Nausica vs. Iota: Dynamic Range and Power Measurement

APN3
rev 1.0

File: L:\Iota\Application Notes\APN3.doc

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HISTORY

Version	Date	Author	Notes
Ver: 1.0	4/2/02	D.Cardi	1
Ver: 2.0			2
Ver: 3.0			3
Ver: 4.0			4

NOTES :

1. Creation
2. ……..
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4.

GLOSSARY

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1 Dynamic range

1.1 Definition

The dynamic range is defined as the ratio of the maximum output signal to the smallest output signal the converter can produce (1LSB).

THEORETICALLY, for a N-bits converter, the dynamic range is defined in dB as

$$DR = 20\log(2^N) = 6.02N$$

1.2 Dynamic Range in Nausica project

The ADC is an 11 bits converter: DR=(6.02*11) # 66dB

1.3 Dynamic Range in Iota project

The ADC is a 13.5bits bits converter: DR=(6.02*13.5) # 81dB

2 Power and DSP measurement

2.1 Definition

The power measured by the DSP is an average of 64 samples of the digitalized I&Q signals (In,Qn).
It has been implemented in the way below:

$$Pm\_dB=10 \log [S(In^2+Qn^2)/128] \quad \text{(Equation 1)}$$

The division by 128 is due to the memory limitation and so a 7bits-shift in the DSP.
Pm, in dBd, is the returned value by the layer 1, i.e. the DSP value shifted by 1bit.

$$Pm\_dBd=2*Pm\_dB$$

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2.2 Comparison between Nausica and Iota projects

The results table below has been obtained applying on Nausica and Iota BDL inputs a sinusoidal signal of 18kHz frequency, and of variable amplitude (from 0dBm0[1] to –66dBm0 or -83dBm0 respectively).
The output power has been computed, for each input level, on 64 test output samples (sampling frequency: 270.833kHz), according to the Equation 1 §2.1.

The dynamic range, as defined in the 1.1 chapter, is the difference between larger and smaller converted signals. It can be found again as a relative difference between maximum and minimum output power.
Applying this definition, the dynamic range is equal to 65.9dB for Nausica and 81.2 dB for Iota.
These results correlate with the theoretical expected value (66dB and 81dB, cf. §1).
It allows confirming the ADC bit number: 11bits in Nausica, and 13.5bits in Iota.

Nausica		**Iota**	
Input level [dBm0][1]	Output Power [dB]	Input level [dBm0]	Output Power [dB]
0	83.41	0	88.54
-5	78.54	-3	87.08
-10	73.50	-10	80.18
-20	63.33	-20	70.22
-30	53.39	-30	60.37
-40	43.50	-40	50.28
-66	17.50	-83	7.35
ICN	8.54	ICN	4.89
DYN_RANGE [dB]	65.91	DYN_RANGE [dB]	81.19

The last value in the table above is the ICN or Idle Channel Noise. It is relative to an I/Q input short-circuit. His dedicated output power has been computed on test output samples in the same way as for a sinusoidal input.

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0dBm0 is relative to a differential input signal of 1.75 Vp applied on each path (I & Q), that's to say a 1.75Vpp amplitude signal on each input (I+/I-/Q+/Q-).

XdBm0 is defined, in the same way, as a differential input signal of 1.75*10^(X/20) Vp.

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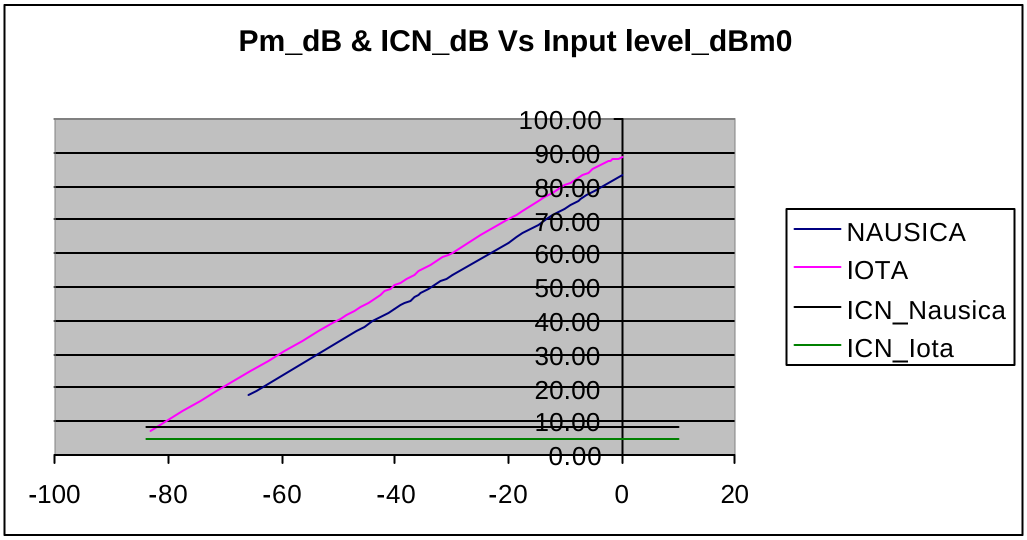
In the laboratory, same kind of experiments has been realized, only for the Iota project, with a board including both Digital and Analog b ase band. In this case, the output power Pm is computed internally by the DSP.
The range of input signal was from 0 to -20dBm0, limited by our equipment.
We can see that the DSP measurement results are the same than those computed by our own on the IOTA in standalone (represented in the third column).

Input level[dBm0]	Pm_dB-DSP	Output Power[dB]
0	88.2	88.54
-3	87	87.08
-10	80.18	80.18
-20	69.96	70.22

Here below, a graph of the output power (Pm_dB) and of the Idle Channel Noise (ICN_dB) versus the input signal (Input_level_dBm0), summarizing the first table.



2.3 Conclusion

In Iota, due to more ADC bits, the dynamic range has been improved by 15dB (from 66dB to 81dB). Iota allows converting a signal of smaller input amplitude (-83dBm0) than Nausica (-66dBm0). For a same input level, Iota achieves an output power level better of 6dB.

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