**Filtro BS Chebyshev I**

|  |  |
| --- | --- |
| **Quantizado 31 bits Forma direta II Second-Order Sections** | |
| --------------------------  Section #1  --------------------------  Quantized Numerator:  1  -0.46916635334491729736328125  1.089938461780548095703125  Quantized Denominator:  1  -0.2964711226522922515869140625  0.41814742051064968109130859375  Quantized Gain:  0.52686798572540283203125  --------------------------  Section #2  --------------------------  Quantized Numerator:  1  -0.3780455850064754486083984375  1.0826715417206287384033203125  Quantized Denominator:  1  -0.0416371636092662811279296875  0.82487000338733196258544921875  Quantized Gain:  1  --------------------------  Section #3  --------------------------  Quantized Numerator:  1  -0.43045214377343654632568359375  0.91748299263417720794677734375  Quantized Denominator:  1  -0.70038955472409725189208984375  0.83701942861080169677734375  Quantized Gain:  1  --------------------------  Section #4  --------------------------  Quantized Numerator:  1  -0.3491784594953060150146484375  0.92364116571843624114990234375  Quantized Denominator:  1  -0.16408178769052028656005859375  0.9511614143848419189453125  Quantized Gain:  1  --------------------------  Section #5  --------------------------  Quantized Numerator:  1  -0.4948164783418178558349609375  1.0235830657184123992919921875  Quantized Denominator:  1  -0.63968464545905590057373046875  0.9534332118928432464599609375  Quantized Gain:  1  --------------------------  Section #6  --------------------------  Quantized Numerator:  1  -0.32172205857932567596435546875  1.0000000037252902984619140625  Quantized Denominator:  1  -0.209914527833461761474609375  0.9881243966519832611083984375  Quantized Gain:  1  --------------------------  Section #7  --------------------------  Quantized Numerator:  1  -0.48341603390872478485107421875  0.97696027345955371856689453125  Quantized Denominator:  1  -0.612816631793975830078125  0.98874096386134624481201171875  Quantized Gain:  1  --------------------------  Quantized Output Gain:  1 | --------------------------  Section #1  --------------------------  Reference Numerator:  1  -0.469166353343302366951661497296299785376  1.089938462111465389270392734033521264791  Reference Denominator:  1  -0.296471121860306774387083805777365341783  0.418147419943034726053099348064279183745  Reference Gain:  0.52686798572540283203125  --------------------------  Section #2  --------------------------  Reference Numerator:  1  -0.378045584676843460236739247193327173591  1.082671541690784389189161629474256187677  Reference Denominator:  1  -0.041637164292504913465364779767696745694  0.824870003482086389112737379036843776703  Reference Gain:  1  --------------------------  Section #3  --------------------------  Reference Numerator:  1  -0.430452143670377374018443106251652352512  0.917482992216778869831728115968871861696  Reference Denominator:  1  -0.700389554923104618033846691105281934142  0.837019427891170231248452182626351714134  Reference Gain:  1  --------------------------  Section #4  --------------------------  Reference Numerator:  1  -0.349178459939221697005962141702184453607  0.92364116499754078670747503565507940948  Reference Denominator:  1  -0.164081787063079020949629693859606049955  0.951161413532358501754515600623562932014  Reference Gain:  1  --------------------------  Section #5  --------------------------  Reference Numerator:  1  -0.494816477800395393416010847431607544422  1.023583065735208075253126480674836784601  Reference Denominator:  1  -0.639684645176383459563851374696241691709  0.953433212065612156749239147757180035114  Reference Gain:  1  --------------------------  Section #6  --------------------------  Reference Numerator:  1  -0.321722059079580513518692441721213981509  1.000000002854211311742460566165391355753  Reference Denominator:  1  -0.209914527018254137846753337726113386452  0.988124396269516647173247747559798881412  Reference Gain:  1  --------------------------  Section #7  --------------------------  Reference Numerator:  1  -0.483416033232757058613060507923364639282  0.976960273175654259070199714187765493989  Reference Denominator:  1  -0.612816631566394542929288036248181015253  0.988740963755510349209032483486225828528  Reference Gain:  1  --------------------------  Reference Output Gain:  1 |

