

LSR: C-2114

Name: TiWi-C-W

Model: TiWi-C-W

Serial: See Section 3.1

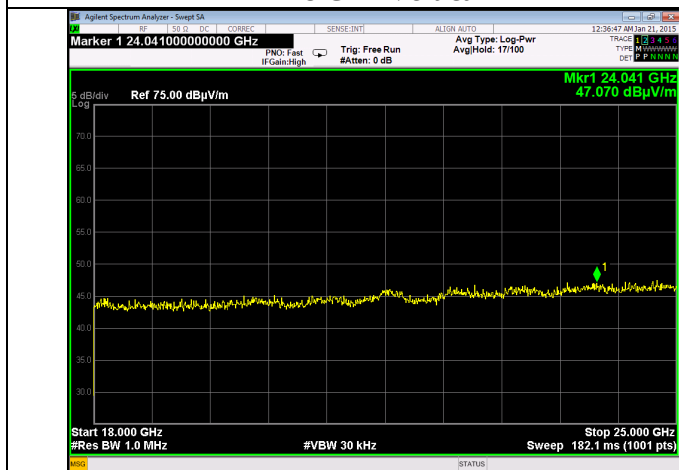
Plots



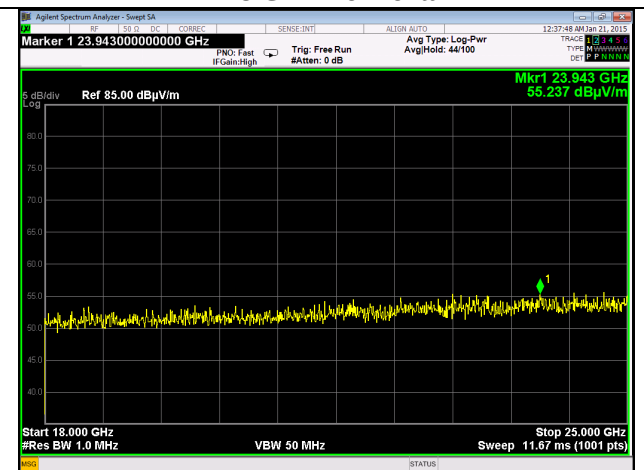
4-18 GHz Vertical



4-18 GHz Horizontal



18-25 GHz Average



18-25 GHz Peak

Prepared For: LSR

Report: TR 314413

LSR: C-2114

Name: TiWi-C-W

Model: TiWi-C-W

Serial: See Section 3.1

B.3 – AC Mains Conducted Emissions

Rule Part(s)	FCC: 15.207 / 15.107 IC: RSS-210 A8 / RSS-GEN
Measurement Procedure	ANSI C63.4 - 2009 ANSI C63.10 – 2009
Test Location	LS Research, LLC – Conducted Emissions Area
Test Voltage	120 VAC 60 Hz
EUT Placement	80 cm height non-conductive table above reference ground plane
Frequency Range of Measurement	150 kHz – 30 MHz
Measurement Detectors	Peak, Quasi-Peak, Average RBW: 9 kHz VBW: At least 27 kHz
Description of Measurement	1) The LISN, cable, limiter, and other necessary measurement system correction factors are loaded onto the EMI receiver / spectrum analyzer when the measurements are performed. The data is gathered and reported as the corrected values. 2) The EUT is placed on a non-conductive pedestal <u>made of expanded polyethylene foam</u> at appropriate distance from ground planes and plugged into LISN. The LISN used has the ability to terminate the unused port with a 50Ω (ohm) load when switched to either L1 (line) or L2 (neutral). 3) Maximum emissions are determined with peak detector and measurements at select points are made with quasi-peak and average detectors. Results are recorded and compared to limit.
Example Calculations	Reported Measurement data = Raw receiver measurement + LISN Factor + Cable factor (dB) + Additional factor (when applicable)

Limits of Conducted Emissions at the AC Mains Ports:

Frequency Range (MHz)	Class B Limits (dBμV)	
	Quasi-Peak	Average
0.150 -0.50 *	66-56	56-46
0.5 – 5.0	56	46
5.0 – 30	60	50
* The limit decreases linearly with the logarithm of the frequency in this range.		

