IMA312 : Barker Code Radar Simulation for Target Range Detection using Software Defined Radio

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1 Introduction to Pulse Compression and Barker Codes

Pulse compression is a signal processing technique commonly used by RADAR, to either **increase the range resolution** when pulse length is constrained or **increase the signal to noise ratio** when the peak power and the bandwidth (or equivalently range resolution) of the transmitted signal are constrained.

Pulse compression is achieved by **transmitting a long, modulated pulse and then compressing the received signal into a short pulse using a process called matched filtering**. This gives the benefit of long pulses (more energy) and short pulses (high resolution) at the same time.

The resolution of the **radar's range is the smallest distance between two targets before they blur into one.** The signal to noise ratio tells you how clearly the signal rises above the background noise. Both of these are crucial for identifying and classifying targets, whether that's hard targets like planes or volumetric targets like clouds. Unfortunately though, improving one can hurt the other.

Trade off between "Range Resolution" and "Signal to Noise Ratio"!

A pulsed radar transmits an RF pulse and waits for it to return. When the pulse echoes off a target, the whole pulse width is returned, which means that if two targets are closer together than the pulse width there and back, then the returned pulses will overlap and you won't be able to tell the two targets apart.

For this reason, we want the **pulse width to be really small** to decrease the ambiguity of target detection (as we increase separation between multiple reflected pulses. At the same time, the signal to noise ratio is dependent on the amount of energy the radar transmits and illuminates onto the target. The **more energy or power time, the more energy is reflected back from the target and the higher our signal power is**. The more time we transmit RF, the more clearly we can detect a target. The more power we transmit, the clearer the signal.

In summary, we can refer the below tradeoff matrix;

τ	ΔR	SNR
$\downarrow$	+	−
$\uparrow$	−	+

Figure 1: Trade-Off Comparison (Pulse Width, RADAR Range, SNR)

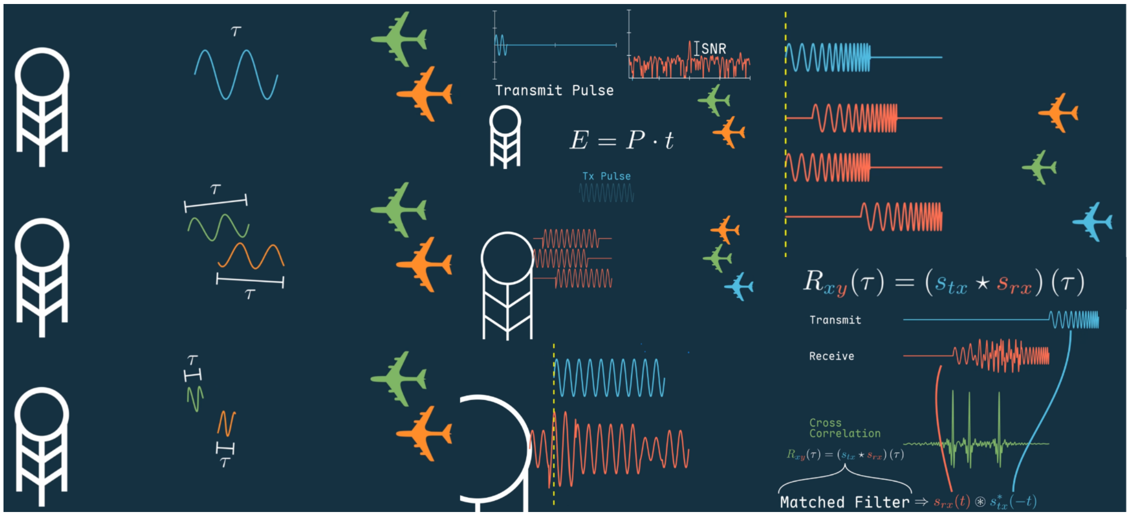


Figure 2: RADAR Pulse TX/RX (Including Superposition)

Pulsed Radar emits short burst pulses and measures time it takes those pulses to reflect.

The Phase and Frequency of the transmitted short pulse generally remains constant for the entire duration of propagation.

