Reproduction of the paper in Qeios (v2.0).

```
In[•]:= nwavesbit = 7;
        (* Cantidad de puestos disponibles para rellenar -- *)
        binaryT = Table[IntegerString[n, 2, nwavesbit], {n, 0, (2^nwavesbit - 1)}]
        Length[binaryT]
```

```
Out[•]= {0000000, 0000001, 0000010, 0000011, 0000100, 0000101, 0000110, 0000111, 0001000,
         0001001, 0001010, 0001011, 0001100, 0001101, 0001110, 0001111, 0010000, 0010001,
         0010010, 0010011, 0010100, 0010101, 0010110, 0010111, 0011000, 0011001, 0011010,
         0011011, 0011100, 0011101, 0011110, 0011111, 0100000, 0100001, 0100010, 0100011,
         0100100, 0100101, 0100110, 0100111, 0101000, 0101001, 0101010, 0101011, 0101100,
         0101101, 0101110, 0101111, 0110000, 0110001, 0110010, 0110011, 0110100, 0110101,
         0110110, 0110111, 0111000, 0111001, 0111010, 0111011, 0111100, 0111101, 0111110,
         0111111, 1000000, 1000001, 1000010, 1000011, 1000100, 1000101, 1000110, 1000111,
         1001000, 1001001, 1001010, 1001011, 1001100, 1001101, 1001110, 1001111, 1010000,
         1010001, 1010010, 1010011, 1010100, 1010101, 1010110, 1010111, 1011000, 1011001,
         1011010, 1011011, 1011100, 1011101, 1011110, 1011111, 1100000, 1100001, 1100010,
         1100011, 1100100, 1100101, 1100110, 1100111, 1101000, 1101001, 1101010, 1101011,
         1101100, 1101101, 1101110, 1101111, 1110000, 1110001, 1110010, 1110011, 1110100,
         1110101, 1110110, 1110111, 1111000, 1111001, 1111010, 1111011, 1111100, 1111101,
         1111110, 1111111}
```

```
Out[•]= 128
```

```
In[•]:= (* -- Esto es como si fuera 8 Hz --- 3 wavebits*)
        (*-- Duración --- *)
        stepTime = 0.0005;
        stepFreq = 1 / stepTime;
        (*Number of points*)
        nn = 10 000;
        (*Sample rate*)
        sr = 550 * stepFreq;
        (*Time increment*)
        dt = 1 / sr;
        df = sr / nn;
        binary = Table[IntegerString[n, 2, nwavesbit], {n, 0, (2^nwavesbit - 1)}];
```

Encoding: 1ro lo dividimos

```
In[ ]:= myString = "Hello World!";
        binaryStringS = StringSplit[myString, ""]
        binaryStringMap = Table[RandomChoice[binary], {i, 1, Length[binaryStringS]}]
        binaryString = Table[ToExpression[StringSplit[binaryStringMap⟦i⟧, ""]],
          {i, 1, Length[binaryStringMap]}]
        (*---*)
        (* La frecuencias --*)
        SizeString = Length[binaryString];
        tinterval = N[sr / 2 / SizeString];
        FreqIn =
         Table[2 π * RandomReal[{i * stepFreq, (i + 100) * stepFreq}], {i, 1, nwavesbit}]

Out[ ]= {H, e, l, l, o,  , W, o, r, l, d, !}

Out[ ]= {0111001, 0100000, 1000011, 1000010, 0110110, 1100001, 1010110, 1101011, 0011100,
         0101010, 0101100, 0011110}

Out[ ]= {{0, 1, 1, 1, 0, 0, 1}, {0, 1, 0, 0, 0, 0, 0}, {1, 0, 0, 0, 0, 1, 1}, {1, 0, 0, 0, 0, 1, 0},
         {0, 1, 1, 0, 1, 1, 0}, {1, 1, 0, 0, 0, 0, 1}, {1, 0, 1, 0, 1, 1, 0}, {1, 1, 0, 1, 0, 1, 1},
         {0, 0, 1, 1, 1, 0, 0}, {0, 1, 0, 1, 0, 1, 0}, {0, 1, 0, 1, 1, 0, 0}, {0, 0, 1, 1, 1, 1, 0}}
```

$\text{Out[ ]=}\ \{337\,563.,\ 301\,570.,\ 1.23139\times10^{6},\ 1.2026\times10^{6},\ 68\,716.4,\ 738\,566.,\ 1.06924\times10^{6}\}$

```
In[ ]:= myDir = NotebookDirectory[]; FreqIn = Import[myDir <> "Freqs_Test1_v3.tex", "List"];

In[ ]:= (* Arreglos -- *)
        SizeElem = SizeString
        Array[Awaves8Avark, {SizeString, nwavesbit}];
        Array[fwaves8Avark, {SizeString, nwavesbit}];
        Array[waves8Avark, {SizeString, nwavesbit}];
        Array[Totalwaves8Avark, SizeString];
        Array[samples1sec8Avark, SizeString];
        Array[Twavesfft8Avark, SizeString];
        (* Para los elementos finales de la matriz *)
        Array[Totalwaves8Avark2, SizeElem];
        Array[samples1sec8Avark2, SizeElem];
        Array[Twavesfft8Avark2, SizeElem];
        (* Para los elementos finales finales de la matriz *)
        Array[Totalwaves8Avark3, 1];
        Array[samples1sec8Avark3, 1];
        Array[Twavesfft8Avark3, 1];

Out[ ]= 12

In[ ]:= tinterval = N[sr / 2 / SizeString];
        Do[
         Do[
            Awaves8Avark[i, j] = binaryString⟦i⟧⟦j⟧;
            fwaves8Avark[i, j] = ToExpression[FreqIn⟦j⟧] * Awaves8Avark[i, j];
            (*Print[binaryString⟦i⟧⟦j⟧," : ",fwaves8Avark[i,j]];*)
            (* Asi todo el mundo va a ser diferente !! --*)
            waves8Avark[i, j] = If[Awaves8Avark[i, j] == 0, 0, Cos[fwaves8Avark[i, j] * t]];
            (*waves8Avark[i,j]=FourierSeries[t/2,t,2];*)
            , {j, 1, nwavesbit}];(*Print["-----"];*), {i, 1, SizeString}]
```

```
In[ ]:= Do[
         (*--- Total ---*)
         Totalwaves8Avark[i] = Sum[waves8Avark[i, n], {n, 1, nwavesbit}];
         samples1sec8Avark[i] =
          Table[N[{t, Totalwaves8Avark[i]}], {t, (i - 1) * stepTime, i * stepTime, dt}];
         Twavesfft8Avark[i] = Fourier[samples1sec8Avark[i][[All, 2]]];
         , {i, 1, SizeString}]
```

