Project: IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)

Submission Title: Adjacent Channel Rejection Performance Study
Date Submitted: March 6, 2011
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Re:

Abstract: Comment Resolution

Purpose: Information to be used to describe functionality of new coexistence option

Adjacent Channel Rejection System Performance Impact Study

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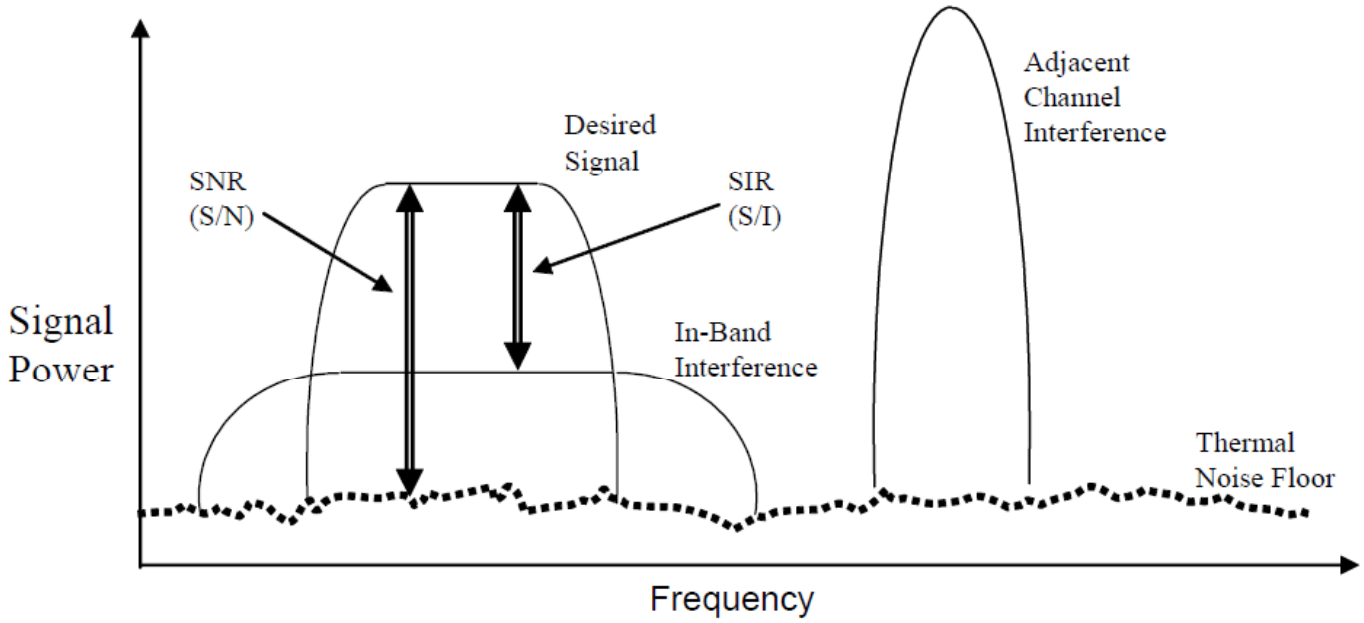
What Is ACR?

Adjacent channel rejection (ACR)
is a measure of how well a receiver performs on its frequency channel when there is an interfering system in the vicinity operating on a nearby channel.



How ACR is Measured

It is defined as follows:

"6.5.3.4 Receiver jamming resistance

The adjacent channel is one on either side of the desired channel that is closest in frequency to the desired channel, and the alternate channel is one more removed from the adjacent channel. For example, when channel 13 is the desired channel, channel12 and channel 14 are the adjacent channels, and channel11 and channel15 are the alternate channels. The adjacent channel rejection shall be measured as follows. The desired signal shall be a compliant IEEE 802.15.4 signal of pseudo-random data. The desired signal is input to the receiver at a level 3 dB above the maximum allowed receiver sensitivity given in 6.5.3.3. In either the adjacent or the alternate channel, an IEEE 802.15.4 signal is input at the required min performance level. The test shall be performed for only one interfering signal at a time. The receiver shall meet the error rate criteria defined in 6.1.6 under these conditions."

It is possible to stack the deck in your favor by using heavily filtered IEEE 802.15.4-2003 interferer signal to measure ACR.
This has the result of removing all energy from the interferer's side lobes that would other wise fall in-band.

Most 802.15.4 ICs exceed the standard's requirements by a long way.