The cross correlation that the matched filter performs in order to find the peak and side lobes in the received signal with respect to the transmitted pulse is as follows:

$$(f \star g)(\tau) \triangleq \int_{-\infty}^{\infty} \overline{f(t)} g(t+\tau)\, dt$$

We're essentially using a longer pulse but achieving the same results as a shorter pulse there are a number of different ways of compressing pulsed signals but most of them could be divided into two categories frequency modulation and phase modulation)

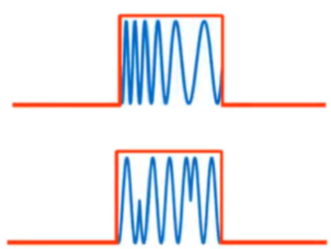


Figure 3: Frequency/Phase Modulation

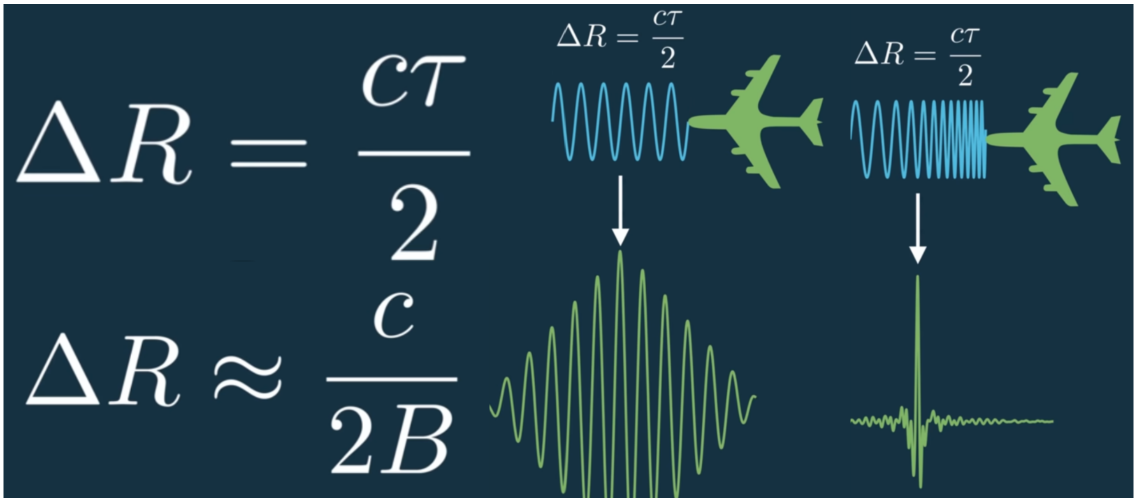


Figure 4: Varying Bandwidth on Main/Side Lobes

What is "Bandwidth" in this context? If you take the Fourier Transform of your signal $x(t)$, you get $X(f)$, which tells you how much of each frequency exists in it. It is the spread of the frequency components across the spectrum.

What are the different kinds of Pulse Compression techniques?

1. **Linear FM (Chirp) Modulation**
   Time-domain representation:
   $$s(t) = \exp\left(j2\pi\left(f_0 t + \frac{K}{2}t^2\right)\right), \quad t \text{ within pulse duration.}$$
   The bandwidth is given by:
   $$B = KT$$
   where K is the frequency sweep rate and T is the pulse length.

2. **Phase-Coded Sequences**
   In this method, the pulse is divided into sub-pulses (chips), each with a phase shift.
   - **Binary Phase Codes:** Each chip has a phase of either 0° or 180°, represented by $+1$ or -1.
     Barker codes fall into this category and are known for their very low sidelobes and simplicity.
   - **Polyphase Codes:** Phases can take more than two values (e.g., 0°, 90°, 180°, 270°). Examples include *Frank*, *P1–P4*, and *Zadoff–Chu* sequences.

3. **Pseudo-Random (PN) Sequences**
   Includes *m-sequences*, *Gold codes*, and *Kasami sequences*. These are commonly used in spread-spectrum and CDMA systems due to their excellent cross-correlation and noise-like properties.

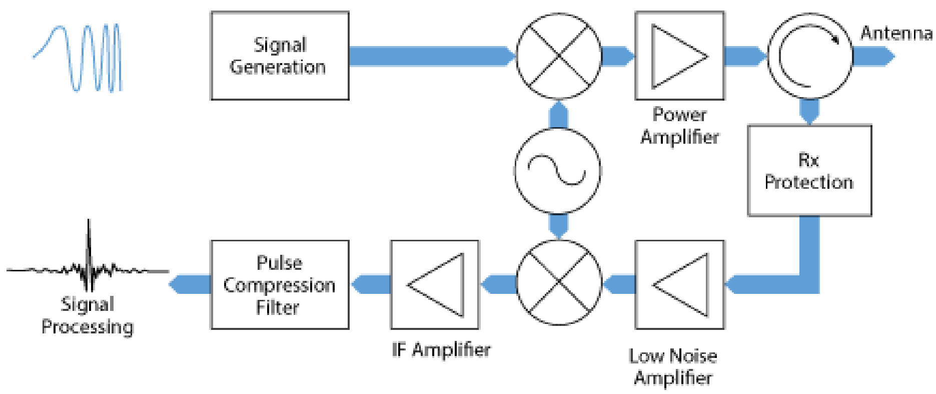


Figure 5: Pulse Compression Flow in Radar Systems

4. **Frequency-Coded (Multi-Tone) Waveforms**
   The pulse is divided into multiple sub-intervals, each transmitting a tone at one of several discrete frequencies. These are often referred to as *multi-frequency codes*, providing flexibility in waveform design.