Prepared For: LSR	Name: TiWi-C-W
Report: TR 314413	Model: TiWi-C-W
LSR: C-2114	Serial: See Section 3.1

B.3.1 – AC Mains Conducted Emissions

Manufacturer	LSR
Date	2-17-15
Operator	Adam A
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Rule Part	15.207 /15.107/ RSS-GEN
Measurement Procedure	ANSI C63.4 - 2009 ANSI C63.10 - 2009
Test Voltage	120 VAC 60 Hz supplying 3.3 VDC to module
EUT Placement	80 cm height non-conductive table, 40 cm from vertical ground plane
Detectors	Peak; RBW 9 kHz Quasi-Peak and Average
Additional Notes	1) Tested in continuous transmit and receive mode with no significant difference between. 2) Emissions not effected by change in channel. 3) Emissions similar between 2-layer and 4-layer designs. Tabular data representative of both.

Example Calculation:

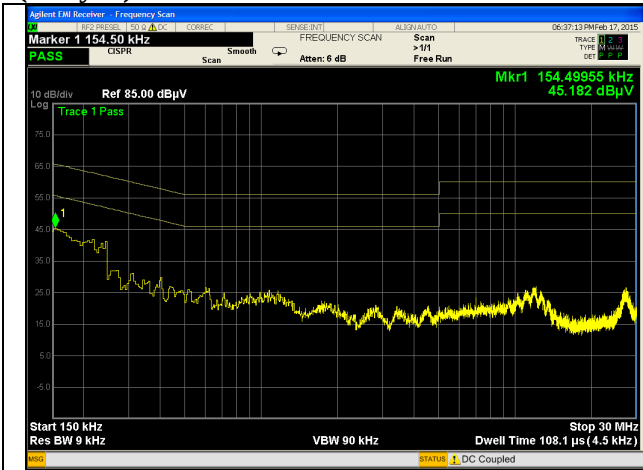
Margin (dB) = Limit (dBμV) – Reading (dBμV)

Table

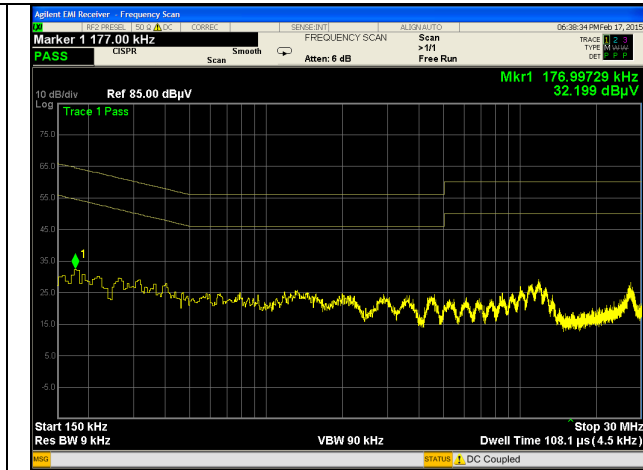
Frequency (MHz)	Line	Peak Reading (dBμV)	Q-Peak Reading (dBμV)	Q-Peak Limit (dBμV)	Quasi-Peak Margin (dB)	Average Reading (dBμV)	Average Limit (dBμV)	Average Margin (dB)
0.172	1	46.1	40.5	64.9	24.4	31.2	54.9	23.7
0.213	1	45.6	39.3	63.1	23.8	30.5	53.1	22.6
0.595	1	27.8	23.6	56.0	32.4	16.4	46.0	29.6
11.786	1	27.1	24.0	60.0	36.0	17.7	50.0	32.3
27.296	1	25.9	20.9	60.0	39.1	13.9	50.0	36.1
0.163	1	47.8	40.9	65.3	24.4	31.5	55.3	23.8
0.177	2	35.3	30.6	64.6	34.0	22.6	54.6	32.0
0.271	2	32.2	26.6	61.1	34.5	19.1	51.1	32.0
0.217	2	33.6	28.4	62.9	34.5	21.1	52.9	31.8
0.644	2	26.4	23.2	56.0	32.8	15.5	46.0	30.5
11.840	2	28.3	25.4	60.0	34.6	19.0	50.0	31.0
27.579	2	25.7	21.4	60.0	38.6	14.3	50.0	35.7

Prepared For: LSR	Name: TiWi-C-W
Report: TR 314413	Model: TiWi-C-W
LSR: C-2114	Serial: See Section 3.1

Plots
(4-layer)