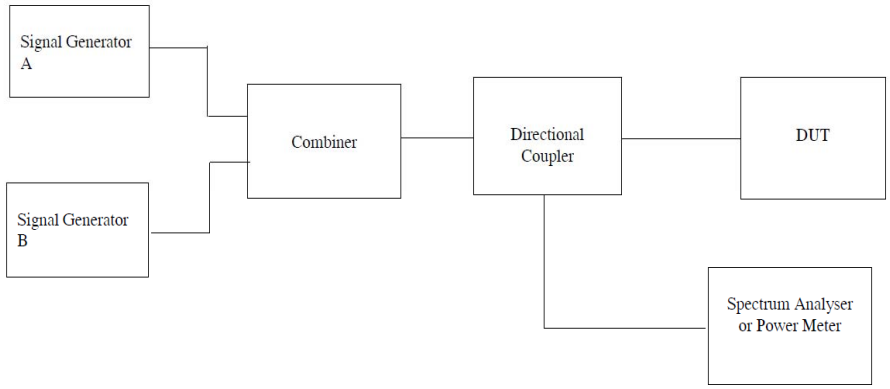
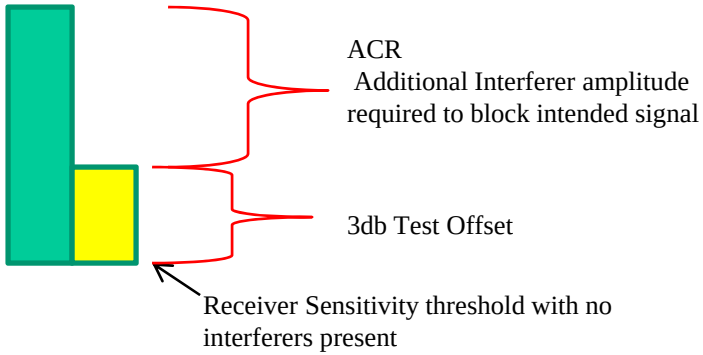


Figure 11: Measurement arrangement

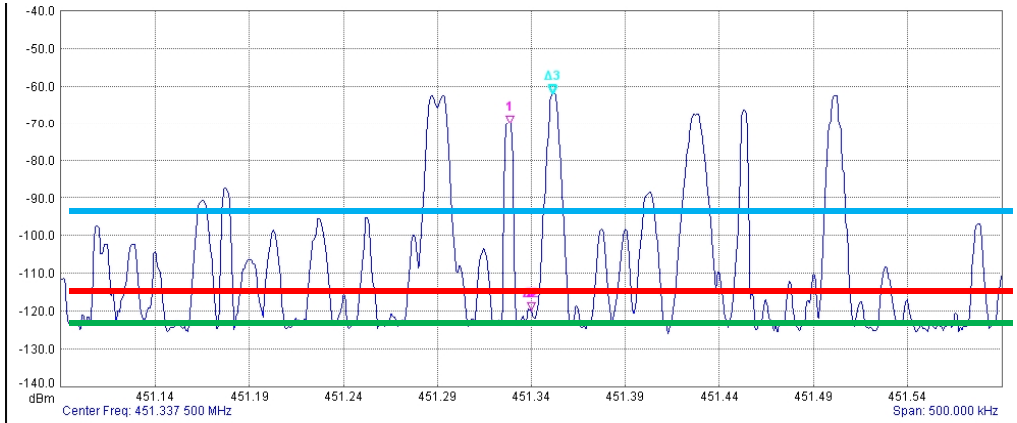


Smart Licensed Band Utility Network Data

licensed band 5dbi antenna 30ft elevation

Proposed ACR Performance

- 3db > RX Threshold
- MIN Alternate Channel Reject
- Min Adjacent Channel Rejection