Para ver cuando es más tiempo:

```
In[ ]:= Do[
         (*--- Total ---*)
         samples1sec8Avark2[i] =
           Table[N[{t, Totalwaves8Avark[i]}], {t, (i - 1), i, dt * 100}];
         , {i, 1, SizeString}]
```

La conformacion de Los 4 elementos:

```
In[ ]:= Totalwaves8Avark[1] (*0000000*)
        Totalwaves8Avark[2] (*001*)
        Totalwaves8Avark[3]
        Totalwaves8Avark[4]
        Totalwaves8Avark[5]
        Totalwaves8Avark[6]
```

Finalmente Concatenamos:

```
In[ ]:= (*-- Aqui se concatenan --*)
        Welem = 1
        Do[
         Print[" desde ", Welem * (i - 1) + 1, " : hasta ", Welem * (i - 1) + Welem];
         (*--- Total ---*)
         Totalwaves8Avark3[i] = Join[Table[Totalwaves8Avark[mm], {mm, 1, SizeString}]];
         samples1sec8Avark3[i] = Table[N[{t, Totalwaves8Avark3[i]}] // Flatten,
            {t, (i - 1) * stepTime, i * stepTime, dt}] // Flatten;
         Twavesfft8Avark3[i] =
          Join[Table[Twavesfft8Avark[mm] // Flatten, {mm, 1, SizeString}]] // Flatten
         (*Fourier[samples1sec8Avark3[i]];*)
         , {i, 1, 1}]

Out[ ]= 1

         desde 1 : hasta 1
```

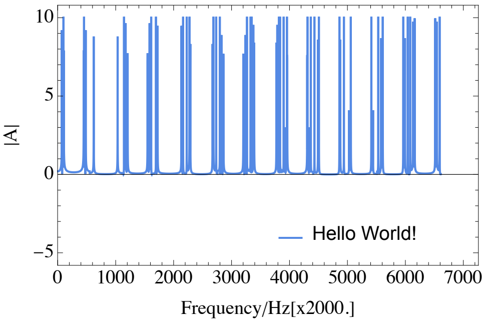
In[ ]:=

```
fsz = 16;
imgsz = {400, 400}
ymin = -250;
ymax = 2;
xmin = -2;
xmax = sr * stepTime * SizeString * 1.1;(*220000*)
(*tambien hay información en 11000 *)
yminHz = -5;
ymaxHz = 10;
k = 1; (*- a -*)
m = 2;(*- b -*)
ptTotalIndi8k2 =
 Column[{ListLinePlot[Abs[(Twavesfft8Avark3[k])],
    Frame → True,
    FrameStyle → Directive[FontFamily → "Times"],
    LabelStyle → Directive[Black, fsz],
    PlotStyle → {{Thickness@0.005, Blue@Darker}},
    FrameLabel → {"Frequency/Hz" <> "[x" <> ToString[stepFreq] <> "]", "|A|"},
    PlotLegends → Placed[{myString}, {0.69, 0.12}],
    PlotRangePadding → {0.2, .8},
    PlotRange → {{xmin, xmax}, {yminHz, ymaxHz}},
    ImageSize → imgsz]}]
```

Out[ ]=

```
{400, 400}
```

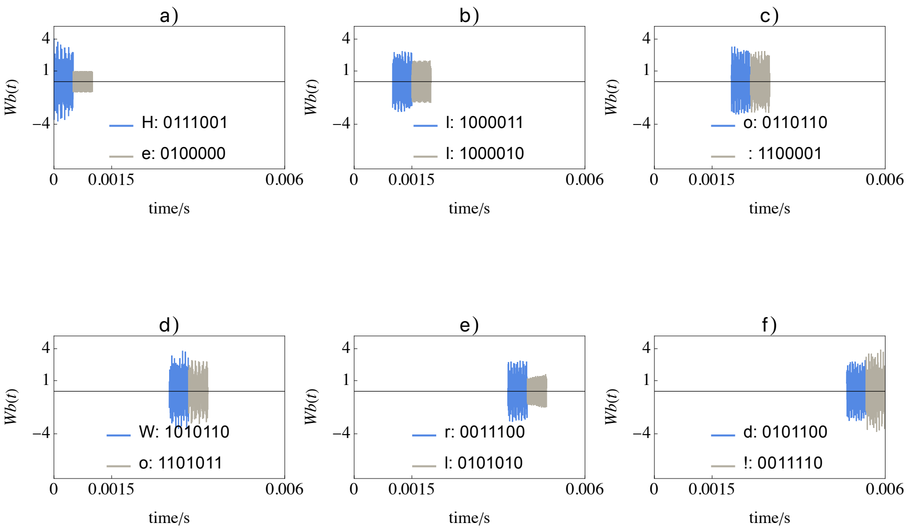
Out[ ]=



```
In[ ]:= fsz = 14;
        imgsz = {250, 250}
        ymin = -8.2;
        ymax = 5.2;
        letters = {"a)", "", "b)", "", "c)", "", "d)", "", "e)", "", "f)"};
        ptTotal1 = Row[Table[
            ListLinePlot[{samples1sec8Avark[m], samples1sec8Avark[m + 1]},
             Frame → True,
             FrameStyle → Directive[FontFamily → "Times"],
             LabelStyle → Directive[Black, fsz],
             PlotStyle → {{Thickness@0.005, Blue@Darker}},
             PlotLabel → letters⟦m⟧,
             PlotLegends → Placed[{
                binaryStringS⟦m⟧ <> ": " <> binaryStringMap⟦m⟧,
                binaryStringS⟦m + 1⟧ <> ": " <> binaryStringMap⟦m + 1⟧
               },
               {0.5, 0.2}],
             FrameLabel → {"time/s", "Wb(t)"},
             PlotRange → {{0, SizeString * stepTime}, {ymin, ymax}},
             FrameTicks →
              {{{-4, 4, 1}, None}, {{0, stepTime * 3, stepTime * SizeString}, None}},
             ImageSize → imgsz], {m, 1, 5, 2}]];
        ptTotal2 = Row[Table[
            ListLinePlot[{samples1sec8Avark[m], samples1sec8Avark[m + 1]},
             Frame → True,
             FrameStyle → Directive[FontFamily → "Times"],
             LabelStyle → Directive[Black, fsz],
             PlotStyle → {{Thickness@0.005, Blue@Darker}},
             PlotLabel → letters⟦m⟧,
             PlotLegends → Placed[{
                binaryStringS⟦m⟧ <> ": " <> binaryStringMap⟦m⟧,
                binaryStringS⟦m + 1⟧ <> ": " <> binaryStringMap⟦m + 1⟧
               },
               {0.5, 0.2}],
             FrameLabel → {"time/s", "Wb(t)"},
             PlotRange → {{0, SizeString * stepTime}, {ymin, ymax}},
             FrameTicks →
              {{{-4, 4, 1}, None}, {{0, stepTime * 3, stepTime * SizeString}, None}},
             ImageSize → imgsz], {m, 7, 11, 2}]];
        ptTotal = Grid[{{ptTotal1}, {ptTotal2}}]

Out[ ]= {250, 250}
```

