



COMPAQ COMPUTER CORPORATION

Information Pursuant to application for Certification of the Compaq PE3012 Multiport Wireless LAN Module (proposed FCC ID: CNTWPE3012) as an intentional radiator subject to the provisions of CFR 47 Part 15 Sub Part C.

Product Description

The PE3012 Multiport Module by Compaq is a **Bluetooth™** radio which mounts on the Multiport of an appropriately equipped computer. Multiport is a Compaq proprietary interface currently incorporated in Notebook computers. The proprietary interface uses a USB bus for data communications. The PE3012 module consists of a PCB, a plastic cover, and screws to secure the board to the interface port Mounting surface. The PE3012 PCB contains a **Bluetooth** module, an antenna, and signal conditioning components.

The Compaq Multiport is a Compaq proprietary port based on the USB interface. The port offers the functionality of USB with a snap on footprint providing ease of design and use on Compaq products. The port is currently incorporated in one series of Compaq Notebook PCs.

Section 15.203 The antenna for the module is permanently attached during manufacturing. The antenna is soldered to a PCB. In the module's intended use, the antenna is inaccessible to the user, with the entire PCB covered by a plastic cover.

Section 15.204 The antenna is a Yagi manufactured by RangeStar, Model 100929. The gain in reference to an isotropic radiator is +3 dBi.

Section 15.247(a) **Pseudorandom Frequency Hopping Sequence** - 79 channels, each separated by 1 MHz, are available for the system.

Five hopping sequences are defined for Bluetooth:

- A **page hopping sequence** with 32 unique wake-up frequencies distributed equally over 79 MHz, with a period length of 32;
- A **page response sequence** covering 32 unique response frequencies that all are in an one-to-one correspondence to the current page hopping sequence. The master and slave use different rules to obtain the same sequence;
- An **inquiry sequence** with 32 unique wake-up frequencies distributed equally over 79 MHz, with a period length of 32;
- An **inquiry response sequence** covering 32 unique response frequencies that all are in an one-to-one correspondence to the current inquiry hopping sequence.
- A **channel hopping sequence** which has a very long period length, which does not show repetitive patterns over a short time interval, but which distributes the hop frequencies equally over the 79 MHz during a short time interval;

The inquiry and inquiry response sequences always utilize the **Bluetooth** GIAC LAP as lower address part and the DCI as upper address part in deriving the hopping sequence, even if it concerns a DIAC inquiry.

The selection scheme consists of two parts:

- selecting a sequence;
- mapping this sequence on the hop frequencies;

The mapping from the input to a particular hop frequency is performed in the selection box. (See Figure 1) Basically, the input is the native clock and the current address. In **CONNECTION** state, the native clock (CLKN) is modified by an offset to equal the master clock (CLK). Only the 27 MSBs of the clock are used. In the **page** and **inquiry** sub states, all 28 bits of the clock are used. However, in **page** sub state the native clock will be modified to the master's estimate of the paged unit.

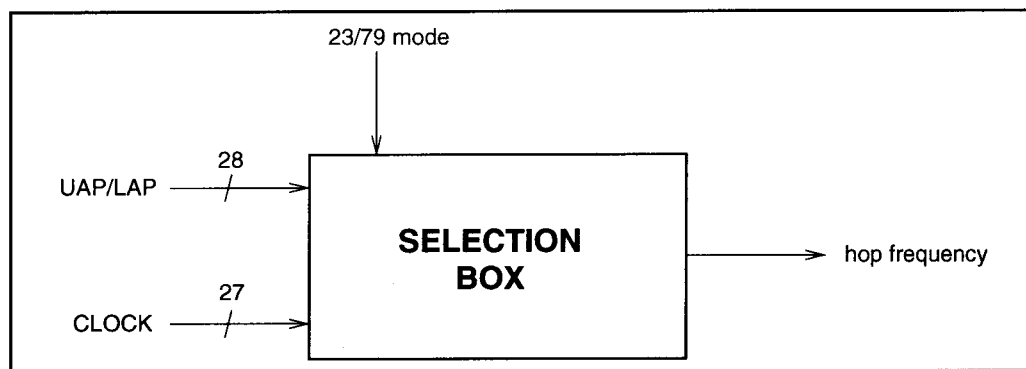


Figure 1. General block diagram of hop selection scheme

The address input consists of 28 bits, i.e., the entire LAP and the 4 LSBs of the UAP. In **CONNECTION** state, the address of the master is used. In **page** sub-state the address of the paged unit is used. When in **inquiry** sub state, the UAP/LAP corresponding to the GIAC is used. The output constitutes a pseudo-random sequence, covering 79 hops.

