DESIGN AND IMPLEMENTATION DIFFERENT LENGTHS OF BARKER CODES BASED ON PIC MICROCONTROLLER [+]

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Abstract :

This paper basically deals with the Barker codes used in spread spectrum communication system, Barker codes are short unique codes that exhibit very good autocorrelation properties. These short codes of length 11 and 13 bits are very well suited for direct sequence spread spectrum (DSSS) applications and pulse compression radar system ,Barker codes have many advantages over other pseudo-Noise (PN)codes.

These codes satisfy the balance property and the run property of the PN codes, therefore in this paper all Barker codes from length 2 to length 13 has been generated practically by using microcontroller PIC16F84A as codes generator.

In this paper found that the method based on microcontroller to generate Barker codes are better than the traditional method which uses several digital integrated circuits (ICs).

This method was low cost, easy construction, less complex, fast generation and very efficient when we need to change the code we do not need to change the hardware or add other components to design but we need to change the software only , in this paper seven programs are written and store in the memory (Flash RAM) of microcontroller, each program responsible for generation one length of Barker codes which select easy by clicking on switches ,each switch responsible for generation one length of Barker code.

Keywords: Direct Sequence, Barker Codes, PIC Microcontroller

تصميم وتنفيذ أطوال مختلفة من شفرات باركر بالأعتماد على المسيطر الدقيق

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المستخلص:

هذا البحث يتعامل مع شفرات باركر المستعملة في انظمة اتصالات الطيف المنتشر،شفرات باركر عبارة عن شفرات قصيرة تعطينا خصائص ارتباط ذاتي فريده من نوعها.وهذه الشفرات التي لها طول 11 و13 بت مناسبة جدا في تطبيقات اتصالات الطيف المنتشرنوع التتابع المباشر ونظام الرادار النبظي, شفرات باركر تمتلك عدة فوائد مقارنة بانواع الشفرات العشوائية الاخرى PN.

هذة الشفرات تلبي خاصيتي التوازن والتعاقب من خواص الشفرات العشوائية PN، لذلك في هذا البحث تم توليد كافة شفرات باركر بطول من 2 بت الى 13 بت عمليا بأستخدام المسيطر الدقيق نوع PIC16F84A كمولد للشفرات.

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في هذا البحث وجد ان الطريقة المعتمده على المسيطر الدقيق في توليد شفرات باركر افضل من الطريقة التقليدية التي تستعمل عدة دوائر رقمية متكاملة ICs .

هذه الطريقة كانت ذات كلفة منخفضة،سهلة البناء،اقل تعقيدا،سريعة في توليد الشفرات وجدا كفؤه عندما نحتاج الى تغير الشفرة فأننا لانحتاج الى تغير الكيان المادي او اضافة قطع الكترونية اخرى للتصميم لكن نحتاج فقط الى تغيير البرنامج،في هذا البحث تم كتابة سبعة برامج وخزنت في ذاكرة المسيطر الدقيق ،كل برنامج مسوؤل عن توليد طول معين من شفرات باركروالتي يتم اختيارها بسهولة عن طريق استخدام مفاتيح ،كل مفتاح مسوؤل عن توليد طول واحد من شفرة باركر.

Introduction:

Spread spectrum is a technique which is used for converting the narrow band information signal into wideband spreaded signal, by using a code of fixed number of bits. This code should be synchronized with the code used at the receiver side for dispreading the information; otherwise the information will not be readable [1].

The prime objective of spread spectrum is the anti-jamming, noise free,and clear communication. Spread spectrum uses digital signals and the information is divided into small packets, each of information's bit is Ex-ORED before transmitted with the psedonoise code in spread spectrum. There is always uses quadrature phase shift keying, frequency shift keying, or phase shift shift keying as coding technique[2]. The DSSS uses the spreading code for converting the narrow band information into the wideband information. That code is called barker code which has a specified length normally of eleven or thirteen bits. In DSSS each of the information bit is EX-ORED (EX-OR logic) with the barker code at the point of transmission, as a result the whole information is converted into a very wideband and the information signal remains the same. This spread spectrum is able to reject the attack to be jammed, interference and also because of this coding technique (DSSS) the information signal can be recovered if less than fifty percent the data bits been damaged during propagation through the channel. If supposed less than fifty percent an error is occurred in the spreaded signal through the channel, and because of the synchronization of barker code at the receiver and transmitter, than the original information can be recovered[2].

