

NEW DEVELOPMENT OF OPTIMUM GROUP SYNCHRONIZATION CODES (N=31 TO 42) FOR TELEMETRY SYSTEMS

Xie Qiu-Cheng Lei Zhong-Kui
(Professor) (Master)
Nanjing Aeronautical Institute, Nanjing, China

ABSTRACT

In this paper, twelve optimum group synchronization codes (n=31 to 42) for PCM telemetry systems are presented. They are the newest achievements up to now.

KEY WORDS: Optimum Code, Synchronization, Optimum Group Synchronization Code.

INTRODUCTION

Since PCM Telemetry Systems came into being, many scholars have devoted themselves to research theory and searching method of optimum group synchronization codes. In 1964, T. L. Maury, Jr and F. J. Styles presented and recommended twenty-four optimum frame synchronization codes (n=7 to 30)[1]. Afterwards, those achievements are brought into American IRIG Standards.

But it is a pity that the progress of searching optimum group synchronization codes was not great, since paper [1] was published. In 1978, ESA published Satellite Telemetry Standards [2] and recommended three optimum frame synchronization codes (n=16, 24, 32,). In 1986, American Telemetry Standards (IRIG Document 106-86)[3] recommended a table of optimum frame synchronization patterns (n=7 to 33) for PCM Telemetry. However, in papers [2,3], the codes of length n=31,32,33 are actually not optimum (see [4]).

NEWEST DEVELOPMENT

In the last ten years, we devoted ourselves to research new theory for constructing optimum group synchronization codes, to develop new methods for searching out the optimum codes of length greater than n=30 and even more. Until December 1988, a set of optimum group synchronization codes of length

n=31 to 42 had been searched out as follows (see Table 1 to 6). Those optimum codes are the newest achievements up to now. in Table 1 to 6, the bit error rate is $P = 0.1$, and error tolerance E is separately 0 to 5.

REFERENCE

- [1]. T. L. Marry, Jr and F. J. Styles, "Development of optimum frame synchronization codes for GODDARD Space Flight Center PCM Telemetry Standards", NTC'64, 1964, USA.
 [2]. "Satellite Telemetry Standards", ESA, 1978, Paris, France.
 [3]. "IRIG Document 106-86/Telemetry Standards", September 1986, USA.
 [4]. Lei Zhong-Kui, Xie Qiu-Cheng and Cao Jie, "Research and recommendation of optimum group synchronization codes for N=7 to 32", ITC'88, October 1988, USA.

Table 1	(E=0, P =0.1)	December 28, 1988
N=31	1111,1110,1100,0110,1001,0001,0100,000	.12017E-09
N=32	1111,1101,1011,0001,1000,0101,0100,0000	.59621E-10
N=33	1111,1110,1101,1000,1100,0010,1010,0000,0	.29611E-10
N=34	1111,1001,1110,1100,1101,0101,1000,0000,00	.14776E-10
N=35	1111,1101,1011,0110,0011,0001,0101,0000,000	.73582E-11
N=36	1111,1100,1110,1101,0101,1001,0110,0000,0000	.36719E-11
N=37	1111,1110,1010,1101,0011,0110,0011,0000,0000,0	.18320E-11
N=38	1111,1110,0111,0110,1010,1100,1011,0000,0000,00	.91363E-12
N=39	1111,1111,0101,0111,0010,0101,1000,1100,0000,000	.45665E-12
N=40	1111,1110,1010,1101,1001,0011,1000,1100,0000,0000	.22830E-12
N=41	1111,1110,1101,1011,0001,1010,1000,1110,0000,0000,0	.11405E-12
N=42	1111,1110,1101,1001,1010,1101,0100,0111,0000,0000,00	.56995E-13

Table 2	(E=1, P =0.1)	
N=31	1111,1110,1100,0110,1001,0001,0100,000	.51925E-08
N=32	1111,1101,1011,0001,1000,0101,0100,0000	.26217E-08
N=33	1111,1110,1101,1000,1100,0010,1010,0000,0	.13273E-08
N=34	1111,1001,1110,1100,1101,0101,1000,0000,00	.67444E-09
N=35	1111,1101,1011,0110,0011,0001,0101,0000,000	.34241E-09
N=36	1111,1100,1110,1101,0101,1001,0110,0000,0000	.17428E-09
N=37	1111,1110,1010,1101,0011,0110,0011,0000,0000,0	.88642E-10
N=38	1111,1110,0111,0110,1010,1100,1011,0000,0000,00	.45046E-10
N=39	1111,1111,0101,0111,0010,0101,1000,1100,0000,000	.22958E-10
N=40	1111,1110,1010,1101,1001,0011,1000,1100,0000,0000	.11699E-10
N=41	1111,1110,1101,1011,0001,1010,1000,1110,0000,0000,0	.59544E-11
N=42	1111,1110,1101,1001,1010,1101,0100,0111,0000,0000,00	.30298E-11

