Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	Image Rejection Requirements and Transmit Power Control Requirements for Low Cost IEEE 802.16 OFDM Radio Transceiver Implementations
Date Submitted	**2003-11-05**
Source(s)	Roger Eline Intel Corporation 350 E. Plumeria San Jose, Ca. Voice: 408-545-9631 roger.j.eline@intel.com
Re:	
Abstract	The contribution proposes a changes to OFDM PHY P802.16-REVd/D1-2003
Purpose	Adoption
Notice	This document has been prepared to assist IEEE 802.16. It is offered as a basis for discussion and is not binding on the contributing individual(s) or organization(s). The material in this document is subject to change in form and content after further study. The contributor(s) reserve(s) the right to add, amend or withdraw material contained herein.
Release	The contributor grants a free, irrevocable license to the IEEE to incorporate material contained in this contribution, and any modifications thereof, in the creation of an IEEE Standards publication; to copyright in the IEEE's name any IEEE Standards publication even though it may include portions of this contribution; and at the IEEE's sole discretion to permit others to reproduce in whole or in part the resulting IEEE Standards publication. The contributor also acknowledges and accepts that this contribution may be made public by IEEE 802.16.
Patent Policy and Procedures	The contributor is familiar with the IEEE 802.16 Patent Policy and Procedures <http://ieee802.org/16/ipr/patents/policy.html>, including the statement "IEEE standards may include the known use of patent(s), including patent applications, provided the IEEE receives assurance from the patent holder or applicant with respect to patents essential for compliance with both mandatory and optional portions of the standard." Early disclosure to the Working Group of patent information that might be relevant to the standard is essential to reduce the possibility for delays in the development process and increase the likelihood that the draft publication will be approved for publication. Please notify the Chair <mailto:chair@wirelessman.org> as early as possible, in written or electronic form, if patented technology (or technology under patent application) might be incorporated into a draft standard being developed within the IEEE 802.16 Working Group. The Chair will disclose this notification via the IEEE 802.16 web site <http://ieee802.org/16/ipr/patents/notices>.

Image Rejection Requirements and Transmit Power Control Requirements for Low Cost IEEE 802.16 OFDM Radio Transceiver Implementations

By Roger Eline, Intel Corporation

Forward

As technology continues to advance, bringing us wireless connectivity only dreamed of by entrepreneurs of the 80's, the anticipated cost of these revolutionary products is headed in the opposite direction. With the world economy slumping, few find worth in paying for over-priced high tech luxuries. But wait, if a value priced product reaches the market, it appears, well at least for IEEE 802.11 products, a slumping market is willing to embrace it.

Prospective IEEE 802.16d product manufacturers, encouraged by the success of IEEE 802.11, should look at what basic properties led to its' success. The question needs to be asked, is the consumer captivated by the technology or the value of the technology. In today's value based economy the latter is more likely the better answer. It is this concept that supplicates the necessity to re-evaluate the rationale behind applying those requirements typical of older Standards that conflict with market requirements of a new technology.

Background

In performance driven wireless technology, high interference immunity is critical to a robust receiver. However, achieving such high immunity levels comes at a cost, requiring expensive filters and high dynamic range components. In a cost driven wireless technology, if the mandated system performance is excessive, the cost of implementation can price a technology out of the market.

Problem 1

A necessary requirement placed on traditional and modern receiver systems is the specification of a minimum acceptable amount of image rejection. With the inexorable proliferation of wireless systems integrated into our customary life, the concern over interfering systems is rightly justified.

To this concern, in order to ensure basic performance, a minimum level of image rejection should be imposed. It is recommended to require a minimum acceptable image rejection level of 60 dB.

The receive image rejection currently imposed by HIPERMAN ETSI TS 102 177, “Broadband Radio Access Networks (BRAN); HIPERMAN; Physical (PHY) Layer” is 75 dB. 75dB rejection is certainly realizable, but imposes costly constraints on the receiver implementation. 60dB image rejection can be attained at a more sensible cost by several approaches. In the case of direct conversion receivers, no image frequency exists, so an image rejection requirement is not applicable. For receive architectures implemented by conversion to an intermediate frequency, front end RF filters providing 60dB rejection at the image frequency can be utilized. In the case of super-heterodyne receivers, additional IF filters with 60dB overall image rejection can also be provided. This implementation is shown in figure 1.

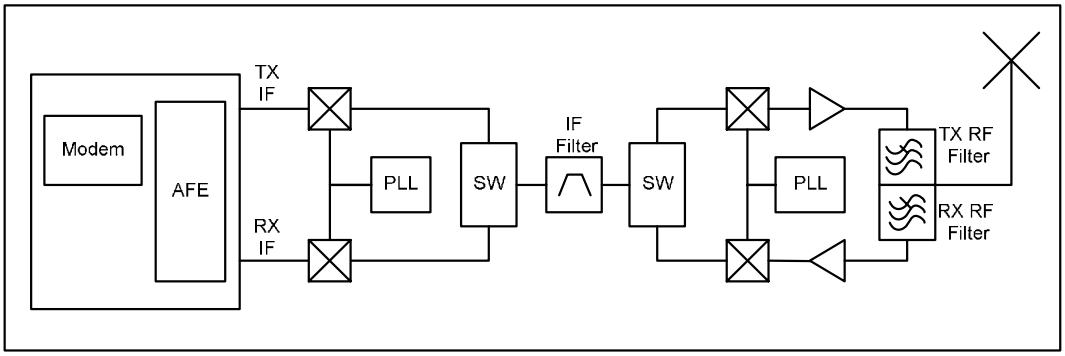

Figure 1. Transceiver implemented with image reject filters

However, a more practical receive architecture might be one that portions the required image suppression across an image reject mixer and image reject filter. Image reject mixers, integrated within the RFIC, typically supply 25-30dB image suppression, while a reasonably priced image reject filter can supply the additional 30-35dB. Cascading the two image reject methods yields roughly 60 dB of image suppression. This type of transceiver is shown in figure 2.