Auto and Cross Correlation Functions and their Properties :

Let us consider two complex sequences $\{a_n\}$, and $\{b_n\}$, both having a period N. Their discrete crosscorrelation function $R_{a,b}(\tau)$ is defined as [3]:

$$R_{a,b}(\tau) = \sum_{n=0}^{N-1} a_n \, b^*_{n+\tau} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where: b^*_n denotes the complex conjugate of b_n. The discrete auto-correlation function $R_a(\tau)$ of
the sequence $\{a_n\}$is defined as [3]:

$$R_a(\tau) = \sum_{n=0}^{N-1} a_n \, a^*_{n+\tau} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Very often, instead of the above un normalized correlation functions, their normalized equivalents are used [3]:

$$R_{a,b}(\tau) = \left(1/N\right)\sum_{n=0}^{N-1} a_n \, b^{*}_{n+\tau} \ldots\ldots\ldots\ldots\ldots (3)$$

$$R_a(\tau) = \left(1/N\right)\sum_{n=0}^{N-1} a_n \, a^{*}_{n+\tau} \ldots\ldots\ldots\ldots\ldots (4)$$

The defined above discrete periodic correlation functions have got several useful properties, below is the short summary of some of the most useful of them :

a. The auto-correlation is an even function of τ[3]:

$$R_a(-\tau) = R_a(\tau) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

b. The peak auto-correlation occurs at zero delay[3]:

$$R_a(0) \geq R_a(\tau), \tau \neq 0 \ldots\ldots\ldots\ldots\ldots\ldots (6)$$

c. The cross-correlation functions have the following symmetry [3]:

$$R_{a,b}(\tau) = R_{a,b}(-\tau) \ldots\ldots\ldots\ldots\ldots\ldots (7)$$

d. Cross-correlation functions are not, in general, even function, and their peak values can be at different delays for different pairs of the sequences.[4]

So, each used sequence code must have good auto and cross correlation properties, i.e. minimum side lobe level in auto correlations and minimum peak in cross correlations with other codes. In this paper Barker sequence codes will be introduced.

Binary Codes :

There are many binary codes for example : m-sequence, Barker codes, Willard codes, Walsh Hadamard sequence codes[3] , in this paper, the proposed new design of the Barker codes will be introduced.

Barker code :

Barker sequences are short length codes that offer good correlation properties. A Barker code is a sequence of some finite length N such that the absolute value of discrete autocorrelation function r $\left|\right.$ (T) $\left|\right.\leq 1$ for T≠ 0. Barker sequences have many advantages over other PN sequences [5]. These sequences have uniformly low auto-correlation side these pseudo-random or pseudo-noise (PN) properties include, among other properties, (a) balance, (b) run and (c) auto-correlation lobes (≤1), but the size of these families is small. Fig.1 shows Barker sequence generator [5].

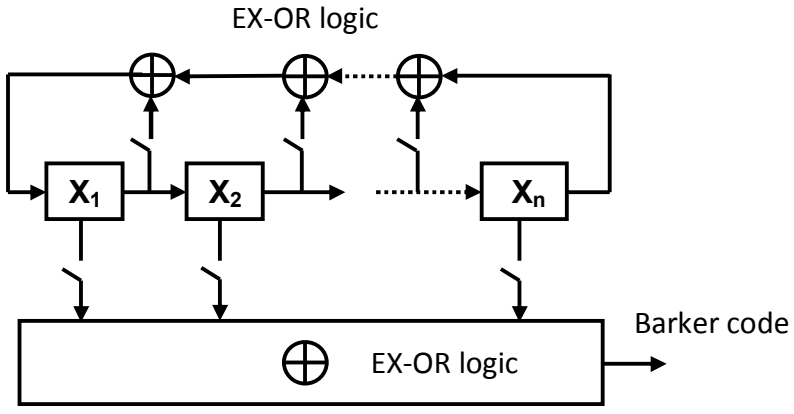

Fig.1: Block diagram of Barker code Generator.

Barker codes which are subsets of PN sequences, are commonly used for frame synchronization in digital communication systems. Barker codes have length at most 13 and have low correlation sidelobes. Barker sequences are too short to be of practical use for spectrum spreading.