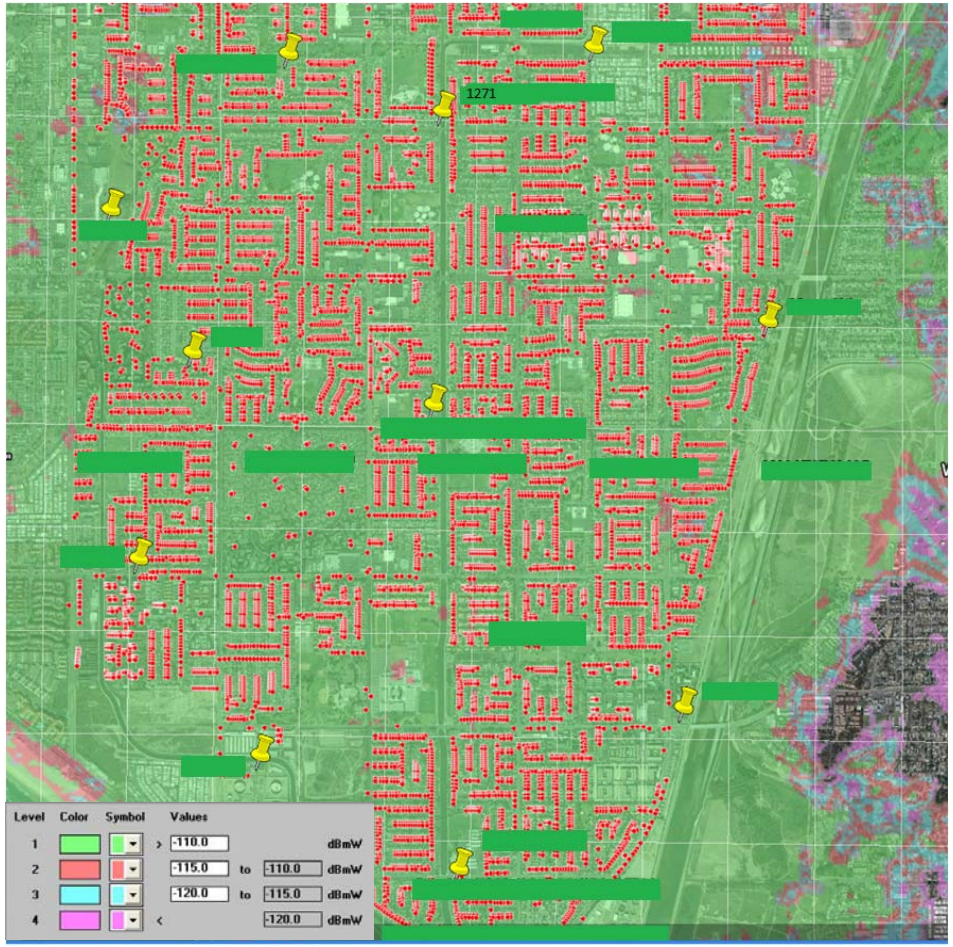


Mkr	Ref	Delta	Ref Freq	Ref Amp	Delta Freq	Delta Amp
1	☐	☐	451.326 1 MHz	-70.0344 dBm	- -	- -
2	☐	☐	451.337 5 MHz	-119.8701 dBm	-6.103 5 Hz	-0.0019 dB
3	☐	☐	451.337 5 MHz	-119.8701 dBm	**11.346 4 kHz**	**57.9221 dB**
4	☐	☐	- -	- -	- -	- -
5	☐	☐	- -	- -	- -	- -
6	☐	☐	- -	- -	- -	- -

Measurement Parameters

		Scale	10.0 dB/div
Trace Mode	Max Hold	GPS Longitude	W 117 59 11
Preamp	ON	GPS Latitude	N 33 40 29
Min Sweep Time	0.000336 S	GPS Fix Time	12 01 2010 18 52 17
Reference Level Offset	0.0 dB	Operator Name	
Input Attenuation	0.0 dB	Tower	
RBW	1.0 kHz	Serial Number	1016158
VBW	1.0 kHz	Base Ver.	V3.38
Detection	Peak	App Ver.	V4.35
Center Frequency	451.337 500 MHz	Model	MS2712E
Start Frequency	451.087 500 MHz	Options	25, 27, 31
Stop Frequency	451.587 500 MHz	Date	12/1/2010 11:51:15 AM

Licensed Band Installed System ACR Impact



40% Increase in Record Count

16,000 - Battery Powered End Points

12 - Data Collectors
Average Number of End Points Received Daily over a 7 day period at Data Collector "DC1271" using a receiver rated at
25 db ACR = 1131

Average Number of End Points Received Daily over a 7 day period at Data Collector "DC1271" using a receiver rated at
50 db ACR = 1835

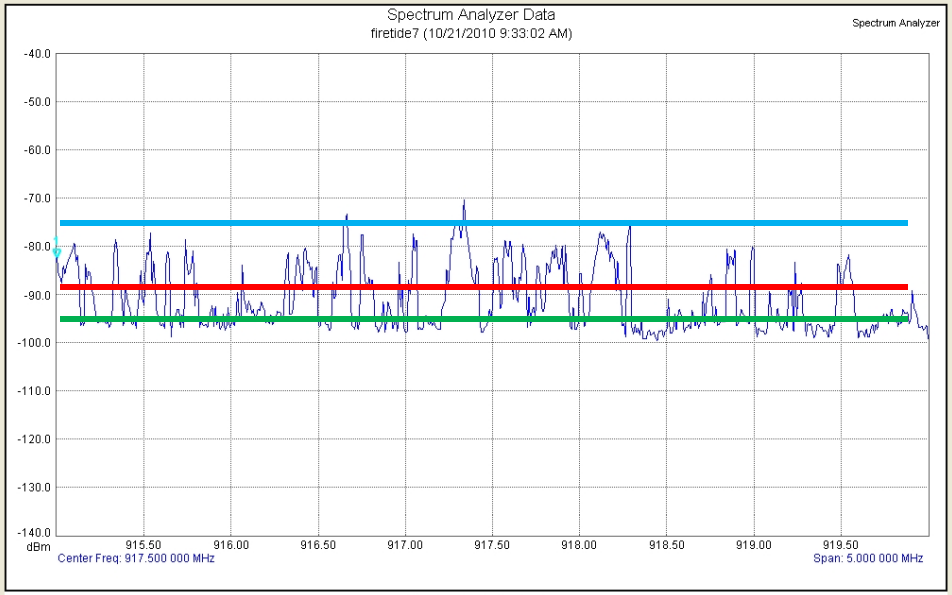
All other receiver specifications were identical

