

OFDM : Cálculo de las N muestras de un bloque

$$s^{(n)}[m] = s[nN + m], \quad m \in \{0, 1, \dots, N-1\}$$

$$s^{(n)}[m] = \frac{N}{\sqrt{T}} \text{IDFT}_N \{A_0[n], A_1[n], \dots, A_{N-1}[n]\} = \frac{1}{\sqrt{T}} \sum_{k=0}^{N-1} A_k[n] e^{j \frac{2\pi k}{N} m}$$

$$s^{(n)}[m] = \frac{1}{\sqrt{T}} \left(A_0[n] \underbrace{e^{j \frac{2\pi \cdot 0}{N} m}}_{e^{j0}=1} + A_1[n] \underbrace{e^{j \frac{2\pi \cdot 1}{N} m}}_{e^{j \frac{2\pi}{N} m}} + A_2[n] \underbrace{e^{j \frac{2\pi \cdot 2}{N} m}}_{e^{j \frac{4\pi}{N} m}} + \dots + A_{N-1}[n] \underbrace{e^{j \frac{2\pi \cdot (N-1)}{N} m}}_{e^{j \frac{2\pi(N-1)}{N} m}} \right)$$

Ejemplo: $N = 4$

$$s^{(n)}[m] = \frac{1}{\sqrt{T}} \left(A_0[n] \underbrace{e^{j \frac{2\pi \cdot 0}{4} m}}_{e^{j0}=1} + A_1[n] \underbrace{e^{j \frac{2\pi \cdot 1}{4} m}}_{e^{j \frac{\pi}{2} m}} + A_2[n] \underbrace{e^{j \frac{2\pi \cdot 2}{4} m}}_{e^{j \pi m}} + \dots + A_3[n] \underbrace{e^{j \frac{2\pi \cdot 3}{4} m}}_{e^{j \frac{3\pi}{2} m}} \right)$$

Ejemplo $N = 4$: Conversión Serie/Paralelo + IDFTs

m	0	1	2	3	4	5	6	7	8	9	10	11
$A[m]$	+1	-3	+1	+3	+1	-1	+1	-1	-1	+3	-1	-3

● Conversión Serie a Paralelo

n	0	1	2
$A_0[n]$	+1	+1	-1
$A_1[n]$	-3	-1	+3
$A_2[n]$	+1	+1	-1
$A_3[n]$	+3	-1	-3

● Muestras de cada bloque: $s^{(n)}[m] = s[nN + m], m \in \{0, 1, 2, 3\}$

$$s^{(0)}[m] = \frac{N}{\sqrt{T}} \text{IDFT}_N \{+1, -3, +1, +3\}$$

$$s^{(1)}[m] = \frac{N}{\sqrt{T}} \text{IDFT}_N \{+1, -1, +1, -1\}$$

$$s^{(2)}[m] = \frac{N}{\sqrt{T}} \text{IDFT}_N \{-1, +3, -1, -3\}$$

Primer bloque: $s^{(0)}[m] \equiv \{s[0], s[1], s[2], s[3]\}$

$$s^{(0)}[m] = \frac{N}{\sqrt{T}} \text{IDFT}_N \{A_0[0], A_1[0], A_2[0], A_3[0]\} = \frac{N}{\sqrt{T}} \text{IDFT}_N \{+1, -3, +1, +3\}$$

$$s^{(0)}[0] = \frac{1}{\sqrt{T}} \left(\underbrace{A_0[0]}_{+1} \underbrace{e^{j\frac{2\pi}{4}0}}_{e^{j0}=1} + \underbrace{A_1[0]}_{-3} \underbrace{e^{j\frac{2\pi}{4}1}}_{e^{j0}=1} + \underbrace{A_2[0]}_{+1} \underbrace{e^{j\frac{2\pi}{4}2}}_{e^{j0}=1} + \underbrace{A_3[0]}_{+3} \underbrace{e^{j\frac{2\pi}{4}3}}_{e^{j0}=1} \right) = \frac{2}{\sqrt{T}}$$

$$s^{(0)}[1] = \frac{1}{\sqrt{T}} \left(\underbrace{A_0[0]}_{+1} \underbrace{e^{j\frac{2\pi}{4}1}}_{e^{j0}=+1} + \underbrace{A_1[0]}_{-3} \underbrace{e^{j\frac{2\pi}{4}1}}_{e^{j\pi/2}=+j} + \underbrace{A_2[0]}_{+1} \underbrace{e^{j\frac{2\pi}{4}2}}_{e^{j\pi}=-1} + \underbrace{A_3[0]}_{+3} \underbrace{e^{j\frac{2\pi}{4}3}}_{e^{j3\pi/2}=-j} \right) = \frac{-j6}{\sqrt{T}}$$