A correlation sidelobe is the correlation of a codeword with a time-shifted version of itself. Autocorrelation function of the balanced 11 chip barker code is shown in Fig.2 [6].

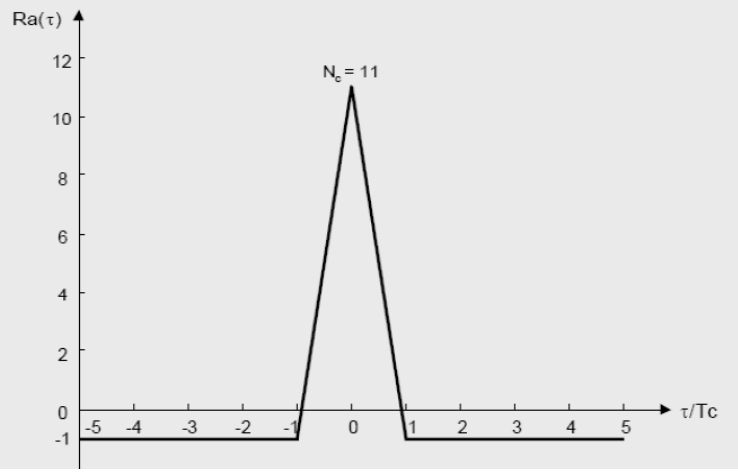

Fig. 2: Autocorrelation function of the balanced 11 chip Barker code.

The correlation sidelobe, C_k for a k-symbol shift of an N-bit code sequence, {Xj} is given by [7 and 8]:

$$C_k = \sum_{j=1}^{N-k} X_j X_{j+k} \quad \ldots\ldots\ldots\ldots\ldots (8)$$

Where: X_j is an individual code symbol taking values +1 and -1, for 0<j<N, and the adjacent symbols are assumed to be zero. The Barker Code Generator block provides the codes listed in the table (1) below [9 and 10]:

Table(1): A List of known Barker codes.

Length (bits)	Sequence
2	[10] , [11]
3	[110]
4	[1110] , [1101]
5	[11101]
7	[1110010]
11	[11100010010]
13	[111110011010 1]

Barker Code Implementation :

This paper present the construction of a PIC16F84A-based module as a Barker code generator for Binary Phase Shift-Keying(BPSK) modulation for direct sequence spread spectrum (DSSS) system as shown in Fig. (3) [11].

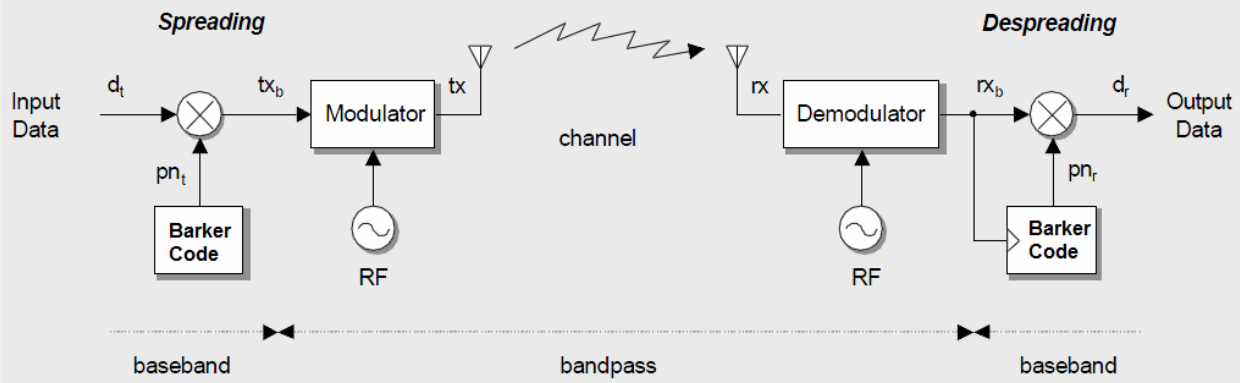

Fig.3:The block diagram of DSSS system.