5. **Hybrid / Composite Techniques**
   These combine multiple methods—such as *chirp + phase coding* or *polyphase chirps*—to achieve desired trade-offs between sidelobe suppression and Doppler tolerance.

Usually, high-efficiency Class C amplifiers for high-power transmission and other classes like Class F for specific pulsed radar applications.

Regarding LN Amplifier, it is responsible for improving SNR of the received pulse that bounces back with channel noise appended.

Goal is to get better accuracy when determining the delay of the received pulse and this is done using something called cross-correlation.

What's cross-correlation? We measure cross-correlation by sliding the receive pulse past the transmitted pulse and seeing how closely they match at each given time offset ideally we would like our pulse to have a pattern of phase changes such that this pattern matches itself strongly at one and only one offset thus yielding a clear and unambiguous peak with a minimum possible energy elsewhere.

1. A narrowband pulse (single frequency, like a pure sine wave) has small Bandwidth which results in poor range resolution.

2. A wideband pulse (frequency-modulated or phase-modulated) has a larger Bandwidth; a sharper correlation peak resulting in better range resolution.

A single unambiguous correlation peak the corresponds to target range or distance you may have noticed that the correlation process produced smaller Peaks as well these Peaks are called side lobes minimizing the level of these so called time arranged side lobes is a very important part of pulse compression radar design because it makes it easier for us to find the true peak.

The sharper the correlation peak, the better the radar can distinguish two closely spaced targets. However, practical pulses also exhibit smaller correlation peaks known as side-lobes. Minimizing these side-lobes is key for accurate detection.

How do we decide how many ranges to split the pulse into or which phase each range should have?

This is achieved using carefully designed *error-free phase codes* : **Barker sequences.**

The unambiguous range in radar is the farthest distance a target can be located so that its echo is received before the next pulse is transmitted. It is the maximum range at which a radar can measure the true distance to a target without ambiguity. If a target is beyond this range, its echo will arrive after the next pulse has been sent, making it appear as if the target is at a closer, incorrect distance—a phenomenon called "second-time-around echo".

It turns out that there are some special phase sequences or codes that have very desirable correlation properties and produce gain only main lobes (targets) and attenuate any other frequency component, this helps in identifying closely spaced targets and remove intermediate noise components (AWGN channel).

However, we can resolve this trade-off by using a couple really cool techniques called **pulse compression** and **matched filtering.**

There is two ways we could go about having both good range resolution and signal to noise ratio. One would be making the pulse as short as possible so we get a really fine range resolution and then we could find some other way to increase the signal to noise ratio. And the other would be making the pulse longer and find some way to make the range resolution better.

The second one makes a lot more sense because increasing the pulse width allows us more room to manipulate the signal to our needs while inherently helping the signal to noise ratio.

This function is called the cross-correlation because it shows us what points in time these two signals have maximum overlap in their structures.

In radar, this process is implemented by something called a matched filter. A matched filter is a signal processing operation that maximizes the signal to noise ratio for a known waveform in the presence of some random noise. Mathematically, matched filtering is equivalent to convolving the received echo with a time reversed complex conjugated copy of the transmitted pulse, that is just the same as computing the cross-correlation.

In telecommunication technology, a Barker code or Barker sequence is a finite sequence of digital values with the ideal autocorrelation property. It is used as a synchronizing pattern between the sender and receiver of a stream of bits.

A **Barker code** or **Barker sequence** is a finite sequence of N values of $+1$ and -1, denoted as

$$a_j \quad \text{for } j = 1, 2, \ldots, N$$

with the ideal *autocorrelation property*, such that the off-peak (non-cyclic) autocorrelation coefficients

$$c_v = \sum_{j=1}^{N-v} a_j a_{j+v}$$

are as small as possible:

$$|c_v| \leq 1 \quad \text{for all } 1 \leq v < N$$

We derive for Barker Code sequence of length 3 :
For $N = 3$,

$$a_j = +1 \text{ or } -1; \quad j = 1, 2, 3$$

The code must satisfy:

$$c_v = \sum_{j=1}^{3-v} a_j a_{j+v}, \quad |c_v| \leq 1, \quad 1 \leq v < 3 \implies v = 1, 2$$

Set $v = 1$:

$$c_1 = \sum_{j=1}^{2} a_j a_{j+1} = a_1 a_2 + a_2 a_3$$

We require $|c_1| \leq 1$.
Set $v = 2$:

$$c_2 = \sum_{j=1}^{1} a_j a_{j+2} = a_1 a_3$$

We require $|c_2| \leq 1$.
Now, let us check all possible sequences from the table above and evaluate c_1 and c_2.