Out[•]=



In[•]:=

```
myDir = NotebookDirectory[];
Export[myDir <> "/Waves_8bits_HelloWorld_v7.png", ptTotal];
```

Decoding?

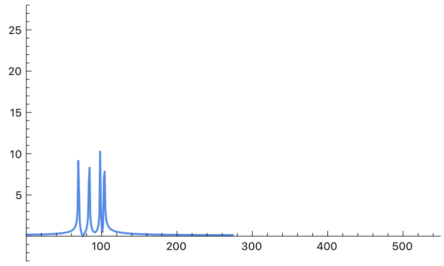
In[•]:=

```
itest = 1;
npuntos = sr;
data = Table[{Range[(itest - 1) * sr * stepTime, itest * sr * stepTime]⟦j⟧,
    Abs[(Twavesfft8Avark[itest])]⟦j⟧}, {j, 1, sr * stepTime / 2}];
```

In[•]:=

```
ListLinePlot[data,
 PlotRange → {{(itest - 1) * sr * stepTime, itest * sr * stepTime}, {-3, 28}}]
```

Out[•]=



In[•]:=

```
(*----*)
binaryStringS⟦itest⟧;
binaryStringMap⟦itest⟧;
Totalwaves8Avark[itest];
FreqIn
peaks = FindPeaks[data⟦All, 2⟧, 1, 1, 5]
```

Out[•]=

```
{513 007., 870 613., 1.0482121082694172*^6, 1.2331338086689976*^6, 264 985., 869 858.,
 1.297988877870819*^6}
```

Out[•]=

```
{{70, 9.19945}, {85, 8.38921}, {99, 10.3355}, {105, 7.91176}}
```

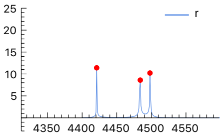
```
In[ ]:= (*----*)
        binaryStringS⟦itest⟧
        Print["Mapa"];
        binaryStringMap⟦itest⟧
        decod1 =
         Table[If[Abs[2 π * N[peaks⟦k, 1⟧] * stepFreq - fwaves8Avark[itest, i]] < 15 * stepFreq
            , 1, 0], {k, 1, Length[peaks]}, {i, 1, nwavesbit}]
        Print["Decodificado"];
        Sum[decod1⟦i⟧, {i, 1, Length[decod1]}]
```

```
Out[ ]= H
        Mapa
Out[ ]= 0111001
Out[ ]= {{0, 1, 0, 0, 0, 0, 0}, {0, 0, 1, 0, 0, 0, 0}, {0, 0, 0, 1, 0, 0, 0}, {0, 0, 0, 0, 0, 0, 1}}
        Decodificado
Out[ ]= {0, 1, 1, 1, 0, 0, 1}
```

Hacer un diagrama cool de esta metodologia.

```
In[•]:= itest = 9;
        Totalwaves8Avark[itest]
        npuntos = sr;
        rango = Range[(itest - 1) * sr * stepTime, itest * sr * stepTime];
        data =
          Table[{rango⟦j⟧, Abs[(Twavesfft8Avark[itest])]⟦j⟧}, {j, 1, sr * stepTime / 2}];
        (*----*)
        binaryString⟦itest⟧
        binaryStringS⟦itest⟧
        binaryStringMap⟦itest⟧
        Totalwaves8Avark[itest];
        FreqIn
        peaks = FindPeaks[data⟦All, 2⟧, 1, 1, 5];
        Table[N[2 π * peaks⟦k, 1⟧] * stepFreq, {k, 1, Length[peaks]}]
        (*----*)
        decod1 =
          Table[If[Abs[2 π * N[peaks⟦k, 1⟧] * stepFreq - fwaves8Avark[itest, i]] < 15 * stepFreq,
            1, 0], {k, 1, Length[peaks]}, {i, 1, nwavesbit}];
        SumDecod = Sum[decod1⟦i⟧, {i, 1, Length[decod1]}]
        SumDecod = Table[If[SumDecod⟦i⟧ > 1, 1, SumDecod⟦i⟧], {i, 1, Length[SumDecod]}];
        (*----*)
        DecodFinal = If[SumDecod == binaryString⟦itest⟧, binaryStringS⟦itest⟧, "Unknown!"];
        (*----*)
        ListLinePlot[
         data,
         PlotStyle → {{Thickness@0.003, Blue@Darker}}, PlotLegends → Placed[{DecodFinal},
           {0.82, 0.95}],
         ImageSize → Small,
         (*PlotRange→
          {{(itest-1)*sr,(itest-1)*sr+0.05*Abs[(itest-1)*sr-itest*sr]},{-3,48}},*)
         PlotRange → {{rango⟦1⟧ * 0.98,
            (peaks⟦Length[peaks]⟧⟦1⟧ + (itest - 1) * sr * stepTime - 1) + 100}, {-3, 25}},
         Epilog → Table[{Text[Style["", 10],
             {peaks⟦l⟧⟦1⟧ + (itest - 1) * sr * stepTime - 1,
              peaks⟦l⟧⟦2⟧ * 1.18}],
            Red, PointSize[Medium],
            Point@{peaks⟦l⟧⟦1⟧ + (itest - 1) * sr * stepTime - 1,
              peaks⟦l⟧⟦2⟧}}, {l, 1, Length[peaks]}]
        ]
Out[•]= Cos[264 985. t] + Cos[1.04821 × 10^6 t] + Cos[1.23313 × 10^6 t]
Out[•]= {0, 0, 1, 1, 1, 0, 0}
Out[•]= r
Out[•]= 0011100
Out[•]= {513 007., 870 613., 1.0482121082694172*^6, 1.2331338086689976*^6, 264 985., 869 858.,
         1.297988877870819*^6}
Out[•]= {276 460., 1.06814 × 10^6, 1.24407 × 10^6}
Out[•]= {0, 0, 1, 1, 1, 0, 0}
```

