Infrared (IR)-PHY Modulation Template and Specifications

Editors:

Peter Blomeyer
Andromeda GMBH
Benzstrasse 30
D-82178 Puchheim
GERMANY
FAX: 49-89-80-60-40
and UBBB, Parsbergstrasse 1
D-81247 München 60
Tel: 49-89-877-377

Kamilo Feher
University of California, Davis
ECE Department
Davis, CA 95616
Tel: 916-752-8127
FAX: 916-752-8428
and Digcom, Inc.
Tel/FAX: 916-753-1788

Summary

This document is an integration and revision/update of the IEEE P.802.11-Infrared (IR) Committee unanimously approved 4Mb/s and 10Mb/s rate FQPSK modulated PHY template and specifications (approved during the IR May 1994 Oshawa, Canada committee meeting-official minutes issued by B. Dobins, Secretary of IEEE 802.11 IR committee, May 1994, document IEEE P802.11-94/.....). The template part of this document is based on IEEE P 802.11-94/131 and the specifications part on document IEEE P.802.11-94/125. Herein we incorporated the approved and agreed revisions, comments and specifications and modulation parameters.

This document is intended to provide a framework for the development of the detailed and final IEEE P.802.11 IR-PHY 4Mb/s and 10Mb/s rate FQPSK modulated standards. A separate document and IR baseband PHY template and specifications for 1 Mb/s and 2 Mb/s rate transmission based on 16-PPM and 4-PPM has been also defined approved and specified by the IR committee. For the baseband IR-PHY please see IEEE P.802.11-94/130 (Rui Valadas and Barry Dobin, Editors, May 1994 and their follow up reviqions/updates) Following extensive study and evaluation by the IR committee all other (approximately 16) baseband and modulation PHY infrared proposals have been specifically rejected. The modulated FQPSK and baseband PPM methods are the only ones that meet and satisfy the IR IEEE 802.11 objectives and specification requirements.

Table 1

Item No.	Spec. No.	System Parameter	Specification	Issue Open/ Closed Date	Comments/Notes
	1	**MODULATED PHY TRANSMIT AND RECEIVE-GENERAL SPECIFICATION**			
	1.1	Data Rates	4 Mb/s and 10 Mb/s	Closed 5/11/94	
	1.2	Number of Channels	1 to 6		
	1.3	IR Wavelength	850 nm to 900 nm	Closed 3/9/94	
	1.4	IR Max. Transmit Power	2 Watt ± 20%		See Section 2; IR Transmitter Details
	1.5	Bandwidth Allocation		Closed 3/9/94	Baseband IR-PHY: see Document IEEE P.802.11-94/130
		Baseband Co-existence band Carrier modulated band	0-5 MHz 5-15 MHz 15-30 MHz		
	1.6	Coverage range	30 meters		
	1.7	CSMA			
	1.8	Propagation Mode	Diffuse		
	1.9	Modulation	FQPSK	Closed 5/11/94	
	1.10	Spectrum/Bandwidth	–20 dBc at f_c±2 MHz for 4Mb/s f_c±5 MHz for 10Mb/s	Closed 5/11/94	
	1.11	BER = 10^{-8}	E_b/N_o = 17 dB	Closed 5/11/94	
	1.12				
	1.13				
	1.14				
	2	**IR TRANSMITTER SPECIFICATION (MAX)**	2 Watt peak ± 20%		
	2.1	Wavelength of Transmitter	850 nm to 900 nm		
	2.2	Minimum IR output cone—FWHM	90°—opening vertically		
	2.3	Maximum IR Irradiance	15 Watts/sr		
	2.4				
	2.5				
	2.6				
	2.7				

Item No.	Spec. No.	System Parameter	Specification	Issue Open/ Closed Date	Comments/Notes
	3.	**IR RECEIVER SPECIFICATION**			
	3.1	Sensitivity for BER = 10^{-x} (10^{-5} or better)	-33 ± 3 dBm/cm^2		
	3.2	Dynamic Range	50 dB		
	3.3	Receiver Field of View – FWHS	120°—full width, half sensitivity		
	3.4	Maximum Field of View	170° at physical limit		
	4	**CARRIER MODULATION TRANSMITTER AND RECEIVER**			
	4.1	Bandwidth Allocation	15 MHz to 30 MHz	Closed 3/9/94	
	4.2	Bit Rates	4 Mb/s and 10 Mb/s	Closed 5/11/94	
	4.3	Bandwidth/spectrum	–20 dBc at $f_c \pm 2$ MHz for 4Mb/s $f_c \pm 5$ MHz for 10Mb/s	Closed 5/11/94	
	4.4	Nonlinearly Amplified Constant Envelope FQPSK Envelope Tolerance	± 5% max tolerance error	Closed 5/11/94	
	4.5	Center Frequencies of FQPSK modulated signals for 4 Mb/s	f_c = 5.5 MHz + 2N × 1 MHz; N = ,5...11		
	4.5.1	Center Frequencies of FQPSK modulated signals for 10 Mb/s	f_c = 23.5 MHz		
	4.6	Modulation Transmitter	FQPSK		See Doc: IEEE P.802.11-94/55; P.802.11-93/97 and references listed therein.
	4.6.1	Digital Encoding	Differential Gray Encoder		

Item No.	Spec. No.	System Parameter	Specification	Issue Open/ Closed Date	Comments/Notes
	4.6.2	Encoder Table	Digit pattern d_o is first in time / Phase Change 0 0 / 0° 0 1 / 90° 1 1 / 180° 1 0 / 270°		
	4.6.3	Offset bit delay in Quadrature Baseband (Q)	1 bit = 0.5 symbol with ± 5% tolerance		
	4.6.4	Baseband Transmit FQPSK filter/processor and Tolerance Mask of Shaped Pulse Format of I and Q signals	Logic In / Output Signal 0 0 / −1 dc value 0 1 / −1 to +1 sinus 1 1 / +1 dc value 1 0 / +1 to −1 sinus Sinusoidal transition starts at beginning of second symbol. 10% tolerance	Closed 5/11/94	Doc. IEEE P.802.11-93/97, July 1993 provides a detailed description. See also references listed in Doc. 94/149.
	4.6.5	Quadrature Modulator Amplitude Error and Phase Error	± 0.25 dB ± 2.5°		
	4.7	Demodulation (Rx) Specs			
	4.7.1	BER Performance	BER = 10^{-2} for E_b/N_o = 9 dB BER = 10^{-5} for E_b/N_o = 13 dB BER = 10^{-8} for E_b/N_o = 17 dB		
	4.6.2	Synchronization Time/Max	30 µsec		
	4.6.3	Delay Spread Tolerance of Basic Rate f_b = 1 Mb/s demodulator for	Maximal performance degradation of BER at BER = 10^{-4}: τ = 100 ns / 0.5 dB τ = 200 ns / 1 dB τ = 300 ns / 1.5 dB		
	4.6.4	Dynamic Range	50 dB		