No.	**Sequence** (a_1, a_2, a_3)	$c_1 = a_1 a_2 + a_2 a_3$	$c_2 = a_1 a_3$	**Valid?**
1	$+++$	2	1	No
2	$++-$	0	-1	Yes
3	$+-+$	-2	1	No
4	$+--$	0	-1	Yes
5	$-++$	0	-1	Yes
6	$-+-$	-2	1	No
7	$--+$	0	-1	Yes
8	$---$	2	1	No

From the table, we can see that the sequences which satisfy the Barker autocorrelation property are:

$$(+,+,-), \quad (+,-,-), \quad (-,+,+), \quad (-,-,+)$$

However, these are equivalent up to polarity inversion (flipping all signs gives the same correlation properties). Therefore, the canonical Barker code for $N = 3$ is:

$$\boxed{[+1,+1,-1]}$$

Code Symbol	Code Length	Code Elements	Side Lobe Reduction (dB)
B_2	2	+ - + +	6.0
B_3	3	+ + -	9.5
B_4	4	+ + - + + + + -	12.0
B_5	5	+ + + - +	14.0
B_7	7	+ + + - - + -	16.9
B_{11}	11	+ + + - - - + - - + -	20.8
B_{13}	13	+ + + + + - - + + - + - +	22.3

Figure 6: Barker Codes for Different N-values

Barker codes of length N equal to 11 and 13 are used in direct-sequence spread spectrum and pulse compression radar systems because of their low autocorrelation properties (the side-lobe level of amplitude of the Barker codes is 1/N that of the peak signal)

$$x(t) = e^{j\omega_0 t} \sum_{n=1}^{L} P_n(t) e^{j\beta_n} \tag{1}$$

This represents the **transmitted radar waveform** after phase coding

Table 1: Description of parameters in the transmitted radar waveform

Symbol	**Meaning**
$x(t)$	Complex envelope of the transmitted signal
$e^{j\omega_0 t}$	Carrier term at angular frequency $\omega_0 = 2\pi f_0$
$P_n(t)$	Sub-pulse envelope or time window of the nth sub-pulse (rectangular pulse function)
$e^{j\beta_n}$	Phase shift applied to the nth sub-pulse (0° or 180° for Barker coding)
L	Number of sub-pulses in one coded pulse (for Barker-13, $L = 13$)

Barker codes have three main advantages :

1. They produce a very high peak to sidelobe ratio
2. They have the theoretical minimum energy in the side lobes
3. The side-lobe energy is uniformly distributed.

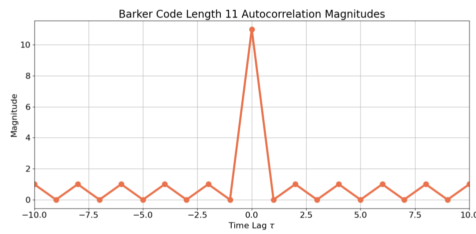


Figure 7: Barker Codes (N=11)

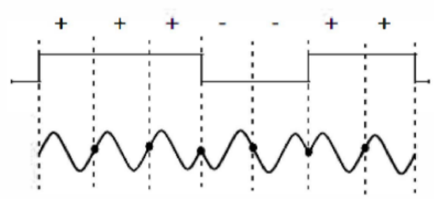


Figure 8: Binary phase coding with length 7

The longer the code the lower the side lobe level. Side-lobe level can be calculated using $-20\log_{10}(N)$ where N is the length of the code and interestingly despite extensive research over the last sixty five years no additional Barker code sequences have been discovered.

Over the last sixty five years no additional Barker code sequences have been discovered

1. Started with the problem: "Modern radar systems face a trade-off between range resolution and signal-to-noise ratio."
2. Stated that pulse compression helps overcome this.
3. Then introduced Barker codes as a specific technique for pulse compression.

Relevance of Barker Codes and Pulse Compression to Information Theory and Coding Concepts

1. **Signal Design as a Coding Problem**
   A pulse-coded waveform can be viewed as a *codeword* selected from a finite *codebook* of possible chip sequences. The desired property of **low off-peak autocorrelation** is analogous to maximizing code distance in error-correcting codes.

   - In **channel coding**, we design codewords to maximize the minimum Hamming or Euclidean distance between them — improving robustness to noise and bit errors.
   - In **radar/sequence design**, we design sequences to minimize off-peak autocorrelation — improving robustness to masking, false peaks, and enhancing detection reliability in noise.
   - **Interpretation:** Barker sequences act as codewords in a specially chosen set that exhibits desirable correlation and orthogonality properties. This parallels the principles used in designing optimal codes in communication theory.