Smart Utility ISM Network Data

ISM band 3 dBi antenna 30ft elevation

Proposed ACR Performance

- 3db > RX Threshold
- MIN Alternate Channel Reject
- Min Adjacent Channel Rejection



Measurement Parameters

		Frequency Span	5.000 000 MHz
Trace Mode	Max Hold	Reference Level	-40.000 dBm
Preamp	ON	Scale	10.0 dB/div
Min Sweep Time	0.001 S	Operator Name	
Reference Level Offset	0.0 dB	Tower	
Input Attenuation	0.0 dB	Serial Number	1018077
RBW	1.0 kHz	Base Ver.	V3.38
VBW	1.0 kHz	App Ver.	V4.35
Detection	Peak	Model	MS2712E
Center Frequency	917.500 000 MHz	Options	25, 31
Start Frequency	915.000 000 MHz	Date	10/21/2010 9:33:02 AM
Stop Frequency	920.000 000 MHz	Device Name	

Example Transceiver ACR Performance

Brand W

RSSI Resolution	RES_{RSSI}		—	±0.5	—	dB
±1-Ch Offset Selectivity[3]	C/I_{1-CH}	Desired Ref Signal 3 dB above sensitivity, BER < 0.1%. Interferer and desired modulated with 40 kbps ΔF = 20 kHz GFSK with BT = 0.5, channel spacing = 150 kHz	—	–31	—	dB
±2-Ch Offset Selectivity[3]	C/I_{2-CH}		—	–35	—	dB
≥ ±3-Ch Offset Selectivity[3]	C/I_{3-CH}		—	–40	—	dB
Blocking at 1 MHz Offset[3]	$1M_{BLOCK}$	Desired Ref Signal 3 dB above sensitivity. Interferer and desired modulated with 40 kbps ΔF = 20 kHz GFSK with BT = 0.5	—	–52	—	dB
Blocking at 4 MHz Offset[3]	$4M_{BLOCK}$		—	–56	—	dB
Blocking at 8 MHz Offset[3]	$8M_{BLOCK}$		—	–63	—	dB
Image Rejection[3]	Im_{REJ}	Rejection at the image frequency. IF=937 kHz	—	–30	—	dB
Spurious Emissions[3]	P_{OB_RX1}	Measured at RX pins	—	—	–54	dBm

Brand X

RFS_O	OOK sensitivity, highest LNA gain	BR = 4.8 kb/s	-	-112	-109	dBm
CCR	Co-Channel Rejection		-13	-10	-	dB
ACR	Adjacent Channel Rejection	Offset = +/- 25 kHz Offset = +/- 50 kHz	- 37	42 42	- -	dB dB
BI	Blocking Immunity	Offset = +/- 1 MHz Offset = +/- 2 MHz Offset = +/- 10 MHz	- - -	-45 -40 -32	- - -	dBm dBm dBm
	Blocking Immunity Wanted signal at sensitivity +16dB	Offset = +/- 1 MHz Offset = +/- 2 MHz Offset = +/- 10 MHz	- - -	-36 -33 -25	- - -	dBm dBm dBm

Brand Y

Adjacent channel rejection (ACR)					Wanted signal 3 dB above the sensitivity level, FM jammer (1 kHz sine, ± 2.5 kHz deviation) at adjacent channel. BER = 10^{-3}
12.5 kHz channel spacing, 433 MHz		32		dB	
25 kHz channel spacing, 433 MHz		37		dB	
25 kHz channel spacing, 868 MHz		32		dB	

Brand Z

±1-Ch Offset Selectivity[3]	C/I_{1-CH}	Desired Ref Signal 3 dB above sensitivity, BER < 0.1%. Interferer and desired modulated with 40 kbps ΔF = 20 kHz GFSK with BT = 0.5, channel spacing = 150 kHz	—	–31	—	dB
±2-Ch Offset Selectivity[3]	C/I_{2-CH}		—	–35	—	dB
≥ ±3-Ch Offset Selectivity[3]	C/I_{3-CH}		—	–40	—	dB

?Questions ?

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