|  |  |
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| **Comparativo** | |
| Discrete-Time IIR Filter (real)  -------------------------------  Filter Structure : Direct-Form II  Numerator Length : 15  Denominator Length : 15  Stable : Yes  Linear Phase : No  Arithmetic : fixed  Numerator : s31,24 -> [-64 64)  Denominator : s31,24 -> [-64 64)  Input : s16,15 -> [-1 1)  Output : s16,4 -> [-2048 2048)  State : s16,15 -> [-1 1)  Numerator Prod : s47,39 -> [-128 128)  Denominator Prod : s47,39 -> [-128 128)  Numerator Accum : s40,28 -> [-2048 2048)  Denominator Accum : s40,28 -> [-2048 2048)  Round Mode : convergent  Overflow Mode : wrap  Cast Before Sum : true    Implementation Cost  Number of Multipliers : 29  Number of Adders : 28  Number of States : 14  Multiplications per Input Sample : 29  Additions per Input Sample : 28 | Discrete-Time IIR Filter (real)  -------------------------------  Filter Structure : Direct-Form II, Second-Order Sections  Number of Sections : 7  Stable : Yes  Linear Phase : No  Arithmetic : fixed  Numerator : s31,29 -> [-2 2)  Denominator : s31,29 -> [-2 2)  Scale Values : s31,30 -> [-1 1)  Input : s16,15 -> [-1 1)  Section Input : s16,10 -> [-32 32)  Section Output : s16,11 -> [-16 16)  Output : s16,11 -> [-16 16)  State : s16,15 -> [-1 1)  Numerator Prod : s47,44 -> [-4 4)  Denominator Prod : s47,44 -> [-4 4)  Numerator Accum : s40,35 -> [-16 16)  Denominator Accum : s40,35 -> [-16 16)  Round Mode : convergent  Overflow Mode : wrap  Cast Before Sum : true    Implementation Cost  Number of Multipliers : 29  Number of Adders : 28  Number of States : 14  Multiplications per Input Sample : 29  Additions per Input Sample : 28 |