The Barker code implementation can be classified into two parts hardware implementation and software implementation as follows:

1-Hardware Implementation

The PIC16F84A is a low cost, high performance CMOS 8-bit FLASH RISC microcontroller with integrated 68 bytes of RAM, 64 bytes of EEPROM, 1k Flash Program Memory, 13 I/O pins and other features [12,13 ,14 ,15.16 and 17] that make it suitable for Barker code generator.

Basic function of this circuit is generates seven lengths (2-bit to 13-bit) of Barker code, the microcontroller PIC16F84A generates the codes on PORTA –RA0 (pin17) when any one of seven push-bottom switchs is pressed in order to generate a specific code ,all switches was connected to PORTB(RB0 to RB6) as shown in the proposal schematic diagram in Fig.4 below.The schematic diagram was designed by using ISIS PROTEUS Software[18].

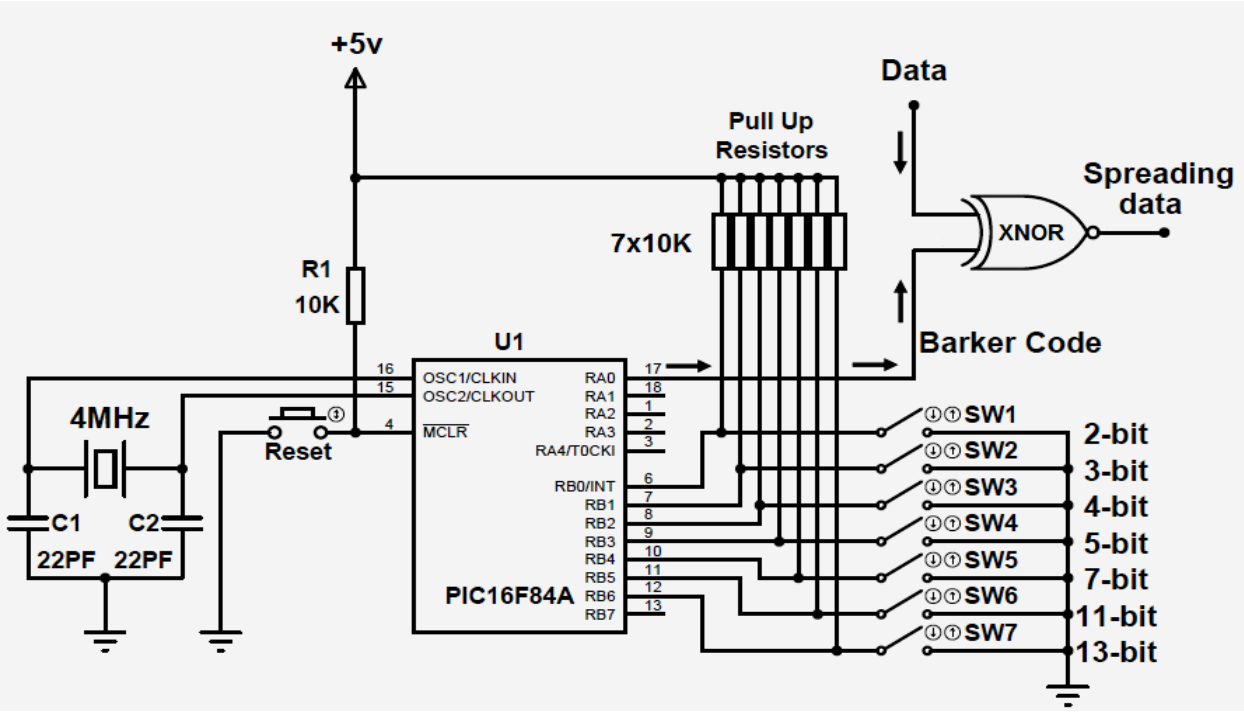

Fig.4: Schematic diagram of Barker code generator.

2-Software Implementation

The software is written by using Proton Basic IDE; the Proton language is a high level language consisting of 165 instructions[19].The flow chart of the software of generating Barker code is shown in Fig. 5 below.