Out[•]=



Conclusion: El cambio de amplitud en las ondas afecta el grosor de los picos de frecuencia.

Entonces la pregunta es: como es o queda

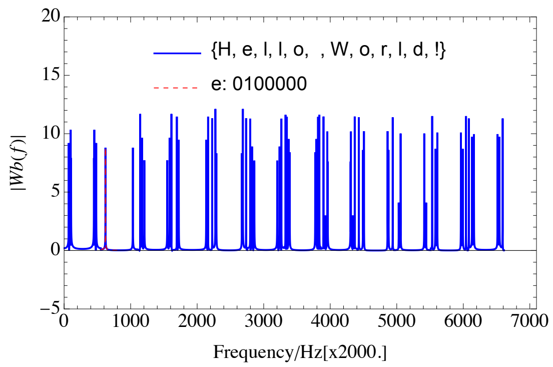
In[ ]:=

```
fsz = 16;
imgsz = {450, 450}
ymin = -4;
ymax = 4;
xmin = -500;
xmax = sr * SizeString * stepTime + 500; (*tambien hay información en 11000 *)
yminHz = -5;
ymaxHz = 20;
k = 1; (*- a -*)
m = 2;(*- 1, no tiene solucion  -- b -*)
ptHelloWHv1 = Show[{ListLinePlot[{
      Abs[(Twavesfft8Avark3[k])],
      Table[{Range[(m - 1) * sr * stepTime, m * sr * stepTime][[j]] + m,
        Abs[(Twavesfft8Avark[m])][[j]]}, {j, 1, sr * stepTime / 2}]
     },
     Frame → True,
     FrameStyle → Directive[FontFamily → "Times"],
     LabelStyle → Directive[Black, fsz],
     PlotStyle → {
       {Thickness@0.004, Blue},
       {Thickness@0.002, Red, Dashed}},
     FrameLabel → {"Frequency/Hz" <> "[x" <> ToString[stepFreq] <> "]", "|Wb(f)|"},
     PlotLegends → Placed[
       {binaryStringS, binaryStringS[[m]] <> ": " <> binaryStringMap[[m]]}, {0.5, 0.82}],
     PlotRange → {{0, xmax}, {yminHz, ymaxHz}},
     ImageSize → imgsz]}, Padding → 0]
```

Out[ ]=

```
{450, 450}
```

Out[ ]=

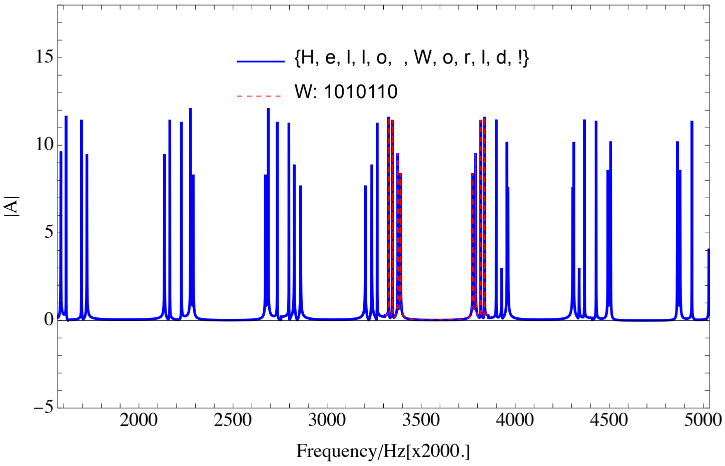


```
myDir = NotebookDirectory[];
Export[myDir <> "/Waves_8bits_Hello_v7.pdf", ptHelloWHv1];
```

```
In[ ]:= fsz = 16;
        imgsz = {600, 600}
        ymin = -4;
        ymax = 4;
        xmin = -500;
        xmax = sr * SizeString * stepTime + 500;
        (*tambien hay información en 11000 *)
        yminHz = -5;
        ymaxHz = 18;
        k = 1; (*- a -*)
        m = 7;(*- 1, no tiene solucion  -- b -*)
        ptTotalIndi8k2 =
         Column[{ListLinePlot[{
              Abs[(Twavesfft8Avark3[k])],
              Table[{Range[(m - 1) * sr * stepTime, m * sr * stepTime]⟦j⟧ + m,
                Abs[(Twavesfft8Avark[m])]⟦j⟧}, {j, 1, sr * stepTime}]
             },
             Frame → True,
             FrameStyle → Directive[FontFamily → "Times"],
             LabelStyle → Directive[Black, fsz],
             PlotStyle → {
               {Thickness@0.004, Blue},
               {Thickness@0.002, Red, Dashed}},
             FrameLabel → {"Frequency/Hz" <> "[x" <> ToString[stepFreq] <> "]", "|A|"},
             PlotLegends → Placed[
               {binaryStringS, binaryStringS⟦m⟧ <> ": " <> binaryStringMap⟦m⟧}, {0.5, 0.82}],
             PlotRange → {{(m - 1) * sr * stepTime -
                 6.3 * Abs[(m - 1) * sr * stepTime - m * sr * stepTime] / 2, (m - 1) * sr * stepTime +
                 6.3 * Abs[(m - 1) * sr * stepTime - m * sr * stepTime] / 2}, {yminHz, ymaxHz}},
             ImageSize → imgsz]}]

Out[ ]= {600, 600}
```

