Draft Standard Text for Direct Sequence Spread Spectrum

Medium Dependent PHY Sublayer

edited by Paul Struhsaker, Telxon/Aironet

This document is a working draft proposal based on the DS PHY template document 93/232. This document will be continually edited and revised until final approval by the 802.11 working group and IEEE 802 balloting.

8.4.1 Direct Sequence Spread Spectrum PHY

The following sections provide a complete specification for the Direct Sequence Spread Spectrum Physical Layer.

8.4.1.1 Frequency Range

The DS PHY will operate in the frequency range of 2.4 to 2.4835 GHz as allocated by regulatory bodies in the USA and Europe.

The 2.471 to 2.497 GHz frequency band has been allocated by regulatory authority in Japan.

Additional frequency bands will follow as they are made available.

8.4.1.2 Number of Channels

For the 2.4 to 2.4835 GHz frequency band, 5 channels are specified. These channels are divided into two channels groups: group 1 and group 2. The group 1 channel center frequencies are as follows:

- Channel 1a : 2412 GHz
- Channel 1b: 2442 GHz
- Channel 1c: 2472 GHz

The group 2 channel center frequencies are as follows:

- Channel 2a: 2427 GHz
- Channel 2b: 2457 GHz

In a multiple cell network topology, adjacent cells using different group 1 channels can operate simultaneously without interference. In a similar fashion, group 2 channels can operate simultaneously with other group 2 channels. Group 1 and group 2 channels may be used simultaneously in a cellular frequency plan where the interference effects have been factored into the cell plan.

8.4.1.3 Spreading Sequence

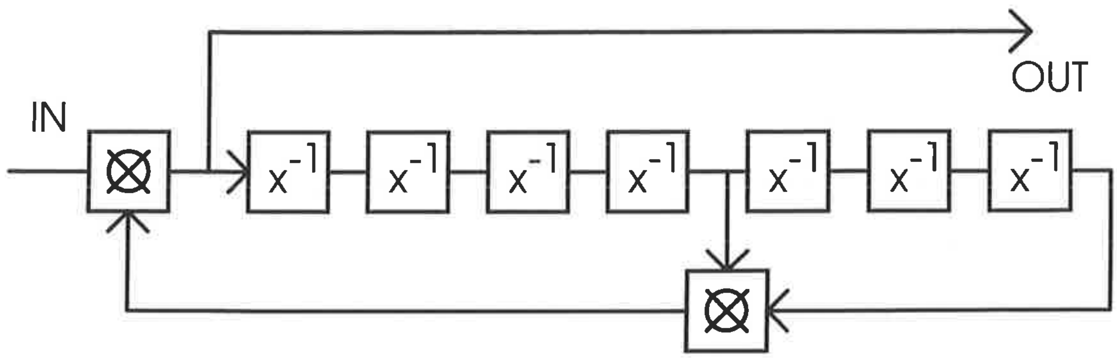
The following 11 chip Barker sequence shall be used :

+1, -1,+1,+1, -1,+1, +1, +1, -1, -1, -1

The left most chip is output first in time. The first chip is aligned as the start of a transmitted symbol. The symbol duration is exactly 11 chips long.

8.4.1.4 Data Scrambling

The polynomial $1 + x^{-4} + x^{-7}$ shall be used to scramble **ALL** data transmitted by the DS PHY. The following diagram illustrates a typical implementation of the data scrambler. Other implementations are possible.



8.4.1.5 Transmitted Power Level

The maximum transmitted power shall be no greater than 1000 mW for the USA and 100 mW for Europe and Japan. The maximum transmitted power is subject to change based on the rules set by regional regulatory bodies.

8.4.1.6 Minimum Transmitted Power Level

The minimum transmitted power shall be no less than 10 mW.

8.4.1.7 Transmitted Power Control

Power control shall be provided for transmitted power greater than 100 mW. A maximum of 4 power levels shall be provided between 100 mW and 1000 mW. At a minimum, a radio capable of transmission greater than 100 mW must be capable of switching power back to 100 mW or less.

8.4.1.8 Maximum Radiated EIRP

The total radiated power (including antenna gain) shall comply with the rules set by the regulatory agencies in each country. For the USA, the maximum radiated EIRP is set per FCC part 15.247. For Europe, the maximum radiated EIRP is set per ETSI res 02-09.

8.4.1.9 Receiver Minimum Input Level Sensitivity

The Bit Error Rate (BER) shall be less than 10^{-5} for an input level of -80 dBm measured at the antenna connector. This BER is specified for 2 MBPS QPSK modulated with the 11 chip Barker spreading sequence.

8.4.1.10 Receiver Maximum Input Level

The Receiver shall tolerate a maximum input level of -4 dBm measured at the antenna connector.

8.4.1.11 Receiver Adjacent Channel Rejection

Adjacent channel rejection is defined for the channel groups (group 1 or group 2) defined in section 8.4.1.2.

The adjacent channel rejection shall be equal to or better than 37 dB with a BER of 10^{-5} using 2 MBPS QPSK with the 11 chip Barker spreading code.