$$s^{(0)}[2] = \frac{1}{\sqrt{T}} \left(\underbrace{A_0[0]}_{+1} \underbrace{e^{j\frac{2\pi}{4}2}}_{e^{j0}=+1} + \underbrace{A_1[0]}_{-3} \underbrace{e^{j\frac{2\pi}{4}2}}_{e^{j\pi}=-1} + \underbrace{A_2[0]}_{+1} \underbrace{e^{j\frac{2\pi}{4}2}}_{e^{j2\pi}=+1} + \underbrace{A_3[0]}_{+3} \underbrace{e^{j\frac{2\pi}{4}3}}_{e^{j3\pi}=-1} \right) = \frac{2}{\sqrt{T}}$$

$$s^{(0)}[3] = \frac{1}{\sqrt{T}} \left(\underbrace{A_0[0]}_{+1} \underbrace{e^{j\frac{2\pi}{4}3}}_{e^{j0}=+1} + \underbrace{A_1[0]}_{-3} \underbrace{e^{j\frac{2\pi}{4}3}}_{e^{j3\pi/2}=-j} + \underbrace{A_2[0]}_{+1} \underbrace{e^{j\frac{2\pi}{4}2}}_{e^{j3\pi}=-1} + \underbrace{A_3[0]}_{+3} \underbrace{e^{j\frac{2\pi}{4}3}}_{e^{j9\pi/2}=+j} \right) = \frac{+j6}{\sqrt{T}}$$

Segundo bloque: $s^{(1)}[m] \equiv \{s[4], s[5], s[6], s[7]\}$

$$s^{(1)}[m] = \frac{N}{\sqrt{T}} \text{IDFT}_N \{A_0[1], A_1[1], A_2[1], A_3[1]\} = \frac{N}{\sqrt{T}} \text{IDFT}_N \{+1, -1, +1, -1\}$$

$$s^{(1)}[0] = \frac{1}{\sqrt{T}} \left(\underbrace{A_0[1]}_{+1} \underbrace{e^{j\frac{2\pi}{4}0}}_{e^{j0}=1} + \underbrace{A_1[1]}_{-1} \underbrace{e^{j\frac{2\pi}{4}1}}_{e^{j0}=1} + \underbrace{A_2[1]}_{+1} \underbrace{e^{j\frac{2\pi}{4}2}}_{e^{j0}=1} + \underbrace{A_3[1]}_{-1} \underbrace{e^{j\frac{2\pi}{4}3}}_{e^{j0}=1} \right) = 0$$

$$s^{(1)}[1] = \frac{1}{\sqrt{T}} \left(\underbrace{A_0[1]}_{+1} \underbrace{e^{j\frac{2\pi}{4}1}}_{e^{j0}=+1} + \underbrace{A_1[1]}_{-1} \underbrace{e^{j\frac{2\pi}{4}1}}_{e^{j\pi/2}=+j} + \underbrace{A_2[1]}_{+1} \underbrace{e^{j\frac{2\pi}{4}2}}_{e^{j\pi}=-1} + \underbrace{A_3[1]}_{-1} \underbrace{e^{j\frac{2\pi}{4}3}}_{e^{j3\pi/2}=-j} \right) = 0$$

$$s^{(1)}[2] = \frac{1}{\sqrt{T}} \left(\underbrace{A_0[1]}_{+1} \underbrace{e^{j\frac{2\pi}{4}2}}_{e^{j0}=+1} + \underbrace{A_1[1]}_{-1} \underbrace{e^{j\frac{2\pi}{4}2}}_{e^{j\pi}=-1} + \underbrace{A_2[1]}_{+1} \underbrace{e^{j\frac{2\pi}{4}2}}_{e^{j2\pi}=+1} + \underbrace{A_3[1]}_{-1} \underbrace{e^{j\frac{2\pi}{4}3}}_{e^{j3\pi}=-1} \right) = \frac{4}{\sqrt{T}}$$

$$s^{(1)}[3] = \frac{1}{\sqrt{T}} \left(\underbrace{A_0[1]}_{+1} \underbrace{e^{j\frac{2\pi}{4}3}}_{e^{j0}=+1} + \underbrace{A_1[1]}_{-1} \underbrace{e^{j\frac{2\pi}{4}3}}_{e^{j3\pi/2}=-j} + \underbrace{A_2[1]}_{+1} \underbrace{e^{j\frac{2\pi}{4}2}}_{e^{j3\pi}=-1} + \underbrace{A_3[1]}_{-1} \underbrace{e^{j\frac{2\pi}{4}3}}_{e^{j9\pi/2}=+j} \right) = 0$$