Out[ ]=

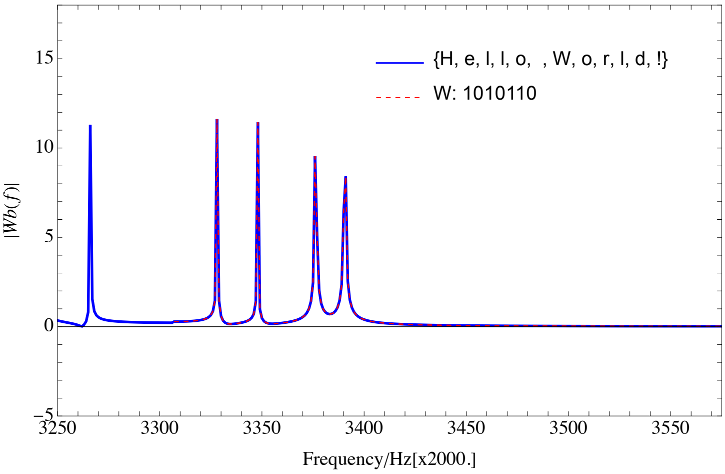

{H, e, l, l, o, , W, o, r, l, d, !}
W: 1010110
|A|
15
10
5
0
−5
2000
2500
3000
3500
4000
4500
5000
Frequency/Hz[x2000.]

In[ ]:=

```
fsz = 16;
imgsz = {600, 600}
ymin = -4;
ymax = 4;
xmin = -500;
xmax = sr * SizeString * stepTime + 500; (*tambien hay información en 11000 *)
yminHz = -5;
ymaxHz = 18;
k = 1; (*- a -*)
m = 7;(*- 1, no tiene solucion  -- b -*)
ptOneletterandHellov1 =
 Column[{ListLinePlot[{
     Abs[(Twavesfft8Avark3[k])],
     Table[{Range[(m - 1) * sr * stepTime, m * sr * stepTime]⟦j⟧ + m,
       Abs[(Twavesfft8Avark[m])]⟦j⟧}, {j, 1, sr * stepTime}]
    },
    Frame → True,
    FrameStyle → Directive[FontFamily → "Times"],
    LabelStyle → Directive[Black, fsz],
    PlotStyle → {
      {Thickness@0.004, Blue},
      {Thickness@0.002, Red, Dashed}},
    FrameLabel → {"Frequency/Hz" <> "[x" <> ToString[stepFreq] <> "]", "|Wb(f)|"},
    PlotLegends → Placed[
      {binaryStringS, binaryStringS⟦m⟧ <> ": " <> binaryStringMap⟦m⟧}, {0.7, 0.82}],
    PlotRange → {{(m - 1) * sr * stepTime - 50, (m - 1) * sr * stepTime +
         0.5 * Abs[(m - 1) * sr * stepTime - m * sr * stepTime]}, {yminHz, ymaxHz}},
    ImageSize → imgsz]}]
```

Out[ ]= {600, 600}

Out[ ]=

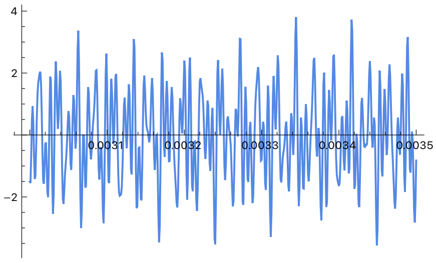


```
myDir = NotebookDirectory[];
Export[myDir <> "/Waves_OneLetter_Hello_v7.pdf", ptOneletterandHellov1];
```

In[ ]:=

```
ListLinePlot[samples1sec8Avark[m]]
```

Out[ ]=



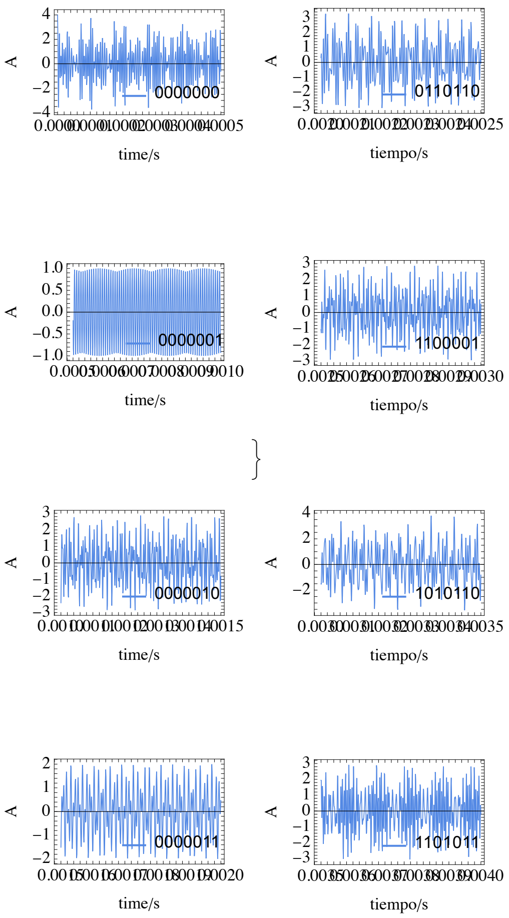
In[ ]:=

```
fsz = 14;
imgsz = {200, 200}
ymin = -5;
ymax = 5;
ptTotal = Style[Row[{{Column[Table[ListLinePlot[samples1sec8Avark[m],
         Frame → True,
         FrameStyle → Directive[FontFamily → "Times"],
         LabelStyle → Directive[Black, fsz],
         PlotStyle → {{Thickness@0.005, Blue@Darker}},
         FrameLabel → {"time/s", "A"},
         (*PlotLegends→{"from binary = "<>binary⟦m⟧},*)
         PlotLegends → Placed[{"" <> binary⟦m⟧}, {0.69, 0.2}],
         (*PlotRange→
          {{(m-1)*sr*dt*stepTime,(m-1)*sr*dt*stepTime+0.5},{ymin,ymax}},*)
         ImageSize → imgsz], {m, 1, 4}]]},
     (*-- Otra mitad --*)
     Column[Table[ListLinePlot[samples1sec8Avark[m],
        Frame → True,
        FrameStyle → Directive[FontFamily → "Times"],
        LabelStyle → Directive[Black, fsz],
        PlotStyle → {{Thickness@0.005, Blue@Darker}},
        FrameLabel → {"tiempo/s", "A"},
        PlotLegends → Placed[{"" <> binaryStringMap⟦m⟧}, {0.69, 0.2}],
        (*PlotRange→
         {{(m-1)*sr*dt*stepTime,(m-1)*sr*dt*stepTime+0.5},{ymin,ymax}},*)
        ImageSize → imgsz], {m, 5, 8}]]
    }]]
```