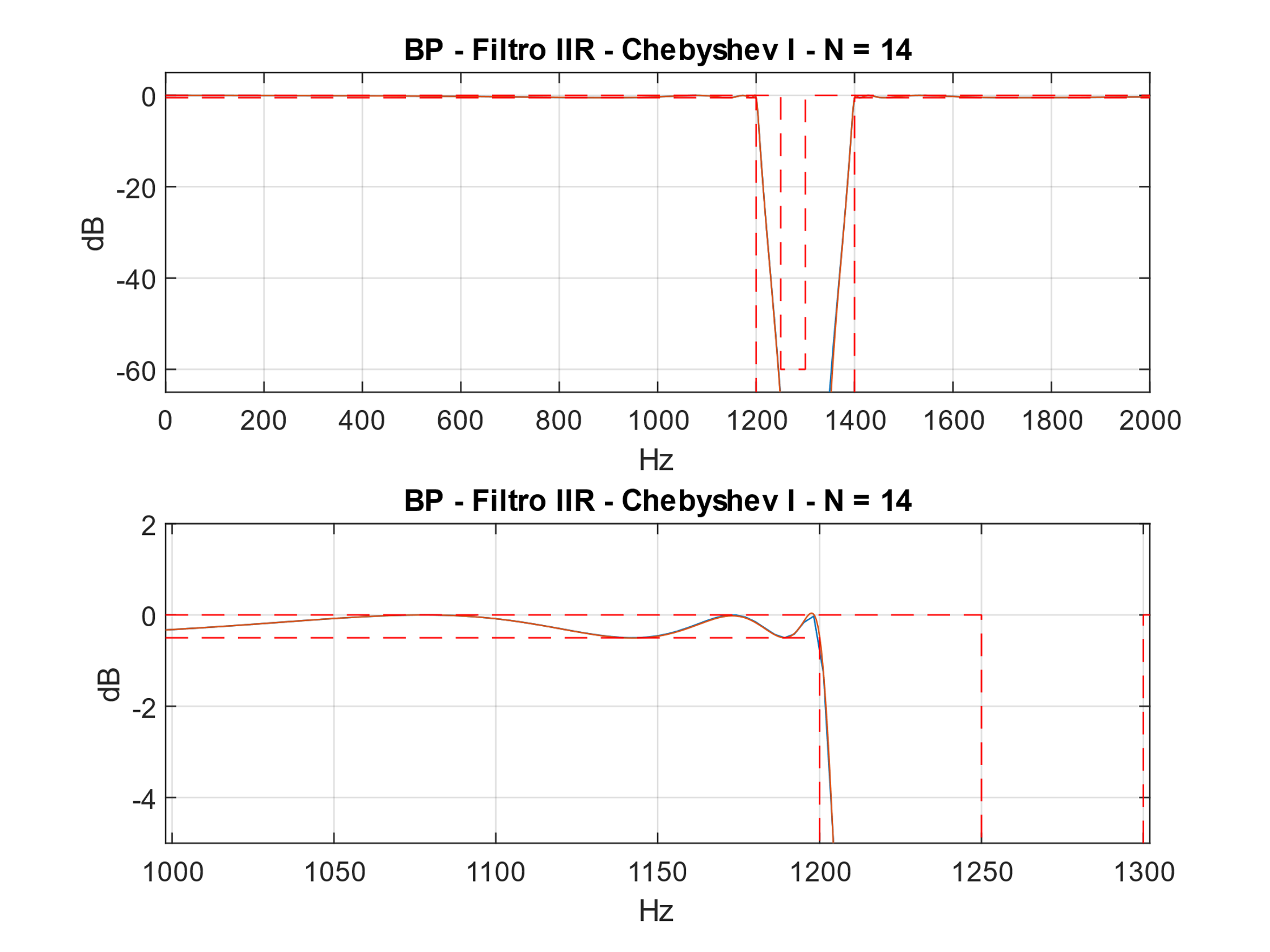


Figura 1 - Filtro DFII

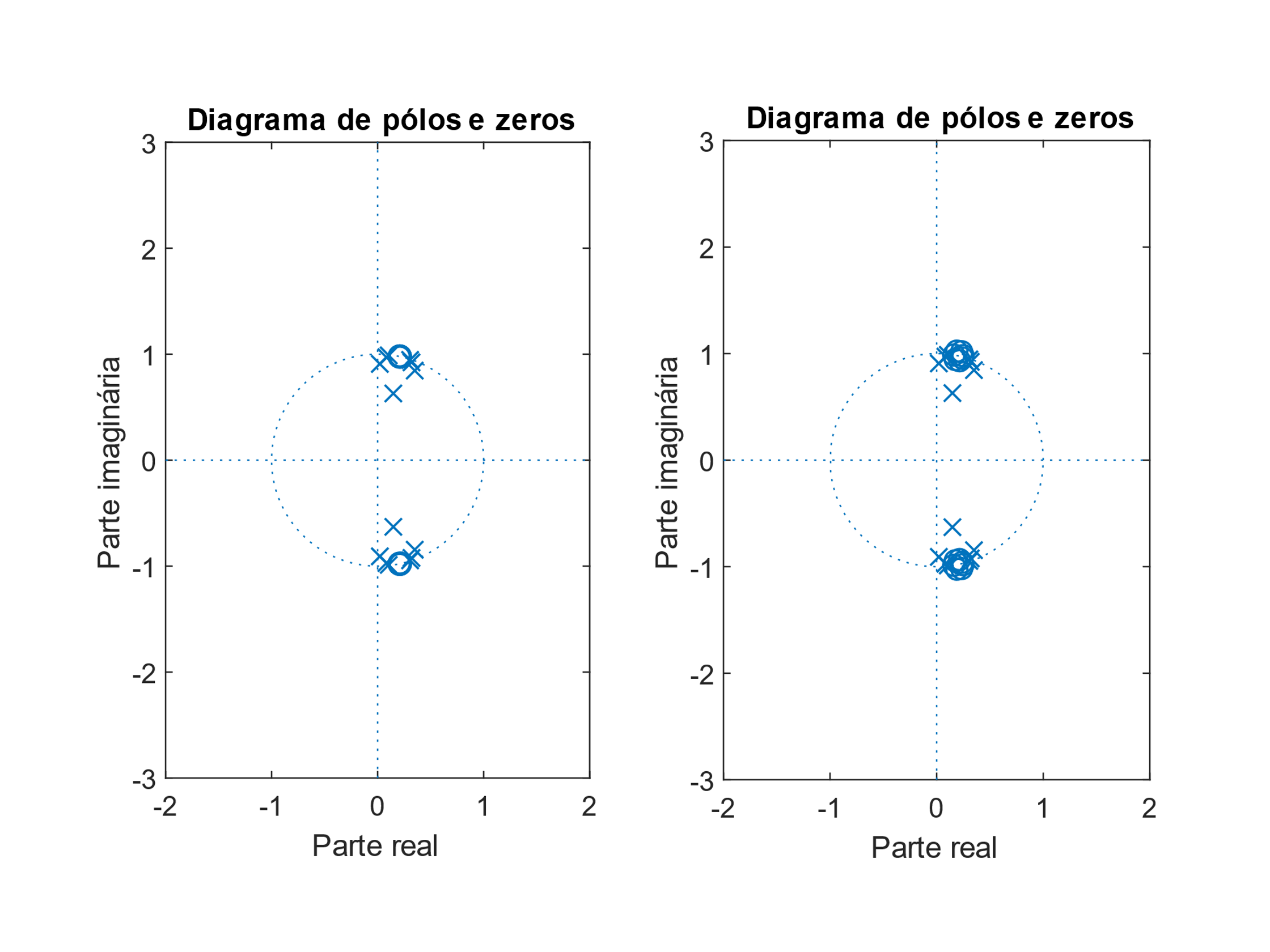


Figura 2 - Filtro DFII

ASIC:

(2M + S + D) \* nº bits

(2 \* 29 + 28 + 14) \* 31 = 3100 elementos

FPGA:

(2M + S) \* nº bits

(2 \* 29 + 28) \* 31 = 2666 elementos

**Filtro BS PM**

|  |  |
| --- | --- |
| **Quantized Numerator 8bits** | **Reference Numerator** |
| 0.00939178466796875  0.00168609619140625  -0.0012359619140625  0.00145721435546875  -0.001708984375  0.00103759765625  -0.00063323974609375  0.00136566162109375  -0.00128936767578125  0.00023651123046875  -0.00061798095703125  0.00144195556640625  -0.00040435791015625  -0.00009918212890625  -0.0011749267578125  0.0008544921875  0.0004730224609375  0.0005645751953125  -0.0012969970703125  -0.0004119873046875  0.00026702880859375  0.0015106201171875  -0.0001678466796875  -0.00112152099609375  -0.001129150390625  0.001251220703125  0.00146484375  -0.00012969970703125  -0.0021820068359375  -0.00060272216796875  0.0017547607421875  0.00189208984375  -0.00128936767578125  -0.0023956298828125  -0.0000457763671875  0.0027313232421875  0.00110626220703125  -0.002105712890625  -0.00225067138671875  0.00122833251953125  0.00261688232421875  0.0001220703125  -0.002532958984375  -0.0011138916015625  0.00170135498046875  0.00179290771484375  -0.00072479248046875  -0.00168609619140625  -0.0002593994140625  0.0011138916015625  0.0006561279296875  -0.00016021728515625  -0.000457763671875  -0.00055694580078125  -0.00042724609375  0.000762939453125  0.00154876708984375  -0.00008392333984375  -0.00249481201171875  -0.00131988525390625  0.002655029296875  0.00316619873046875  -0.0017852783203125  -0.00478363037109375  -0.00019073486328125  0.005584716796875  0.00283050537109375  -0.0050506591796875  -0.00550079345703125  0.0030975341796875  0.0074005126953125  -0.00003814697265625  -0.0078887939453125  -0.00341033935546875  0.00667572021484375  0.00637054443359375  -0.0040130615234375  -0.00801849365234375  0.0005340576171875  0.00794219970703125  0.00276947021484375  -0.0062103271484375  -0.0050201416015625  0.003448486328125  0.005615234375  -0.000640869140625  -0.00457763671875  -0.0012054443359375  0.0024871826171875  0.00142669677734375  -0.000396728515625  0.00005340576171875  -0.00054168701171875  -0.0025787353515625  -0.0005035400390625  0.00493621826171875  0.003662109375  -0.005706787109375  -0.0082550048828125  0.00374603271484375  0.01280975341796875  0.0013427734375  -0.01548004150390625  -0.00894927978515625  0.0145721435546875  0.01740264892578125  -0.00914764404296875  -0.0243988037109375  -0.00054931640625  0.0275115966796875  0.012969970703125  -0.0249481201171875  -0.0254974365234375  0.01615142822265625  0.03501129150390625  -0.0021209716796875  -0.03870391845703125  -0.0146636962890625  0.03485870361328125  0.03072357177734375  -0.02342987060546875  -0.04236602783203125  0.00615692138671875  0.04663848876953125  0.013671875  -0.04210662841796875  -0.03199005126953125  0.02924346923828125  0.0448760986328125  -0.01045989990234375  0.92211151123046875  -0.01045989990234375  0.0448760986328125  0.02924346923828125  -0.03199005126953125  -0.04210662841796875  0.013671875  0.04663848876953125  0.00615692138671875  -0.04236602783203125  -0.02342987060546875  0.03072357177734375  0.03485870361328125  -0.0146636962890625  -0.03870391845703125  -0.0021209716796875  0.03501129150390625  0.01615142822265625  -0.0254974365234375  -0.0249481201171875  0.012969970703125  0.0275115966796875  -0.00054931640625  -0.0243988037109375  -0.00914764404296875  0.01740264892578125  0.0145721435546875  -0.00894927978515625  -0.01548004150390625  0.0013427734375  0.01280975341796875  0.00374603271484375  -0.0082550048828125  -0.005706787109375  0.003662109375  0.00493621826171875  -0.0005035400390625  -0.0025787353515625  -0.00054168701171875  0.00005340576171875  -0.000396728515625  0.00142669677734375  0.0024871826171875  -0.0012054443359375  -0.00457763671875  -0.000640869140625  0.005615234375  0.003448486328125  -0.0050201416015625  -0.0062103271484375  0.00276947021484375  0.00794219970703125  0.0005340576171875  -0.00801849365234375  -0.0040130615234375  0.00637054443359375  0.00667572021484375  -0.00341033935546875  -0.0078887939453125  -0.00003814697265625  0.0074005126953125  0.0030975341796875  -0.00550079345703125  -0.0050506591796875  0.00283050537109375  0.005584716796875  -0.00019073486328125  -0.00478363037109375  -0.0017852783203125  0.00316619873046875  0.002655029296875  -0.00131988525390625  -0.00249481201171875  -0.00008392333984375  0.00154876708984375  0.000762939453125  -0.00042724609375  -0.00055694580078125  -0.000457763671875  -0.00016021728515625  0.0006561279296875  0.0011138916015625  -0.0002593994140625  -0.00168609619140625  -0.00072479248046875  0.00179290771484375  0.00170135498046875  -0.0011138916015625  -0.002532958984375  0.0001220703125  0.00261688232421875  0.00122833251953125  -0.00225067138671875  -0.002105712890625  0.00110626220703125  0.0027313232421875  -0.0000457763671875  -0.0023956298828125  -0.00128936767578125  0.00189208984375  0.0017547607421875  -0.00060272216796875  -0.0021820068359375  -0.00012969970703125  0.00146484375  0.001251220703125  -0.001129150390625  -0.00112152099609375  -0.0001678466796875  0.0015106201171875  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|  |  |
| --- | --- |
| **Comparativo** | |
| Discrete-Time FIR Filter (real)  -------------------------------  Filter Structure : Direct-Form Symmetric FIR  Filter Length : 261  Stable : Yes  Linear Phase : Yes (Type 1)  Arithmetic : fixed  Numerator : s18,17 -> [-1 1)  Input : s16,15 -> [-1 1)  Filter Internals : Full Precision  Output : s35,32 -> [-4 4) (auto determined)  Tap Sum : s17,15 -> [-2 2) (auto determined)  Product : s34,32 -> [-2 2) (auto determined)  Accumulator : s35,32 -> [-4 4) (auto determined)  Round Mode : No rounding  Overflow Mode : No overflow    Implementation Cost  Number of Multipliers : 131  Number of Adders : 261  Number of States : 260  Multiplications per Input Sample : 131  Additions per Input Sample : 261 | Discrete-Time FIR Filter (real)  -------------------------------  Filter Structure : Direct-Form FIR Transposed  Filter Length : 261  Stable : Yes  Linear Phase : Yes (Type 1)  Arithmetic : fixed  Numerator : s18,17 -> [-1 1)  Input : s16,15 -> [-1 1)  Filter Internals : Full Precision  Output : s35,32 -> [-4 4) (auto determined)  States : s35,32 -> [-4 4) (auto determined)  Product : s33,32 -> [-1 1) (auto determined)  Accumulator : s35,32 -> [-4 4) (auto determined)  Round Mode : No rounding  Overflow Mode : No overflow    Implementation Cost  Number of Multipliers : 261  Number of Adders : 260  Number of States : 260  Multiplications per Input Sample : 261  Additions per Input Sample : 260 |