The adjacent channel rejection shall be measured using the following method:

Input a 2 MBPS QPSK signal spread with the 11 chip Barker spreading code at a level 2 dB greater than specified in section 8.4.1.9. In an adjacent channel (as defined by the channel groups), input a signal modulated in a similar fashion to a level 39 dB above the level specified in 8.4.1.9. Under these conditions, the BER shall be no worse than 10^{-5}.

Note: The adjacent channel signal must be derived from a separate signal source. It can not be a frequency shifted version of the reference channel.

8.4.1.12 Transmit Channel Spectrum Mask

The transmitted spectral products shall be less than -30 dBc at +/- 11 MHz (dB compared the SINx/x center peak) and -50 dBc at +/- 22 MHz.

8.4.1.13 Transmit Center Frequency Tolerance

The transmitted center frequency tolerance is +/- 25 ppm over the specified temperature. Two temperature ranges are specified. Type 1 is defined as 0^{o} C to 40^{o} C for office environments. Type 2 is defined as -30^{o} C to 70^{o} C.

8.4.1.14 Modulation and Channel Data Rates

The following modulation formats are specified:

- Basic Access Rate of 1 MBPS DBPSK using the encoder specified in the following table:

Bit Input	Phase Change (+jw)
0	0
1	Π

- Enhanced Access Rate of 2 MBPS DQPSK using the encoder specified in the following table:

•Dibit Pattern (d0,d1) d0 is first in time	Phase Change (+jw)
00	0
01	Π/2
11	Π
10	3Π/2 (-Π/2)

A compatible DOQPSK Enhanced Access Rate modulation may be used by introducing a 1/2 chip offset in the Q (Quadrature) transmit path.

8.4.1.15 Chip Clock Accuracy

The chip clock accuracy shall be less than +/- 50 ppm across the appropriate Type 1 or Type 2 temperature range specified in section 8.4.1.12.

8.4.1.16 Radio Preamble and Data Packet

All data packets transmitted by the DS PHY shall start with a 160 bit radio synchronization preamble transmitted using DQPSK Basic Rate modulation at 1 MBPS as described in section 8.4.1.14. All bits in the preamble are scrambled as described in section 8.4.1.

The preamble contains the following fields with the left most bit in each field transmitted first in time:

- Synchronization field: 128 bits of 1 (ones)
- Unique word: 16 bits 0000010111001111 (octal 02717)
- 802.11 modulation signaling bits: 8 bits
  11000000: 1 MBPS DBPSK

  00110000: 2 MBPS DQPSK
  00001100: 2 MBPS DOQPSK
  Additional services based on 802.11 signaling bits will be specified as they are approved.
- Vendor bits provided for custom services: 8 bits which must be all 0's for 802.11

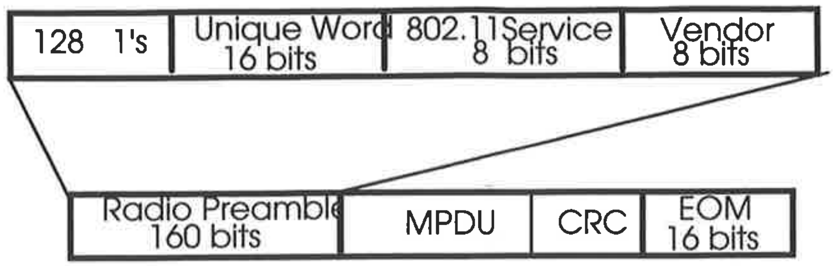
The modulation specified by the 802.11 signaling bits is applied to the first symbol (bit or dibit) in the MDPU which directly follows the radio preamble and is applied to all symbols that follow. The 802.11 service bit feature allows support of multiple data rates within a BSS. The DQPSK Basic Rate modulation provides common access for all DS PHY APs and STAs for each transmitted packet.

An end of message (EOM) delimiter shall be directly appended to the MDPU and shall consist of the following 16 bit word:

1111001110010000 (octal 171640)

The EOM in NOT UNIQUE and is used in conjunction with a loss of correlation at the receiver to establish the end of frame indication. The receiver shall detect a loss of correlation within 16 bits from the termination of the EOM. The end of frame signal shall be asserted within the fourth (4) byte from the end of the MDPU. The transmitter will immediately disable TX after transmission of the EOM.

The following illustration of the full DS PHY packet is provided as a reference.



Editors note: Based on the TX power down specification in section 8.4.1.20, the current EOM technique will have to be modified to provide acceptable performance.

8.4.1.17 Receiver Energy Detection Time and Threshold

The maximum response time from energy incident upon the receiver antenna to receiver signal level crossing the Energy Detection Threshold shall be less than or equal to 20 usec.

The Energy Detection Threshold is TBD.

8.4.1.18 Transmit and Receive Out of Band Spurious Emissions

The DS PHY shall conform with out of band spurious emissions as set by regulatory bodies in the USA and Europe. For the USA, refer to FCC 15.247, 15.205, and 15.209. For Europe, refer to ETSI res 02-09.

8.4.1.19 Receive In Band Spurious Emissions

The in band spurious receiver emissions shall be less than TBD dBm.