Out[ ]=

```
{200, 200}
```

Out[ ]= { }


A
4
2
0
−2
−4
0000000
0.0000000010000200030000400005
time/s
A
3
2
1
0
−1
−2
−3
0110110
0.0020002100220002300240025
tiempo/s
A
1.0
0.5
0.0
−0.5
−1.0
0000001
0.0005000600070008000900010
time/s
A
3
2
1
0
−1
−2
−3
1100001
0.0025002600270028002900030
tiempo/s
A
3
2
1
0
−1
−2
−3
0000010
0.0010001100120001300140015
time/s
A
4
2
0
−2
1010110
0.0030003100320003300340035
tiempo/s
A
2
1
0
−1
−2
0000011
0.0015001600170018001900020
time/s
A
3
2
1
0
−1
−2
−3
1101011
0.0035003600370038003900040
tiempo/s

Individuales:

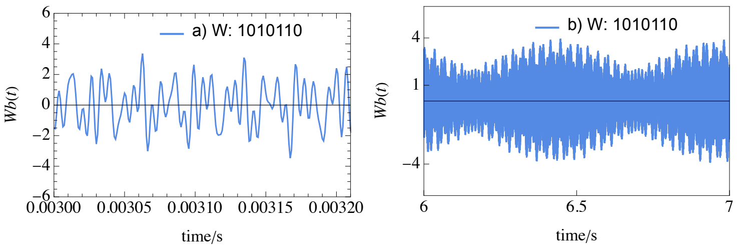
In[ ]:=

```
fsz = 14;
imgsz = {300, 300};
imgsz2 = {800, 300}
ymin = -6;
ymax = 6;
mm = 7;
ptIndi2Rowa = Grid[{{ListLinePlot[samples1sec8Avark[mm],
      Frame → True,
      FrameStyle → Directive[FontFamily → "Times"],
      LabelStyle → Directive[Black, fsz],
      PlotStyle → {{Thickness@0.005, Blue@Darker}},
      FrameLabel → {"time/s", "Wb(t)"},
      PlotLegends → Placed[
        {"a) " <> "" <> binaryStringS⟦mm⟧ <> ": " <> binaryStringMap⟦mm⟧}, {0.6, 0.9}],
      PlotRange → {{(mm - 1) * stepTime,
          (mm - 1) * stepTime + (mm - 1) * stepTime * 0.07}, {ymin, ymax}},
      (*FrameTicks→
       {{{-4,4,1},None},{{0,stepTime*4,stepTime*SizeString*0.8},None}},*)
      ImageSize → imgsz],
    ListLinePlot[samples1sec8Avark2[mm],
      Frame → True,
      FrameStyle → Directive[FontFamily → "Times"],
      LabelStyle → Directive[Black, fsz],
      PlotStyle → {{Thickness@0.005, Blue@Darker}},
      FrameLabel → {"time/s", "Wb(t)"},
      PlotLegends → Placed[
        {"b) " <> "" <> binaryStringS⟦mm⟧ <> ": " <> binaryStringMap⟦mm⟧}, {0.6, 0.9}],
      PlotRange → {{6, 7}, {ymin, ymax}},
      FrameTicks → {{{-4, 4, 1}, None}, {{6, 6.5, 7}, None}},
      ImageSize → imgsz]}}]
```

Out[ ]=

```
{800, 300}
```

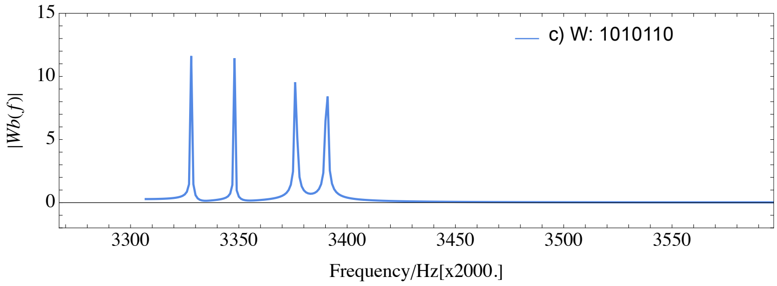
Out[ ]=



```
fsz = 16;
imgsz = {300, 300};
imgsz2 = {640, 250}
mm = 7;
ymin = -2;
ymax = 4;
xmin = 10 300;
xmax = 10 700; (*tambien hay información en 11000 *)
yminHz = -2;
ymaxHz = 15;

ptIndi2Rowb =
 ListLinePlot[Table[{Range[(mm - 1) * sr * stepTime, mm * sr * stepTime]⟦j⟧ + mm,
    Abs[(Twavesfft8Avark[mm])]⟦j⟧}, {j, 1, sr * stepTime}],
  Frame → True,
  FrameStyle → Directive[FontFamily → "Times"],
  LabelStyle → Directive[Black, fsz],
  PlotStyle → {{Thickness@0.003, Blue@Darker}},
  FrameLabel → {"Frequency/Hz" <> "[x" <> ToString[stepFreq] <> "]", "|Wb(f)|"},
  (* -- *)
  PlotLegends → Placed[
    {"c)  " <> "" <> binaryStringS⟦mm⟧ <> ":  " <> binaryStringMap⟦mm⟧}, {0.75, 0.9}],
  PlotRange → {{(mm - 1) * sr * stepTime * 0.99, (mm - 1) * sr * stepTime * 0.99 +
      0.6 * Abs[(mm - 1) * sr * stepTime - mm * sr * stepTime]}, {yminHz, ymaxHz}},
  AspectRatio → 0.3,
  ImageSize → imgsz2]
```