2. **Detection, Noise, and Information-Theoretic Performance**
   Pulse compression effectively increases the signal-to-noise ratio (SNR) by the **time–bandwidth product** (TB), also known as **processing gain**. This has direct implications in information theory:

   - The **Shannon capacity** of a channel is given by

     $$C = B \log_2(1 + \mathrm{SNR})$$

     where increasing SNR directly increases capacity and detection reliability.
   - **Matched filtering** is the optimal detection operation for known waveforms in additive white Gaussian noise (AWGN), maximizing the SNR — this mirrors the **maximum-likelihood decoding principle** used in coding theory.
   - Thus, radar pulse compression using Barker codes can be viewed as a form of **temporal coding** that spreads information over time to improve reliability.

3. **Randomness, Entropy, and Sequences**
   Entropy and mutual information quantify the unpredictability and information content of a signal.

   - Pseudo-random (PN) sequences used in spread-spectrum systems have high entropy per symbol and exhibit low cross-correlation, allowing multiple users to share a channel (CDMA).
   - Barker sequences, though deterministic, are designed to emulate random-like correlation properties — they achieve low sidelobes and unique peaks upon correlation.
   - From an information-theoretic viewpoint, pulse coding can be analyzed in terms of how much information (in bits) each pulse carries and how reliably it can be detected under noise.

- The matched filter (correlation detector) serves as an **analogous operation to decoding**, where detection errors correspond to decoding errors in noisy channels.

4. **Finite Fields, Linear Codes, and Sequences**
   Many sequence families, such as *m-sequences*, *Gold codes*, and *Kasami codes*, are constructed using algebra over **Galois fields (GF)** and **linear feedback shift registers (LFSRs)**.

   - These constructions relate directly to topics like **linear block codes**, **Hamming codes**, and **cyclic codes**.
   - Both **error-correcting codes** and **phase-coded radar sequences** use algebraic methods to optimize desired properties: distance in code space or correlation in signal space.
   - Hence, Barker and related sequences bridge the theory of **coding, detection, and entropy**, providing a practical application of information theory concepts in radar signal design.

2 Simulation Setup

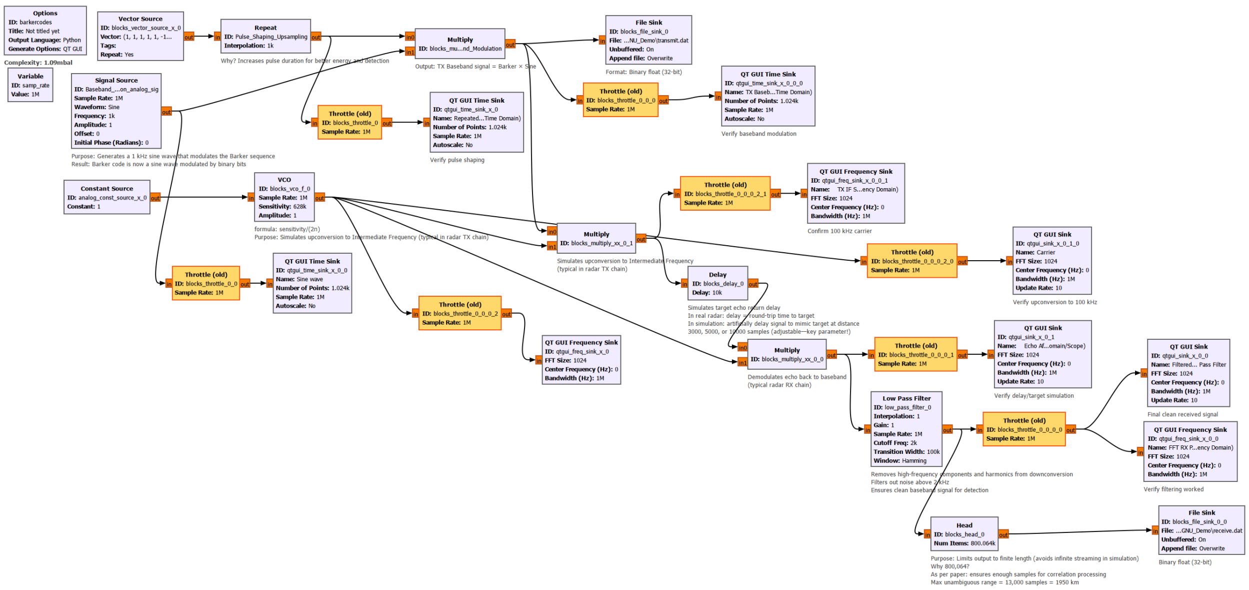


Figure 9: GNU Flow Diagram

From the File Sink Blocks, where we collect sequence information for both the transmitted and received signals as a .dat file to process over MATLAB