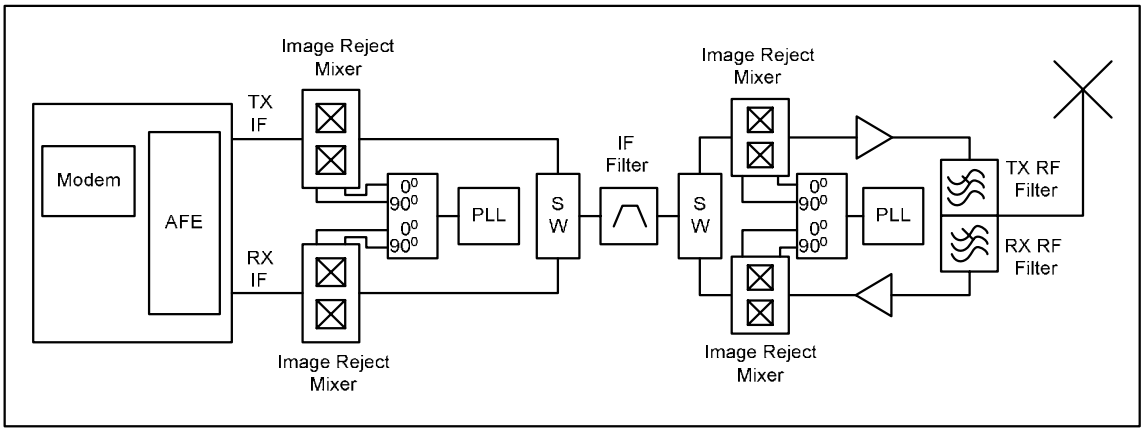

Figure 2. Transceiver implemented with image reject mixers

Conclusion

Imposing a minimum receive image rejection requirement of 60dB will set a minimum level of performance consistent with high quality systems while assuring the ability to architect a cost efficient receiver solution. The practical realization of 60dB image rejection is reasonable and provides substantial immunity to hostile signals. 60dB image suppression can be achieved cost effectively by the use of image reject mixers and filters, allowing low cost systems to be deployed with sufficient performance. It is also suggested that HIPERMAN ETSI TS 102 177 Standard follow in suit and relax the minimum receive image rejection requirement from 75dB to 60dB. This will allow lower cost system solutions, while still permitting those interested in providing higher performance system solutions to do so.

Problem 2

TX Power Control, Relative Accuracy Requirements

Another stringent performance requirement adversely affecting Radio cost is TX power control range accuracy. IEEE 802.16 for OFDM PHY in document P802.16-REVd/D1-2003, Section 8.4.9.1 states:

"The transmitter shall support monotonic power level control of 30 dB minimum with a minimum step size of 1 dB, a relative accuracy of ± 0.5 dB for a SS and 10 dB minimum with a minimum step size of 1 dB and a relative accuracy of ± 0.5 dB for a BS.

Subscriber station supporting subchannelization shall be capable of monotonic power level control of 50 dB minimum."

Section 12.3.2, Table 303 of document P802.16-REVd/D1-2003 provides the OFDM PHY profile:

Table 303—Minimum Performance basic requirements

Capability	Minimum Performance
Tx Dynamic range SS SS (if subchannelization supported) BS	 ≥ 30 dB ≥ 50 dB ≥ 10 dB
Tx Power Level minimum adjustment step	≤ 1 dB
Tx Power Level minimum relative step accuracy	≤ +/- 0.5 dB

According to the current requirements, a relative step accuracy of +/- 0.5dB is required for all transmit power level changes. In practical radio realizations this accuracy is difficult to achieve for modest step changes in transmit power, and impractical to implement for large step changes in power level. It is recommended to change the relative step accuracy requirement of section 8.4.9.1 to more closely align with the transmit power control defined for WirelessMAN-SCa single carrier PHY and shown in table 293.

Solution

Change P802.16-REVd/D1-2003, Section 8.4.9.1 to read:

A SS transmitter shall support 30 dB of monotonic power level control ~~of 30 dB minimum~~ with an absolute tolerance of +/-3dB, minimum step size of 1 dB, and relative accuracy of the lesser of ±50% of the incremental power level step or ±3 dB. A Subscriber station supporting subchannelization shall be capable of monotonic transmit power level control of 50 dB minimum with an absolute tolerance of +/-3dB, minimum step size of 1 dB, and relative accuracy of the lesser of ±50% of the incremental power level step or ±3 dB. ~~, a relative accuracy of ± 0.5 dB for a SS and 10 dB minimum with a minimum step size of 1 dB and a relative accuracy of ± 0.5 dB for a BS~~.

A BS transmitter shall support 10 dB of monotonic power level control with an absolute tolerance of +/-1 dB, minimum step size of 1 dB, and relative accuracy of the lesser of 50% of the incremental power level step or ±1 dB.

Change P802.16-REVd/D1-2003, Section 12.3.2, Table 303 to:

Capability	Minimum Performance
Tx Dynamic range SS SS (if subchannelization supported) BS	 ≥ 30 dB ± 3dB ≥ 50 dB ± 3dB ≥ 10 dB ± 1dB
Tx Power Level minimum adjustment step	≤ 1 dB
Tx Power Level minimum relative step accuracy	Lesser of 50% of incremental power level step or ± 3 dB