The selection scheme chooses a segment of 32 hop frequencies spanning about 64 MHz and visits these hops once in a random order. Next, a different 32-hop segment is chosen, etc. In case of the **page**, **page scan**, or **page response** sub states, the same 32-hop segment is used all the time (the segment is selected by the address; different units will have different paging segments). In connection state, the output constitutes a pseudorandom sequence that slides through the 79 hops.

In the hop selection kernels for the 79 hop system (Figure 2), the X input determines the phase in the 32-hop segment, whereas Y1 and Y2 selects between master-to-slave and slave-to-master transmission. The inputs A to D determine the ordering within the segment, the inputs E and F determine the mapping onto the hop frequencies. The kernel addresses a register containing the hop frequencies. This list should be created such that first all even hop frequencies are listed and then all odd hop frequencies. In this way, a 32-hop segment spans about 64 MHz.

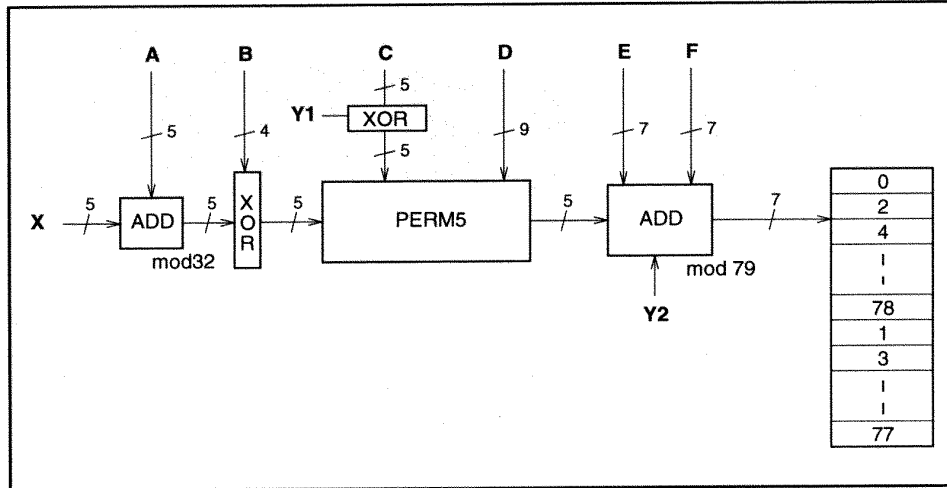


Figure 2. Block diagram of hop selection kernel for the 79-hop system

The selection procedure consists of an addition, an XOR operation, a permutation operation, an addition, and finally a register selection. In the remainder of this chapter, the notation A_i is used for bit i of the BD_ADDR .

The first addition operation only adds a constant to the phase and applies a modulo 32 operation. For the page hopping sequence, the first addition is redundant since it only changes the phase within the segment. However, when different segments are concatenated (as in the channel hopping sequence), the first addition operation will have an impact on the resulting sequence.

Let Z' denote the output of the first addition. In the XOR operation, the four LSBs of Z' are modulo-2 added to the address bits A_{22-19} .

The permutation operation involves the switching from 5 inputs to 5 outputs for the 79 hop system in a manner controlled by the control word. The permutation or switching box consists of 7 stages of butterfly operations.

The addition operation only adds a constant to the output of the permutation operation. As a result, the 32-hop segment is mapped differently on the hop frequencies. The addition is applied modulo 79.

The output of the adder addresses a bank of 79. The registers are loaded with the synthesizer code words corresponding to the hop frequencies 0 to 78. Note that the upper half of the bank contains the even hop frequencies, whereas the lower half of the bank contains the odd hop frequencies.