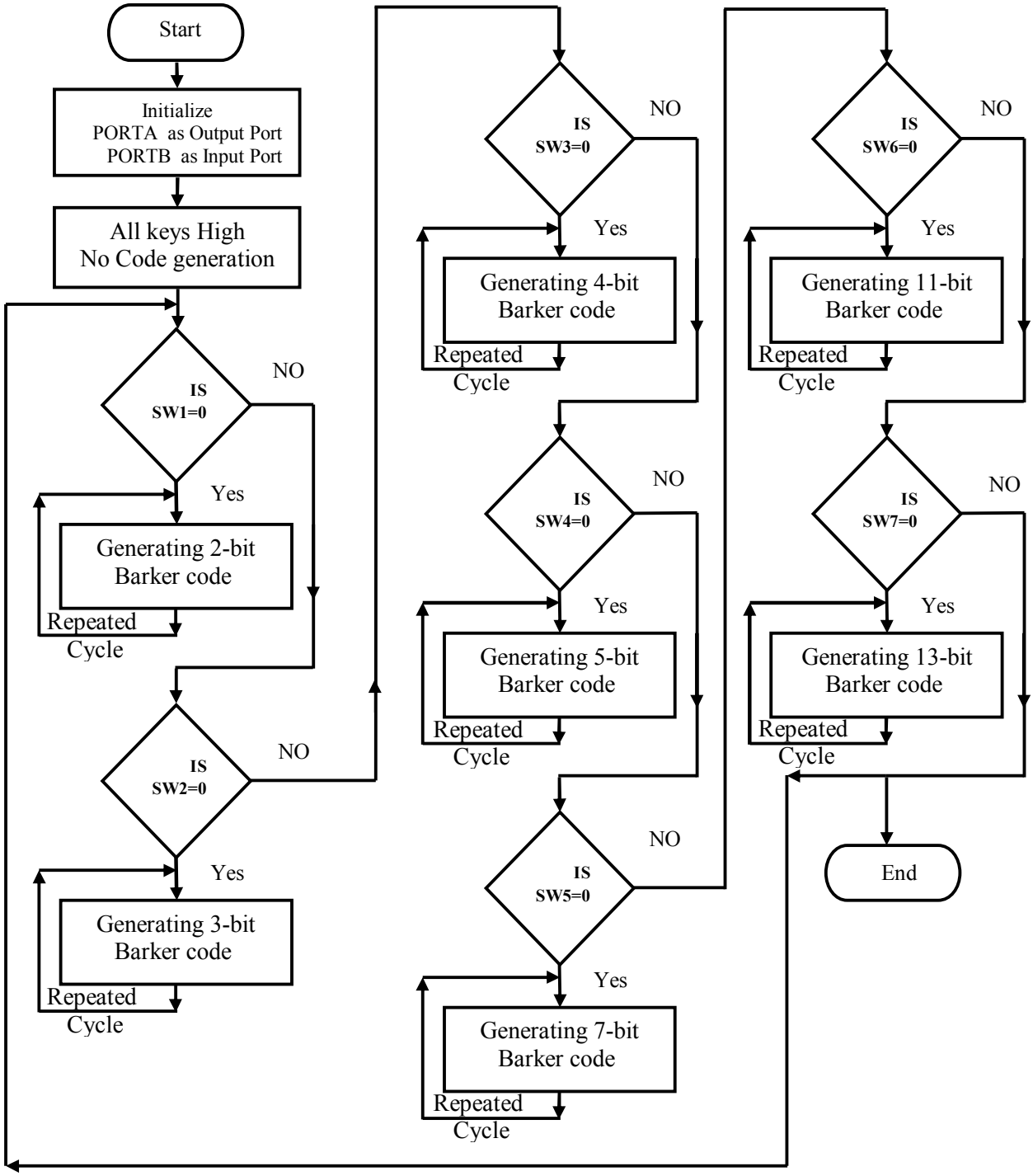

Fig.5: Flow chart of generating Barker codes.

Results :

The barker codes can be generated when any of seven push-bottom switch is pressed, if one switch is press the specific code will be generate and repeated cycle of this code forever ,when we want to generate another codes the microcontroller must be reset and release the switch of the older code and press the switch of the newer code ,the output of the Barker code is EXNOR with the specific data to get the spreading data in direct sequence spread spectrum system as shown in schematic diagram in Fig.5 above .

Fig.6 shows the waveform of the Barker codes observed by oscilloscope which generated from the proposal design of the Barker code schematic diagram.