Tercer bloque: $s^{(2)}[m] \equiv \{s[8], s[9], s[10], s[11]\}$

$$s^{(n)}[m] = \frac{N}{\sqrt{T}} \text{IDFT}_N \{A_0[2], A_1[2], A_2[2], A_3[2]\} = \frac{N}{\sqrt{T}} \text{IDFT}_N \{-1, +3, -1, -3\}$$

$$s^{(n)}[0] = \frac{1}{\sqrt{T}} \left(\underbrace{A_0[2]}_{-1} \underbrace{e^{j\frac{2\pi}{4}0}}_{e^{j0}=1} + \underbrace{A_1[2]}_{+3} \underbrace{e^{j\frac{2\pi}{4}1}}_{e^{j0}=1} + \underbrace{A_2[2]}_{-1} \underbrace{e^{j\frac{2\pi}{4}2}}_{e^{j0}=1} + \underbrace{A_3[2]}_{-3} \underbrace{e^{j\frac{2\pi}{4}3}}_{e^{j0}=1} \right) = \frac{-2}{\sqrt{T}}$$

$$s^{(n)}[1] = \frac{1}{\sqrt{T}} \left(\underbrace{A_0[2]}_{-1} \underbrace{e^{j\frac{2\pi}{4}1}}_{e^{j0}=+1} + \underbrace{A_1[2]}_{+3} \underbrace{e^{j\frac{2\pi}{4}1}}_{e^{j\pi/2}=+j} + \underbrace{A_2[2]}_{-1} \underbrace{e^{j\frac{2\pi}{4}2}}_{e^{j\pi}=-1} + \underbrace{A_3[2]}_{-3} \underbrace{e^{j\frac{2\pi}{4}3}}_{e^{j3\pi/2}=-j} \right) = \frac{+j6}{\sqrt{T}}$$

$$s^{(n)}[2] = \frac{1}{\sqrt{T}} \left(\underbrace{A_0[2]}_{-1} \underbrace{e^{j\frac{2\pi}{4}2}}_{e^{j0}=+1} + \underbrace{A_1[2]}_{+3} \underbrace{e^{j\frac{2\pi}{4}1}}_{e^{j\pi}=-1} + \underbrace{A_2[2]}_{-1} \underbrace{e^{j\frac{2\pi}{4}2}}_{e^{j2\pi}=+1} + \underbrace{A_3[2]}_{-3} \underbrace{e^{j\frac{2\pi}{4}3}}_{e^{j3\pi}=-1} \right) = \frac{-2}{\sqrt{T}}$$

$$s^{(n)}[3] = \frac{1}{\sqrt{T}} \left(\underbrace{A_0[2]}_{-1} \underbrace{e^{j\frac{2\pi}{4}3}}_{e^{j0}=+1} + \underbrace{A_1[2]}_{+3} \underbrace{e^{j\frac{2\pi}{4}1}}_{e^{j3\pi/2}=-j} + \underbrace{A_2[2]}_{-1} \underbrace{e^{j\frac{2\pi}{4}2}}_{e^{j3\pi}=-1} + \underbrace{A_3[2]}_{-3} \underbrace{e^{j\frac{2\pi}{4}3}}_{e^{j9\pi/2}=+j} \right) = \frac{-j6}{\sqrt{T}}$$

Muestras OFDM

m	0	1	2	3	4	5	6	7	8	9	10	11
$A[m]$	+1	-3	+1	+3	+1	-1	+1	-1	-1	+3	-1	-3

- Muestras de cada bloque : $s^{(n)}[m] = s[nN + m]$, $m \in \{0, 1, 2, 3\}$

$$s^{(0)}[m] = \frac{N}{\sqrt{T}} \text{IDFT}_N \{+1, -3, +1, +3\} = \left\{ \frac{+2}{\sqrt{T}}, \frac{-j6}{\sqrt{T}}, \frac{+2}{\sqrt{T}}, \frac{+j6}{\sqrt{T}} \right\}$$

$$s^{(1)}[m] = \frac{N}{\sqrt{T}} \text{IDFT}_N \{+1, -1, +1, -1\} = \left\{ 0, 0, \frac{+4}{\sqrt{T}}, 0 \right\}$$

$$s^{(2)}[m] = \frac{N}{\sqrt{T}} \text{IDFT}_N \{-1, +3, -1, -3\} = \left\{ \frac{-2}{\sqrt{T}}, \frac{+j6}{\sqrt{T}}, \frac{-2}{\sqrt{T}}, \frac{-j6}{\sqrt{T}} \right\}$$

m	0	1	2	3	4	5	6	7	8	9	10	11
$s[m]$	$\frac{+2}{\sqrt{T}}$	$\frac{-j6}{\sqrt{T}}$	$\frac{+2}{\sqrt{T}}$	$\frac{+j6}{\sqrt{T}}$	0	0	$\frac{+4}{\sqrt{T}}$	0	$\frac{-2}{\sqrt{T}}$	$\frac{+j6}{\sqrt{T}}$	$\frac{-2}{\sqrt{T}}$	$\frac{-j6}{\sqrt{T}}$