Table 3 (E=2, P =0.1)

N=31	1111,1110,1100,0110,1001,0001,0100,000	.10771E-06
N=32	1111,1101,1011,0001,1000,0101,0100,0000	.55268E-07
N=33	1111,1110,1101,1000,1100,0010,1010,0000,0	.28565E-07
N=34	1111,1001,1110,1100,1101,0101,1000,0000,00	.14726E-07
N=35	1111,1101,1011,0110,0011,0001,0101,0000,000	.76263E-08
N=36	1111,1100,1110,1101,0101,1001,0110,0000,0000	.39604E-08
N=37	1111,1110,1010,1101,0011,0110,0011,0000,0000,0	.20545E-08
N=38	1111,1110,0111,0110,1010,1100,1011,0000,0000,00	.10650E-08
N=39	1111,1111,0101,0111,0010,0101,1000,1100,0000,000	.55369E-09
N=40	1111,1110,1010,1101,1001,0011,1000,1100,0000,0000	.28764E-09
N=41	1111,1110,1101,1011,0001,1010,1000,1110,0000,0000,0	.14928E-09
N=42	1111,1110,1101,1001,1010,1101,0100,0111,0000,0000,00	.77313E-10

Table 4 (E=3, P =0.1)

N=31	1111,1110,1100,0110,1001,0001,0100,000	.14675E-05
N=32	1111,1101,1011,0001,1000,0101,0100,0000	.76277E-06
N=33	1111,1110,1101,1000,1100,0010,1010,0000,0	.40371E-06
N=34	1111,1001,1110,1100,1101,0101,1000,0000,00	.20917E-06
N=35	1111,1101,1011,0110,0011,0001,0101,0000,000	.11043E-06
N=36	1111,1100,1110,1101,0101,1001,0110,0000,0000	.58423E-07
N=37	1111,1110,1010,1101,0011,0110,0011,0000,0000,0	.30895E-07
N=38	1111,1110,0111,0110,1010,1100,1011,0000,0000,00	.16363E-07
N=39	1111,1111,0101,0111,0010,0101,1000,1100,0000,000	.86655E-08
N=40	1111,1110,1010,1101,1001,0011,1000,1100,0000,0000	.45795E-08
N=41	1111,1110,1101,1011,0001,1010,1000,1110,0000,0000,0	.24240E-08
N=42	1111,1110,1101,1001,1010,1101,0100,0111,0000,0000,00	.12740E-08

Table 5 (E=4, P =0.1)

N=31	1111,1110,1100,0110,1001,0001,0100,000	.15118E-04
N=32	1111,1101,1011,0001,1000,0101,0100,0000	.79377E-05
N=33	1111,1110,1101,1000,1100,0010,1010,0000,0	.43308E-05
N=34	1111,1001,1110,1100,1101,0101,1000,0000,00	.22221E-05
N=35	1111,1101,1011,0110,0011,0001,0101,0000,000	.11943E-05
N=36	1111,1100,1110,1101,0101,1001,0110,0000,0000	.64150E-06
N=37	1111,1110,1010,1101,0011,0110,0011,0000,0000,0	.34547E-06
N=38	1111,1110,0111,0110,1010,1100,1011,0000,0000,00	.18773E-06
N=39	1111,1111,0101,0111,0010,0101,1000,1100,0000,000	.10085E-06
N=40	1111,1110,1010,1101,1001,0011,1000,1100,0000,0000	.53907E-07
N=41	1111,1110,1101,1011,0001,1010,1000,1110,0000,0000,0	.29095E-07
N=42	1111,1110,1101,1001,1010,1101,0100,0111,0000,0000,00	.15404E-07

Table 6 (E=5, P =0.1)

N=31	1111,1110,1100,0110,1001,0001,0100,000	.12752E-03
N=32	1111,1101,1011,0001,1000,0101,0100,0000	.67684E-04
N=33	1111,1110,1101,1000,1100,0010,1010,0000,0	.38473E-04
N=34	1111,1001,1110,1100,1101,0101,1000,0000,00	.19260E-04
N=35	1111,1101,1011,0110,0011,0001,0101,0000,000	.10528E-04
N=36	1111,1100,1110,1101,0101,1001,0110,0000,0000	.57138E-05
N=37	1111,1110,1010,1101,0011,0110,0011,0000,0000,0	.31334E-05
N=38	1111,1110,0111,0110,1010,1100,1011,0000,0000,00	.17631E-05
N=39	1111,1111,0101,0111,0010,0101,1000,1100,0000,000	.95421E-06
N=40	1111,1110,1010,1101,1001,0011,1000,1100,0000,0000	.51055E-06
N=41	1111,1110,1101,1011,0001,1010,1000,1110,0000,0000,0	.28095E-06
N=42	1111,1110,1101,1001,1010,1101,0100,0111,0000,0000,00	.14772E-06

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