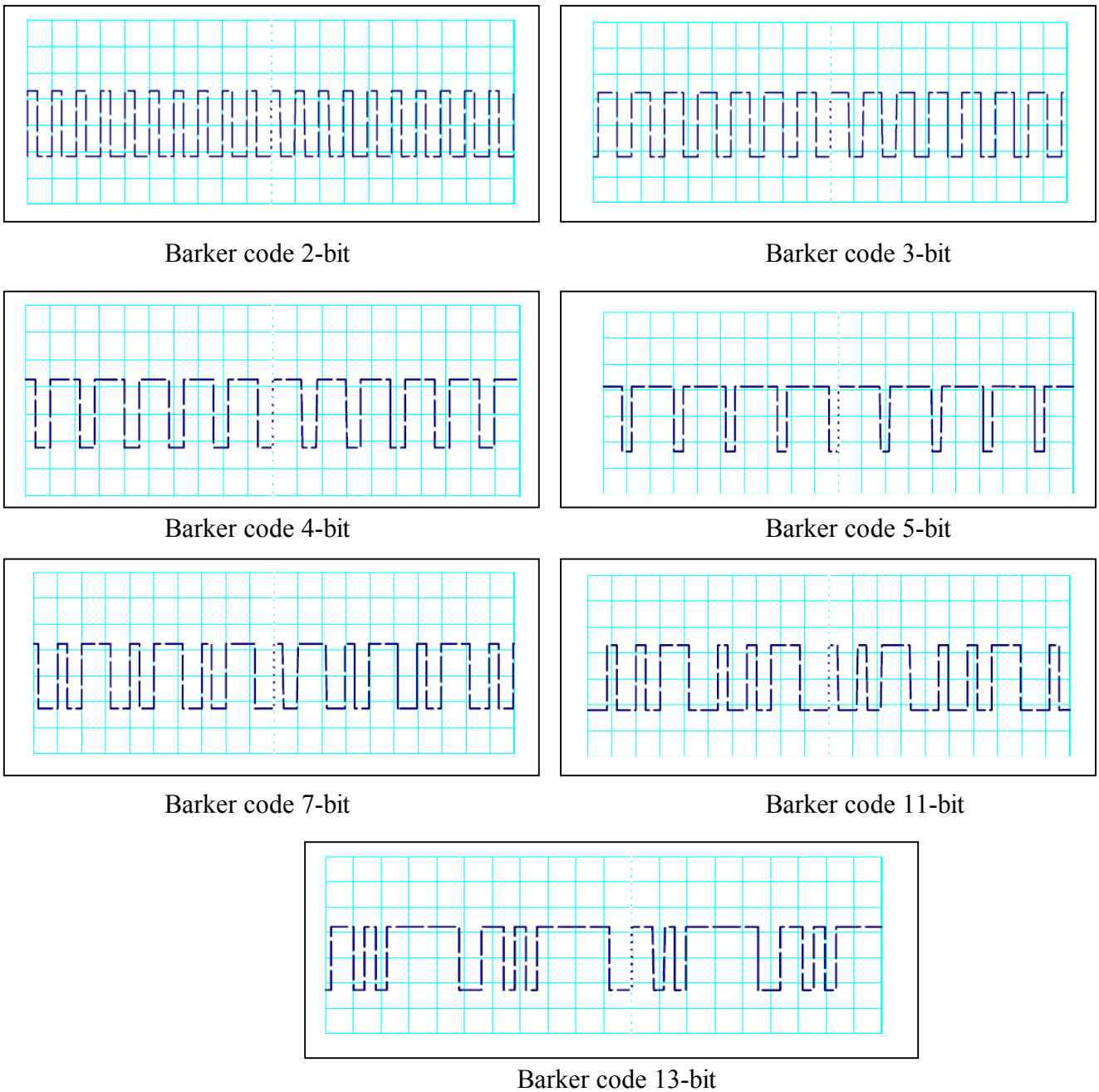

Fig.6: Seven types of Barker codes.

Conclusions :

Barker Codes are short unique codes that exhibit very good correlation properties. These short codes with **N** bits are very well suited for DSSS applications.

A new method was introduced her for generating Barker code based on microcontroller techniques, the use of microcontroller gives us more benefits like low cost, easy construction, less complex, fast generation and very efficient when we need to generate the different Barker codes which can be done by changing the software only without change the hardware.

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