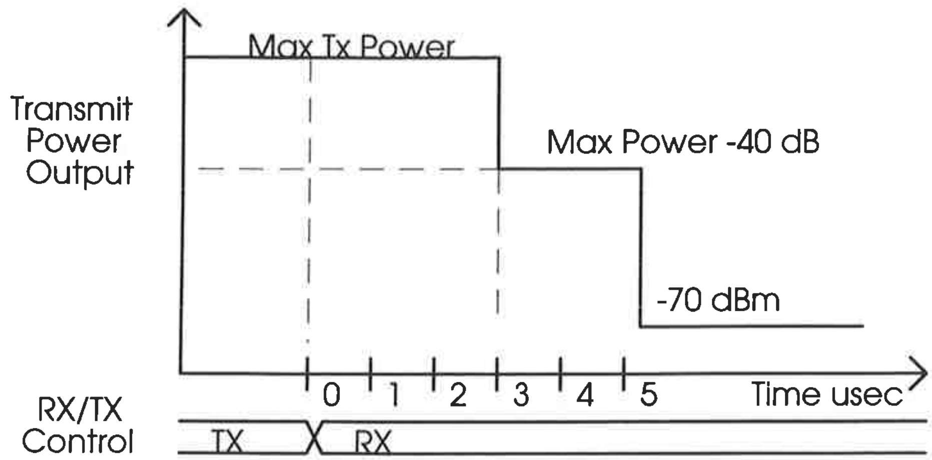
8.8.20 Transmit Power Down

The time from transition of an exposed RX/TX control line from the TX state to the RX state until the output power is at least -70 dbm shall be less than or equal to 5 usec.

The transmit power shall be -40 dB down from the maximum transmit level in less than 3 usec.

The power level shall be measured at the antenna.

The following diagram illustrates the TX power down function:



8.4.1.21 Transmit To Receive Turnaround Time

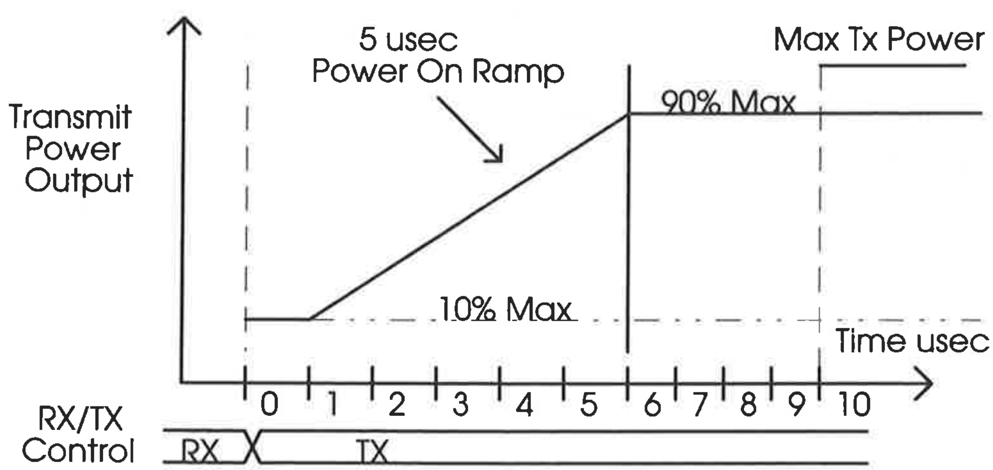
The time from transition of an exposed RX/TX control line from the TX state to the RX state until the radio is in receive mode shall be less than or equal to 25 usec. This includes the transmit power down ramp described in section 8.4.1.20.

8.4.1.22 Receive To Transmit Switching Time and Power Up Ramp

The time from transition of an exposed RX/TX control line from the RX state to the TX state until the 90% of maximum power shall be less than or equal to 10 usec.

The RX to TX transition shall include a TX power on ramp. The time for the transmit power to ramp form 10% to 90% maximum power shall be greater than 5 usec.

The following diagram illustrates the power on ramp function:



8.4.1.23 Frame Capture Ratio

The radio shall capture a DS PHY packet signal when the packet signal is greater than or equal to 10 dB of any continuous interferer or other DS PHY source.

Given a continuous interferer at -50 dbm, an error rate of 10^{-5} shall be maintained from a desired packetized source of -40 dBm. Both signals shall conform to DS PHY modulation.

8.4.1.24 Receiver Bit Error Rate

The receiver shall provide a BER of 10^{-5} when the Eb/No = 17 dB. The despread PSK Eb/No shall be used for this calculation.

8.4.1.25 Transmit and Receive Antenna Port Impedance

The transmit and receive and antenna port(s) impedance shall be 50Ω if the port is exposed.

8.4.1.26 Transmit and Receive VSWR

Devices shall withstand no damage and remain unconditionally stable over a range $0 \leq VSWR \leq \infty$.

8.4.1.27 Interface Lines to Convergence Layer (when exposed)

TBD

8.4.1.28 MAC-PHY Network Management Control Variables

TBD

8.4.1.29 Other MAC-PHY Network Managnent Variables

TBD