Sample Hopping Sequence Channels Data - First set

=====

79 HOP SYSTEM

=====

Hop sequence {k} for PAGE SCAN/INQUIRY SCAN:

CLKN start: 0x0000000

ULAP: 0x00000000

#ticks: 0000 | 1000 | 2000 | 3000 | 4000 | 5000 | 6000 | 7000 |

0x0000000:	0		2		4		6		8		10		12		14	
0x0008000:	16		18		20		22		24		26		28		30	
0x0010000:	32		34		36		38		40		42		44		46	
0x0018000:	48		50		52		54		56		58		60		62	
0x0020000:	0		2		4		6		8		10		12		14	
0x0028000:	16		18		20		22		24		26		28		30	
0x0030000:	32		34		36		38		40		42		44		46	
0x0038000:	48		50		52		54		56		58		60		62	

Hop sequence {k} for PAGE STATE/INQUIRY STATE:

CLKE start: 0x0000000

ULAP: 0x00000000

#ticks: 00 01 02 03 | 04 05 06 07 | 08 09 0a 0b | 0c 0d 0e 0f |

0x0000000:	48	50	09	13		52	54	41	45		56	58	11	15		60	62	43	47	
0x0000010:	00	02	64	68		04	06	17	21		08	10	66	70		12	14	19	23	
0x0000020:	48	50	09	13		52	54	41	45		56	58	11	15		60	62	43	47	
0x0000030:	00	02	64	68		04	06	17	21		08	10	66	70		12	14	19	23	

...

0x0001000:	48	18	09	05		20	22	33	37		24	26	03	07		28	30	35	39	
0x0001010:	32	34	72	76		36	38	25	29		40	42	74	78		44	46	27	31	
0x0001020:	48	18	09	05		20	22	33	37		24	26	03	07		28	30	35	39	
0x0001030:	32	34	72	76		36	38	25	29		40	42	74	78		44	46	27	31	

...

0x0002000:	16	18	01	05		52	54	41	45		56	58	11	15		60	62	43	47	
0x0002010:	00	02	64	68		04	06	17	21		08	10	66	70		12	14	19	23	
0x0002020:	16	18	01	05		52	54	41	45		56	58	11	15		60	62	43	47	
0x0002030:	00	02	64	68		04	06	17	21		08	10	66	70		12	14	19	23	

...

0x0003000:	48	50	09	13		52	22	41	37		24	26	03	07		28	30	35	39	
0x0003010:	32	34	72	76		36	38	25	29		40	42	74	78		44	46	27	31	
0x0003020:	48	50	09	13		52	22	41	37		24	26	03	07		28	30	35	39	
0x0003030:	32	34	72	76		36	38	25	29		40	42	74	78		44	46	27	31	

Hop sequence {k} for SLAVE PAGE RESPONSE STATE:

CLKN* = 0x0000010

ULAP: 0x00000000

#ticks: 00 | 02 04 | 06 08 | 0a 0c | 0e 10 | 12 14 | 16 18 | 1a 1c | 1e

0x0000012:	64		02	68		04	17		06	21		08	66		10	70		12	19		14	23		16
0x0000032:	01		18	05		20	33		22	37		24	03		26	07		28	35		30	39		32
0x0000052:	72		34	76		36	25		38	29		40	74		42	78		44	27		46	31		48
0x0000072:	09		50	13		52	41		54	45		56	11		58	15		60	43		62	47		00

Hop sequence {k} for MASTER PAGE RESPONSE STATE:

Offset value: 24

CLKE* = 0x0000012

ULAP: 0x00000000

#ticks: 00 02 | 04 06 | 08 0a | 0c 0e | 10 12 | 14 16 | 18 1a | 1c 1e |

0x0000014:	02	68		04	17		06	21		08	66		10	70		12	19		14	23		16	01	
0x0000034:	18	05		20	33		22	37		24	03		26	07		28	35		30	39		32	72	
0x0000054:	34	76		36	25		38	29		40	74		42	78		44	27		46	31		48	09	
0x0000074:	50	13		52	41		54	45		56	11		58	15		60	43		62	47		00	64	

Hop sequence {k} for CONNECTION STATE:

CLK start: 0x0000010

ULAP: 0x00000000

#ticks: 00 02 | 04 06 | 08 0a | 0c 0e | 10 12 | 14 16 | 18 1a | 1c 1e |

0x0000010:	08	66		10	70		12	19		14	23		16	01		18	05		20	33		22	37	
0x0000030:	24	03		26	07		28	35		30	39		32	72		34	76		36	25		38	29	
0x0000050:	40	74		42	78		44	27		46	31		48	09		50	13		52	41		54	45	
0x0000070:	56	11		58	15		60	43		62	47		32	17		36	19		34	49		38	51	