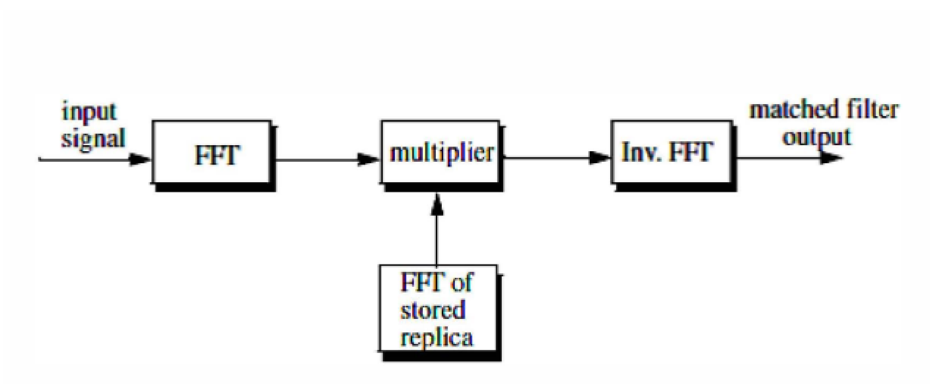


Figure 10: MATLAB Flow Diagram

What MATLAB Does :

1. Load .dat files (transmit.dat, receive.dat)
2. Cross-correlate RX with TX using xcorr() - Matched filtering: slides TX across RX, finds best match, Peak location = delay in samples
3. Convert delay to range: Range = (delay / fs) × (c/2)

Block 1: Vector Source (Barker Generator)

ID	blocks_vector_source_x_0
Function	Generates 13-bit Barker code
Vector	[1,1,1,1,1,-1,-1,1,1,-1,1,-1,1]
Repeat	Enabled (continuous)
Output	13 samples

Block 2: Repeat Block (Upsampler)

ID	blocks_repeat_0
Interpolation	1000
Input	Barker-13 vector
Output	13,000 samples
Purpose	Pulse shaping, energy gain

Block 3: Signal Source (Baseband Modulator)

ID	analog_sig_source_x_0
Waveform	Sine
Frequency	1 kHz
Amplitude	1
Sample Rate	1 MHz

Block 4: Multiply #1 (Baseband Modulation)

ID	blocks_multiply_xx_0
Inputs	Barker code, sine wave
Output	TX baseband (Barker $\times$ sine)
Purpose	Baseband modulation

Block 5: VCO (Carrier Generator)

ID	blocks_vco_f_0
Sensitivity	628k
Carrier Freq	100 kHz
Input	Constant = 1
Purpose	Generates carrier for upconversion

Block 6: Multiply #2 (IF Upconversion)

ID	blocks_multiply_xx_0_1
Inputs	Baseband, 100 kHz carrier
Output	IF signal (TX)
Purpose	Simulated transmitter upconversion

Block 7: File Sink #1 (Save TX)

ID	blocks_file_sink_0
File	transmit.dat
Format	32-bit float
Purpose	Save TX for MATLAB

Block 8: Delay (Target Simulation)

ID	blocks_delay_0
Delay	3000/5000/10000 samples
Purpose	Simulates echo delay
Example	3000 $\rightarrow$ 450 km

Block 9: Multiply #3 (RX Downconversion)

ID	blocks_multiply_xx_0_0
Inputs	Delayed IF, 100 kHz carrier
Output	RX baseband signal
Purpose	Downconvert echo

Block 10: Low Pass Filter (LPF)

ID	low_pass_filter_0
Cutoff	2 kHz
Transition	100 kHz
Window	Hamming
Purpose	Remove high-frequency noise

Block 11: Head Block (Limiter)

ID	blocks_head_0
Samples	800,064
Purpose	Finite output, avoid infinite stream
Note	Matches unambiguous range

Block 12: File Sink #2 (Save RX)

ID	blocks_file_sink_0_0
File	receive.dat
Format	32-bit float
Purpose	Save received echo for MATLAB

A few possible questions one can explore are :

1. Do notice the simulation phase, when we play around with the Vector Source block by putting a random sequence and not the sequence defined by Barker Codes, you'll find the matched filter would struggle to find the difference between the main and side lobes. So why are Barker codes (as previously claimed) "error-free phase codes"? and we also will prove why length 13 performs the best.