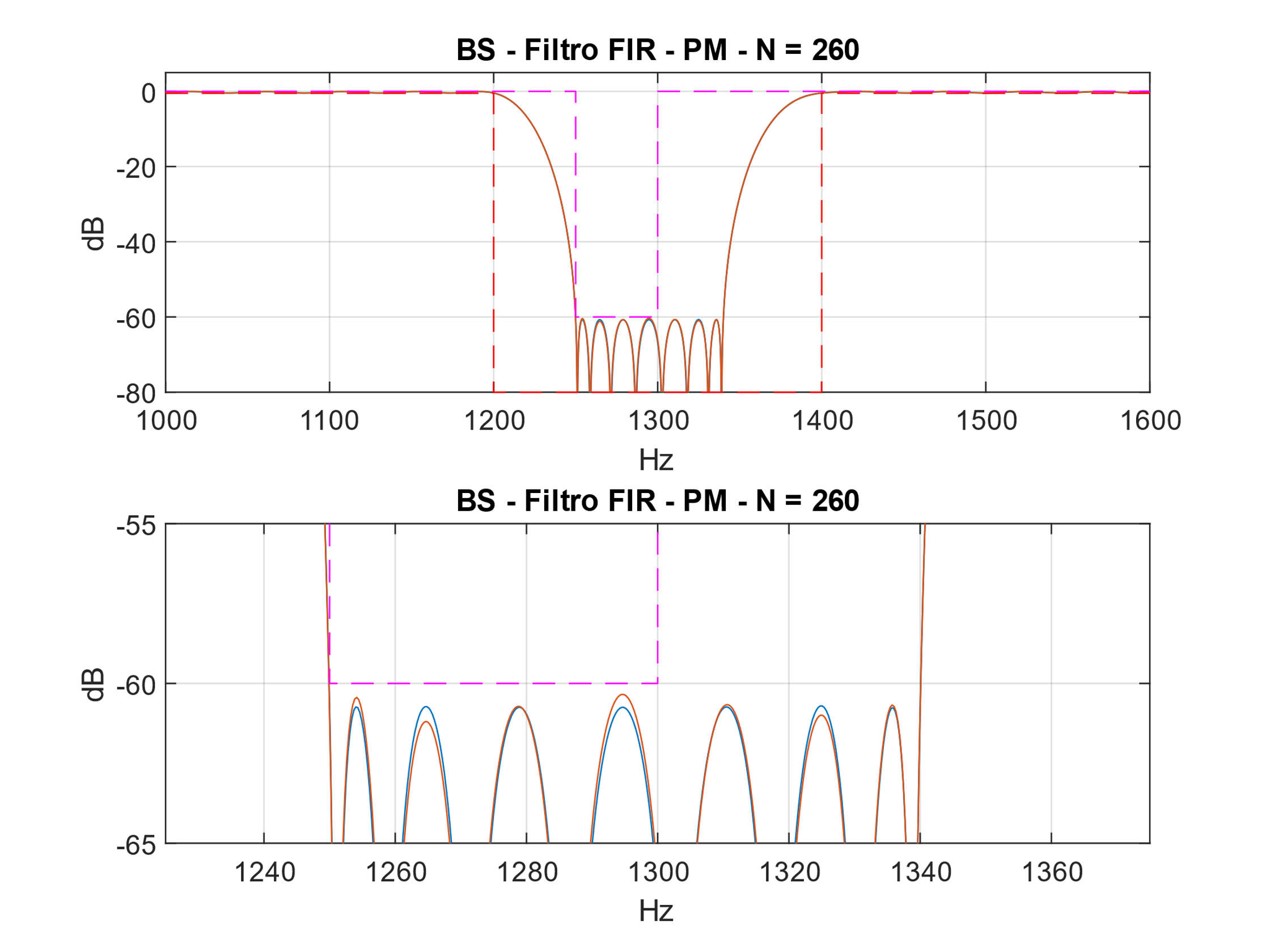


Figura 3 - Filtro DF Symmetric.