0x0000090:	40 21	44 23	42 53	46 55	48 33	52 35	50 65	54 67
0x00000b0:	56 37	60 39	58 69	62 71	64 25	68 27	66 57	70 59
0x00000d0:	72 29	76 31	74 61	78 63	01 41	05 43	03 73	07 75
0x00000f0:	09 45	13 47	11 77	15 00	64 49	66 53	68 02	70 06
0x0000110:	01 51	03 55	05 04	07 08	72 57	74 61	76 10	78 14
0x0000130:	09 59	11 63	13 12	15 16	17 65	19 69	21 18	23 22
0x0000150:	33 67	35 71	37 20	39 24	25 73	27 77	29 26	31 30
0x0000170:	41 75	43 00	45 28	47 32	17 02	21 04	19 34	23 36
0x0000190:	33 06	37 08	35 38	39 40	25 10	29 12	27 42	31 44
0x00001b0:	41 14	45 16	43 46	47 48	49 18	53 20	51 50	55 52
0x00001d0:	65 22	69 24	67 54	71 56	57 26	61 28	59 58	63 60
0x00001f0:	73 30	77 32	75 62	00 64	49 34	51 42	57 66	59 74
0x0000210:	53 36	55 44	61 68	63 76	65 50	67 58	73 03	75 11
0x0000230:	69 52	71 60	77 05	00 13	02 38	04 46	10 70	12 78
0x0000250:	06 40	08 48	14 72	16 01	18 54	20 62	26 07	28 15
0x0000270:	22 56	24 64	30 09	32 17	02 66	06 74	10 19	14 27
0x0000290:	04 70	08 78	12 23	16 31	18 03	22 11	26 35	30 43
0x00002b0:	20 07	24 15	28 39	32 47	34 68	38 76	42 21	46 29
0x00002d0:	36 72	40 01	44 25	48 33	50 05	54 13	58 37	62 45
0x00002f0:	52 09	56 17	60 41	64 49	34 19	36 35	50 51	52 67
0x0000310:	38 21	40 37	54 53	56 69	42 27	44 43	58 59	60 75
0x0000330:	46 29	48 45	62 61	64 77	66 23	68 39	03 55	05 71
0x0000350:	70 25	72 41	07 57	09 73	74 31	76 47	11 63	13 00
0x0000370:	78 33	01 49	15 65	17 02	66 51	70 67	03 04	07 20
0x0000390:	68 55	72 71	05 08	09 24	74 59	78 75	11 12	15 28
0x00003b0:	76 63	01 00	13 16	17 32	19 53	23 69	35 06	39 22
0x00003d0:	21 57	25 73	37 10	41 26	27 61	31 77	43 14	47 30
0x00003f0:	29 65	33 02	45 18	49 34	19 04	21 08	23 20	25 24

Channels shown are offset(MHz) from 2402 MHz.

Section 15.247(a) Equal Hopping Frequency Use - The selection scheme chooses a segment of 32 hop frequencies spanning 64 MHz and visits these hops once in a random order. Next, a different 32 hop segment is chosen. In the connection state, the output is a pseudorandom sequence that slides through the 79 hops. After every 32 time slots, a new length 32 segment is selected. The sequence order within a specific segment will not be repeated for a very long time. The overall hopping sequence consists of concatenated segments of 32-hops each. Each 32-hop sequence covers more than 80% of the 79 MHz band.

Section 15.247(a) System Receiver Input Bandwidth - A single RF filter is used for both transmit and receive ensuring that the receiver input bandwidth is equal to the transmit bandwidth.

Section 15.247(a) System Receiver Hopping Capability - A single local oscillator is switched between transmit and receive modes, ensuring that the receiver shifts frequencies in synchronization with the transmitted signal.

Section 15.247(b) De Facto EIRP Limit - Only one antenna is available for the PE3012 module. The antenna is permanently mounted on the circuit board, and not accessible to the user. The maximum antenna gain is +3 dBi. Since the maximum output power is +10 dBm (no cable loss since the antenna is mounted on circuit board), the maximum EIRP for the module is +13 dBm or 20 mW.

Section 15.247(g) When the transmitter is presented with continuous data, the data is broken up into packets per the **Bluetooth** specification. The data is burst out in packets in a time division duplexing scheme. Each time slot is 625 microseconds long. The maximum packet size covers



five time slots (DH5 or DM5). The Bluetooth device is required to hop frequencies for each new packet per the hopping sequences defined above. So, the minimum hopping rate will be 320 hops/second and the average hopping rate will be 1600 hops/second.

Section 15.247(h) The hopping sequence selected within a **Bluetooth** piconet is controlled by the master of the piconet in accordance with the selection schemes discussed above, and is not coordinated in any way with devices outside of the piconet.