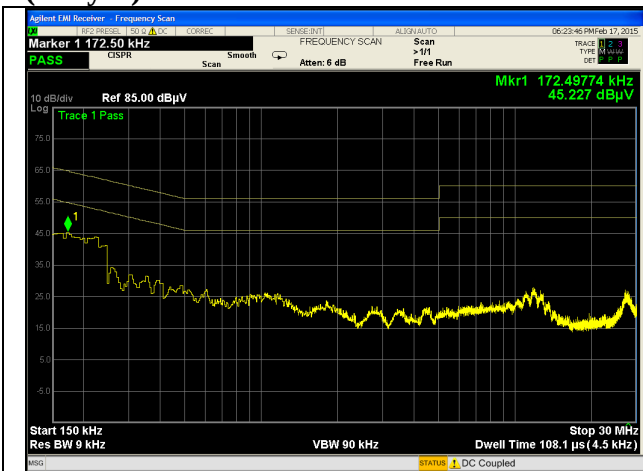


Line 1

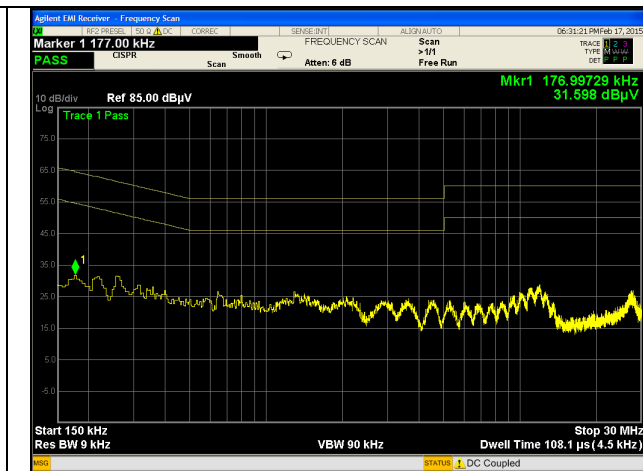


Line 2

(2-layer)



Line 1



Line 2

Prepared For: LSR	Name: TiWi-C-W
Report: TR 314413	Model: TiWi-C-W
LSR: C-2114	Serial: See Section 3.1

Appendix C - Uncertainty Summary

This uncertainty represents an expanded uncertainty expressed at approximately the 95 % confidence level, using a coverage factor of $k=2$.

Table of Expanded Uncertainty Values, (K=2) for Specified Measurements

Measurement Type	Particular Configuration	Uncertainty Values
Radiated Emissions	3 – Meter chamber, Biconical Antenna	4.82 dB
Radiated Emissions	3-Meter Chamber, Log Periodic Antenna	4.88 dB
Radiated Emissions	3-Meter Chamber, Horn Antenna	4.85 dB
Absolute Conducted Emissions	Agilent PSA/ESA Series	1.38 dB
AC Line Conducted Emissions	Shielded Room/EMCO LISN	3.20 dB
Radiated Immunity	3 Volts/Meter in 3-Meter Chamber	2.05 Volts/Meter
Conducted Immunity	3 Volts level	2.33 V
EFT Burst, Surge, VDI	230 VAC	54.4 V
ESD Immunity	Discharge at 15kV	3200 V
Temperature/Humidity	Thermo-hygrometer	0.64°/ 2.88 %RH

Appendix D - References

Publication	Year	Title
FCC CFR Parts 0-15	2015	Code of Federal Regulations – Telecommunications
ANSI C63.4	2009	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
RSS-210 Annex 8	2010	Low-power License-exempt Radio communication Devices (All Frequency Bands): Category I Equipment
RSS-GEN Issue 4	2014	General Requirements and Information for the Certification of Radio Apparatus
ANSI C63.10	2009	American National Standard for Testing Unlicensed Wireless Devices
FCC KDB 558074 D01 DTS Meas Guidance v03r02	2014	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247

END OF REPORT

Date	Version	Comments	Person
2-18-15	V0	Initial Draft Release	Adam A
2-23-15	V1	Final Release	Adam A
3-12-15	V1a	TCB Response Corrections / Additions	Adam A
4-22-15	V1b	TCB Response Clarifications	Adam A

Prepared For: LSR	Name: TiWi-C-W
Report: TR 314413	Model: TiWi-C-W
LSR: C-2114	Serial: See Section 3.1