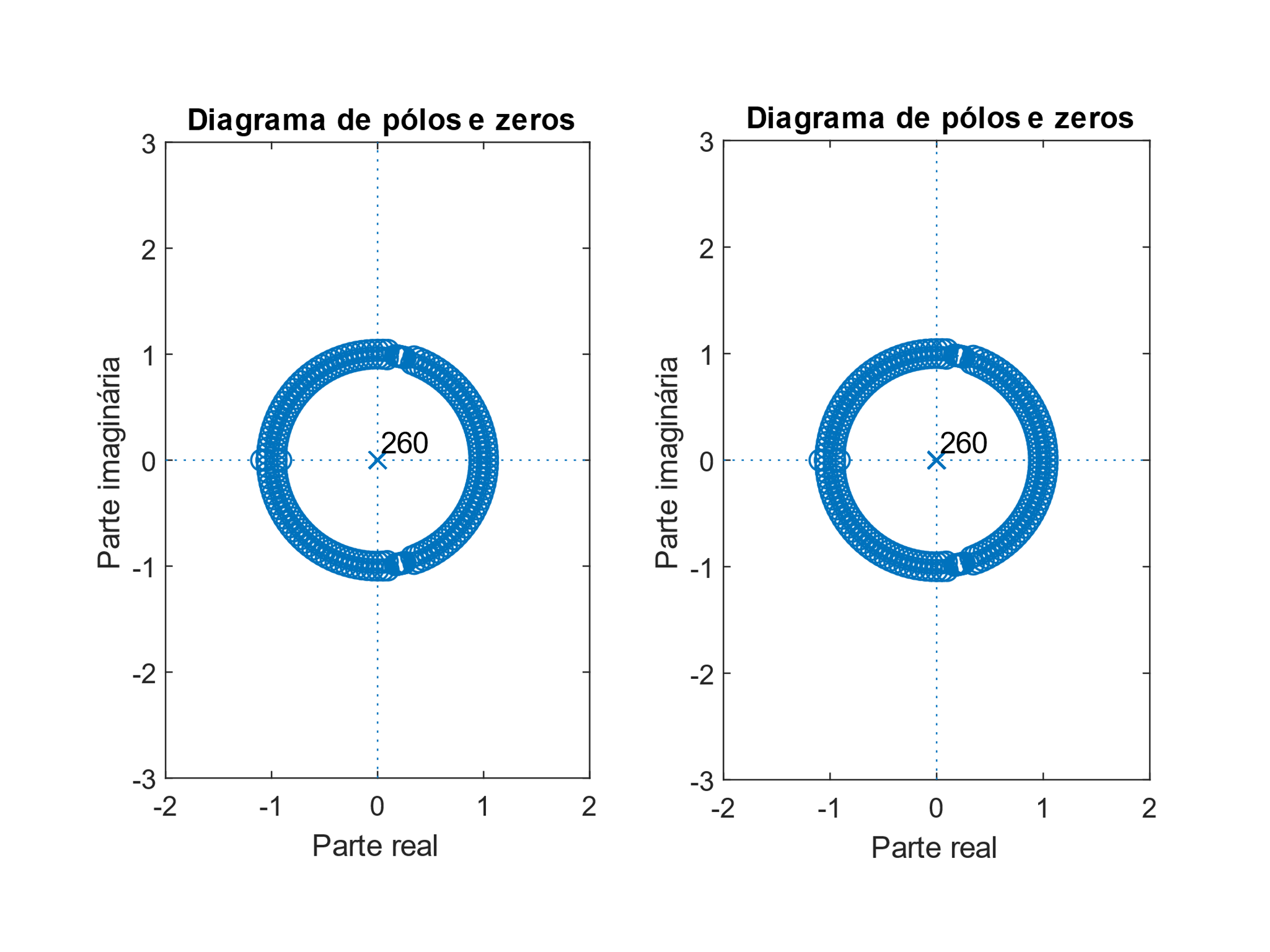


Figura 4 - Filtro DF Symmetric.

ASIC:

(2M + S + D) \* nº bits

(2 \* 131 + 261 + 260) \* 18 = 14094elementos

FPGA:

(2M + S) \* nº bits

(2 \* 131 + 261) \* 18 = 9414 elementos