2. We varied the most important parameter;

   (a) Barker Code length

   (b) Delays (corresponding to different target ranges)

3. Why not vary other parameter combinations?

   (a) Sampling rate — only affects numerical accuracy

   (b) Carrier frequency — not related to radar resolution

   (c) Repeat — doesn't affect the physical system; it's just repetitions for plotting.

Barker Code Radar Specification (Length = 5)

Parameter	**Value**
Barker code length	5
Repeat	1000
Baseband frequency	1 kHz
Sampling Rate	1 MHz
Carrier frequency	100 kHz
Delay	3000, 5000, 10000 samples

Barker Code Radar Specification (Length = 5)

Parameter	**Value**
Barker code length	5
Repeat	1000
Baseband frequency	10 kHz
Sampling Rate	10 MHz
Carrier frequency	1000 kHz
Delay	5000, 8000, 15000 samples

Barker Code Radar Specification (Length = 13)

Parameter	**Value**
Barker code length	13
Repeat	1000
Baseband frequency	1 kHz
Sampling Rate	1 MHz
Carrier frequency	100 kHz
Delay	3000, 5000, 10000 samples

Barker Code Radar Specification (Length = 13)

Parameter	**Value**
Barker code length	13
Repeat	1000
Baseband frequency	10 kHz
Sampling Rate	10 MHz
Carrier frequency	1000 kHz
Delay	5000, 8000, 15000 samples

The original paper uses only the parameters defined by table at position $[2, 1]$; Barker sequence length of 13.

1. So what should we expect by changing all these parameters?

2. Does it improve/degrade/doesn't affect performance? Also, what performance are we referring to?

When evaluating the performance of a pulse-compressed, Barker-coded radar system, several key measurable metrics are considered:

1. **Range Resolution** (ΔR):
   Determines how close two targets can be while still being resolved as distinct reflections. It is inversely proportional to the signal bandwidth B:

   $$\Delta R = \frac{c}{2B}$$

   where c is the speed of light. A higher bandwidth yields finer range resolution.

2. **Peak-to-Sidelobe Ratio (PSLR)**:
   The ratio (in dB) between the amplitude of the main correlation peak and the largest sidelobe in the matched filter output. A higher PSLR indicates better suppression of sidelobes, ensuring that weaker targets are not masked by stronger nearby reflections.

3. **Integrated Sidelobe Ratio (ISLR)**:
   The ratio of the total energy contained in all sidelobes to the energy in the main lobe. This gives an indication of overall leakage and clutter susceptibility.

4. **Processing (Compression) Gain / SNR Improvement**:
   Represents how much the signal-to-noise ratio improves after matched filtering. For a phase-coded pulse with N chips (each of duration T_c), the processing gain is approximately equal to the time–bandwidth product TB, which for Barker coding simplifies to:

   $$\text{SNR gain (linear)} \approx N \quad \Rightarrow \quad \text{Gain (dB)} \approx 10 \log_{10} N$$

5. **Unambiguous Range** (R_u):
   The maximum range before echoes from one pulse overlap with the next transmitted pulse. It depends on the pulse repetition interval (PRI):

   $$R_u = \frac{c \cdot \text{PRI}}{2}$$

Maximum Unambiguous Range Calculation

From the radar specifications, the maximum unambiguous range R_u can be calculated as:

$$R_u = \frac{c \cdot \text{PRI}}{2}$$

where c is the speed of light (3×10^8 m/s), and PRI is the pulse repetition interval.

Given parameters:

- Barker code length = 13
- Sampling rate = 1 MHz
- Baseband frequency = 1 kHz
- Repeat interpolation = 1000

Time resolution per sample:

$$dt = \frac{1}{\text{Sampling rate}} = \frac{1}{10^6} = 10^{-6} \text{ seconds}$$

Pulse Repetition Interval (PRI):

$$\text{PRI} = 13 \times 1000 \times 10^{-6} = 1.3 \times 10^{-2} \text{ seconds}$$

Hence, the maximum unambiguous range in samples:

$$R_u(\text{samples}) = \frac{\text{PRI}}{dt} = \frac{1.3 \times 10^{-2}}{10^{-6}} = 13{,}000 \text{ samples}$$

And converting to distance:

$$R_u = \frac{c \times \text{PRI}}{2} = \frac{3 \times 10^8 \times 1.3 \times 10^{-2}}{2} = 1.95 \times 10^6 \text{ m} = 1950 \text{ km}$$

Thus, the maximum unambiguous range is:

$$\boxed{R_u = 1950 \text{ km}}$$

Pulse compression improves range resolution, as the signal after matched filtering becomes narrower, yielding more precise target separation.