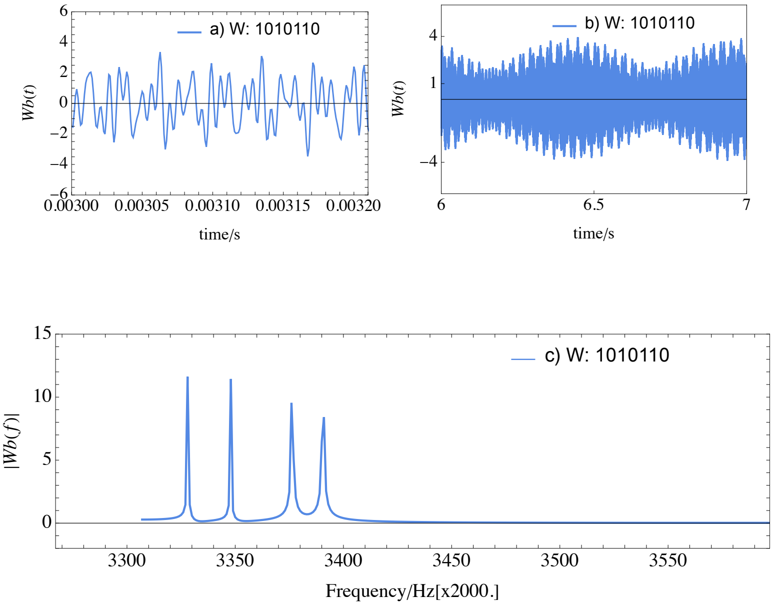
```
{640, 250}
```



In[ ]:=

```
ptIndiTotaln7 = Grid[{{ptIndi2Rowa}, {ptIndi2Rowb}}]
```

Out[ ]=



In[ ]:=

```
myDir = NotebookDirectory[];
Export[myDir <> "/Waves_128bits_Indi_variable_v7.png", ptIndiTotaln7];
```

In[ ]:=

```
fsz = 14;
imgsz = {300, 300};
imgsz2 = {800, 300}
ymin = -6;
ymax = 6;
mm = 4;
strings = {"a) ", "b) ", "c) ", "d) "}
pt4wavesRows = Row[Table[ListLinePlot[
     samples1sec8Avark[mm],
     Frame → True,
     FrameStyle → Directive[FontFamily → "Times"],
     LabelStyle → Directive[Black, fsz],
     PlotStyle → {{Thickness@0.005, Blue@Darker}},
     FrameLabel → {"time/s", "Wb(t)"},
     (*PlotLegends→{"from binary = "<>binary⟦m⟧},*)
     PlotLegends → Placed[{strings⟦mm - 1⟧ <> binary⟦mm⟧}, {0.75, 0.9}],
     PlotRange →
      {{(mm - 1) * sr * dt * stepTime, (mm - 1) * sr * dt * stepTime + 0.001}, {ymin, ymax}},
     ImageSize → imgsz], {mm, 2, 5}]]
```

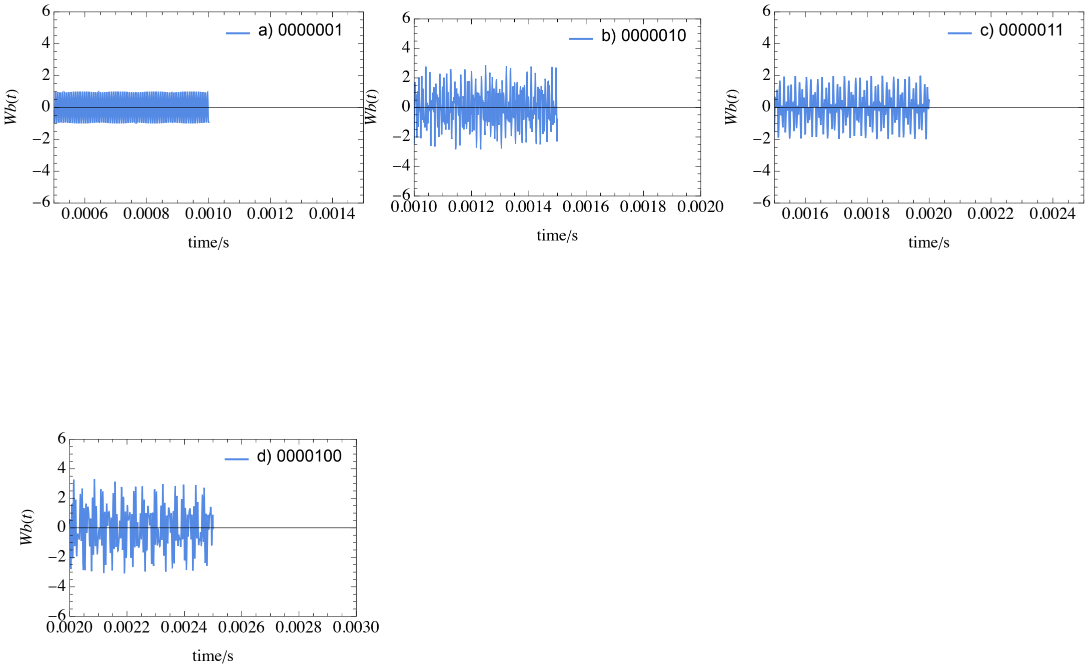
Out[ ]=

```
{800, 300}
```

Out[ ]=

```
{a) , b) , c) , d) }
```

Out[ ]=



In[ ]:=

```
myDir = NotebookDirectory[];
Export[myDir <> "/Waves_8bits_4waves_variable_v4.png", pt4wavesRows];
```

Decodificando:

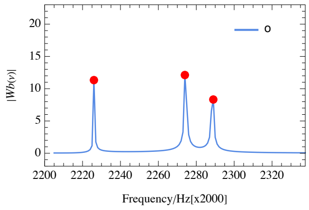
In[ ]:=

```
Clear[ptDecod]
```

```
In[ ]:=  Array[ptDecod, 2]
Out[ ]=  {ptDecod[1], ptDecod[2]}
In[ ]:=  binaryStringS
Out[ ]=  {H, e, l, l, o,  , W, o, r, l, d, !}
```

```
In[ ]:=  fsz = 10;
         imgsz = {250, 250}
         yminHz = -2;
         ymaxHz = 23;
         letters = {"a)", "", "b)", "", "c)", "", "d)", "", "e)", "", "f)"};
         m = 5;
         data = Table[{Range[(m - 1) * sr * stepTime, m * sr * stepTime]⟦j⟧ + (m),
              Abs[(Twavesfft8Avark[m])]⟦j⟧}, {j, 1, sr * stepTime / 2}];
         peaks = FindPeaks[data⟦All, 2⟧, 1, 1, 5];
         p5 = ListLinePlot[{Table[{Range[((m) - 1) * sr * stepTime, (m) * sr * stepTime]⟦j⟧ + (m),
                Abs[(Twavesfft8Avark[(m)])]⟦j⟧}, {j, 1, sr * stepTime}]},
            (*--*)
            Epilog → Table[{Text[Style["", 10],
                  {peaks⟦l⟧⟦1⟧ + ((m) - 1) * sr * stepTime + 1, peaks⟦l⟧⟦2⟧ * 1.18}], Red,
                PointSize[Large], Point@{peaks⟦l⟧⟦1⟧ + ((m) - 1) * sr * stepTime + m - 1,
                  peaks⟦l⟧⟦2⟧}}, {l, 1, Length[peaks]}],
            (*--*)
            Frame → True,
            FrameStyle → Directive[FontFamily → "Times"],
            LabelStyle → Directive[Black, fsz],
            PlotStyle → {{Thickness@0.005, Blue@Darker}},
            (*PlotLabel→letters⟦m⟧,*)
            PlotLegends → Placed[{
                binaryStringS⟦m⟧,
                binaryStringS⟦m + 1⟧
              },
              {0.8, 0.85}],
            FrameLabel → {"Frequency/Hz" <> "[x2000]", "|Wb(ν)|"},
            PlotRange → {{(m - 1) * sr * stepTime,
                (m - 1) * sr * stepTime + 0.5 * Abs[(m - 1) * sr * stepTime - m * sr * stepTime] / 2},
              {yminHz, ymaxHz}},
            ImageSize → imgsz]
Out[ ]=  {250, 250}
```

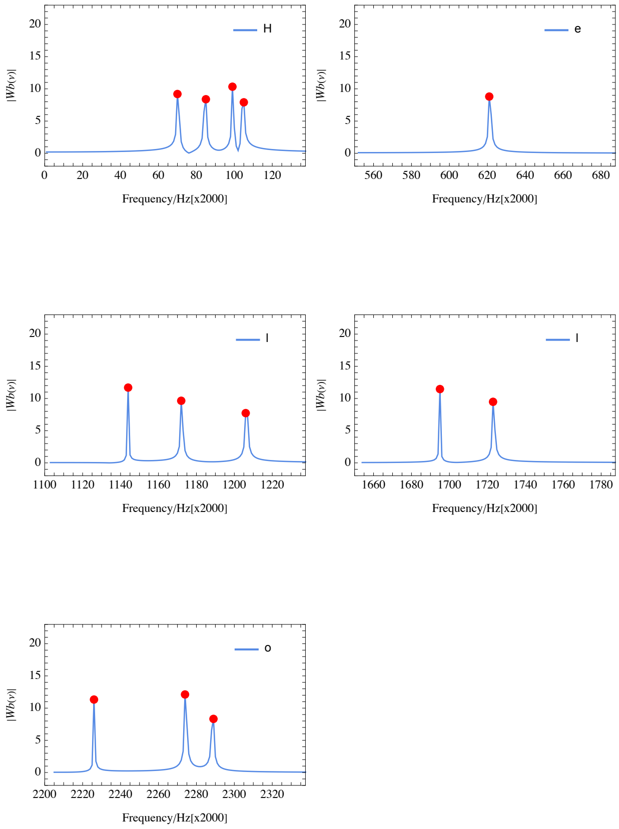
Out[ ]=



In[∘]:=

```
ptDecodHellov4 = Grid[{{p1, p2}, {p3, p4}, {p5}}]
```

Out[∘]=



In[∘]:=

```
myDir = NotebookDirectory[];
Export[myDir <> "/Decodifying_8bits_HelloW_v6_Paper.png", ptDecodHellov4];
```

La onda completa:

In[ ]:=

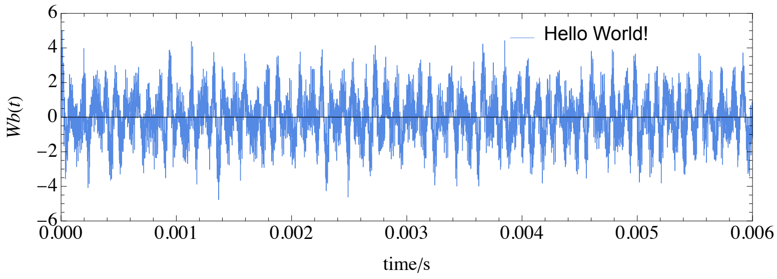
```
fsz = 16;
imgsz = {300, 300};
imgsz2 = {640, 250}
mm = 7;
ymin = -6;
ymax = 6;
xmin = 10 300;
xmax = 10 700; (*tambien hay información en 11000 *)
yminHz = -2;
ymaxHz = 32;

ptTotalWave2 =
 ListLinePlot[
  Table[{i * dt, samples1sec8Avark3[1]⟦i⟧}, {i, 1, Length[samples1sec8Avark3[1]]}],
  Frame → True,
  FrameStyle → Directive[FontFamily → "Times"],
  LabelStyle → Directive[Black, fsz],
  PlotStyle → {{Thickness@0.001, Blue@Darker}},
  FrameLabel → {"time/s", "Wb(t)"},
  (* -- *)
  PlotLegends → Placed[{"Hello World!"}, {0.75, 0.9}],
  AspectRatio → 0.3,
  PlotRange → {{0, SizeString * stepTime}, {ymin, ymax}},
  ImageSize → imgsz2]
```

Out[ ]=

```
{640, 250}
```

Out[ ]=



In[ ]:=

```
myDir = NotebookDirectory[];
Export[myDir <> "/Decodifying_Total_HelloW_v5.png", ptTotalWave2];
```