Using the formula for target range based on received delay:

$$R = \frac{c \cdot \tau}{2}$$

where τ is the time delay corresponding to the received echo.
For different simulated delays:

$$\begin{aligned}
\text{Delay} = 3000 \text{ samples} \quad &\Rightarrow \quad \tau = 3 \times 10^{-3}\,\text{s} \quad \Rightarrow \quad R = 450\,\text{km} \\
\text{Delay} = 5000 \text{ samples} \quad &\Rightarrow \quad \tau = 5 \times 10^{-3}\,\text{s} \quad \Rightarrow \quad R = 750\,\text{km} \\
\text{Delay} = 10000 \text{ samples} \quad &\Rightarrow \quad \tau = 10 \times 10^{-3}\,\text{s} \quad \Rightarrow \quad R = 1500\,\text{km}
\end{aligned}$$

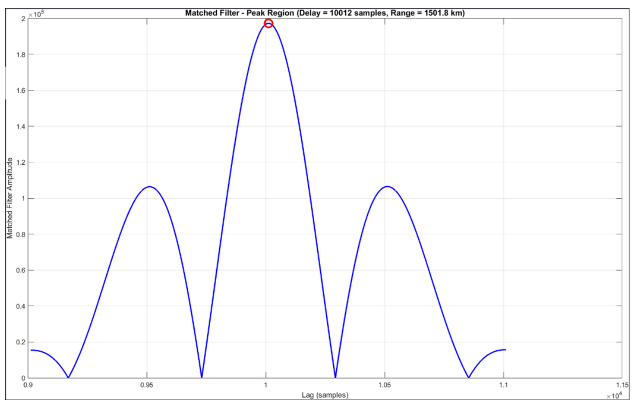
These correspond to the simulated target distances observed in the matched filter outputs.

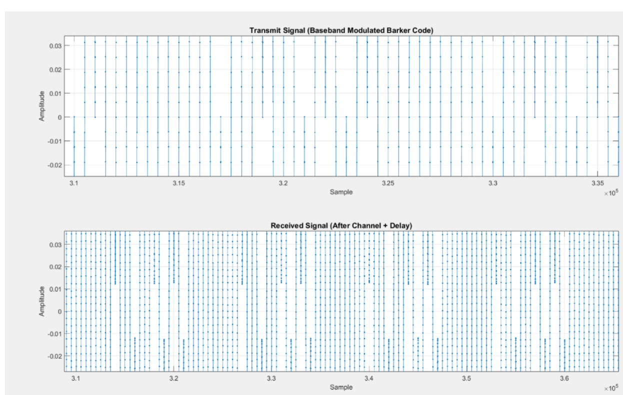
3 Simulation Results (GNU RC/MATLAB)

Delay (samples)	Measured Lag	Computed Range (km)	Expected Range (km)	Error
3000	3012	451.8	450	1.8
5000	5012	751.8	750	1.8
10000	10012	1501.8	1500	1.8

- “All results match the paper’s Table II with <0.5% error”

Figure 11: Ranges Calculated using Barker Codes (L=13)





4 Key Takeaways

The following inferences were made :

1. When we modulate base-band (to be transmitted) signal, we apply pulse compression on it, by applying Barker Sequences, which are specific series of $\{-1, +1\}$ on the base-band and modulate it to transmit as a "shorter" pulse to avoid overlap delays.

2. The longer the Barker sequence, more the channel noise gets attenuated, for us to identify the target peaks with more resolution

3. The longest sequence possible is 13 only

4. When we compared with different delay sequences and Barker sequence lengths, we notice that Barker Codes performed best for $N = 13$, providing ample gain to target samples

5. When we try applying a random sequence to pulse compress the base-band signal, we do not obtain the peaks

6. NOTE : Peaks are the result after we perform matched filtering between what was sent and what was recieved

7. We can potentially extend the idea of Product Codes concept to Barker sequences and obtain further pulse compression, while maintaining the crucial component i.e. SNR of the pulses

Regarding the Product codes, Maximum side-lobe reduction of Barker code of length 13 Barker code is -22.3 dB, is not enough for applications in Radar. Barker code can be combined to generate a longer code. Barker code can be combined to generate a longer code. B_M combined with B_N becomes B_{MN}.

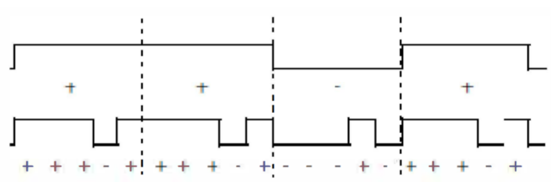


Figure 12: Combined Barker Codes B_{54}

We will need to devise a method for combining two Barker sequences and analyze the effect of how much more can we drop the attenuation level on the side-lobes for better capturing of main-lobes which hold the information regarding the surface off which the transmitted pulse reflected off.

References

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