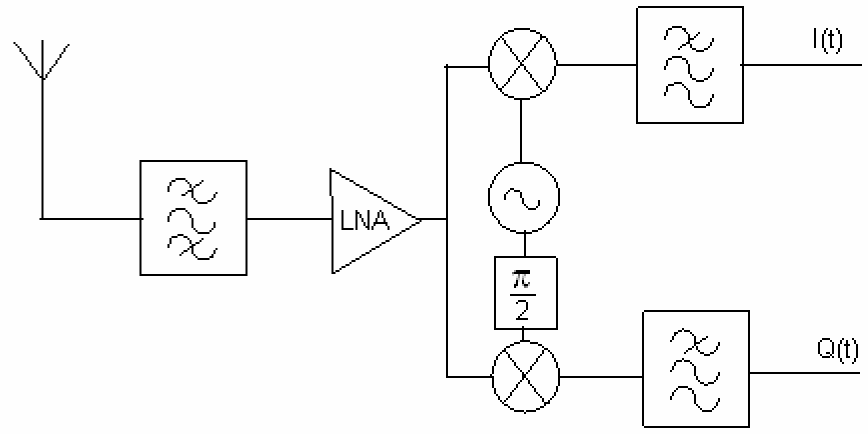
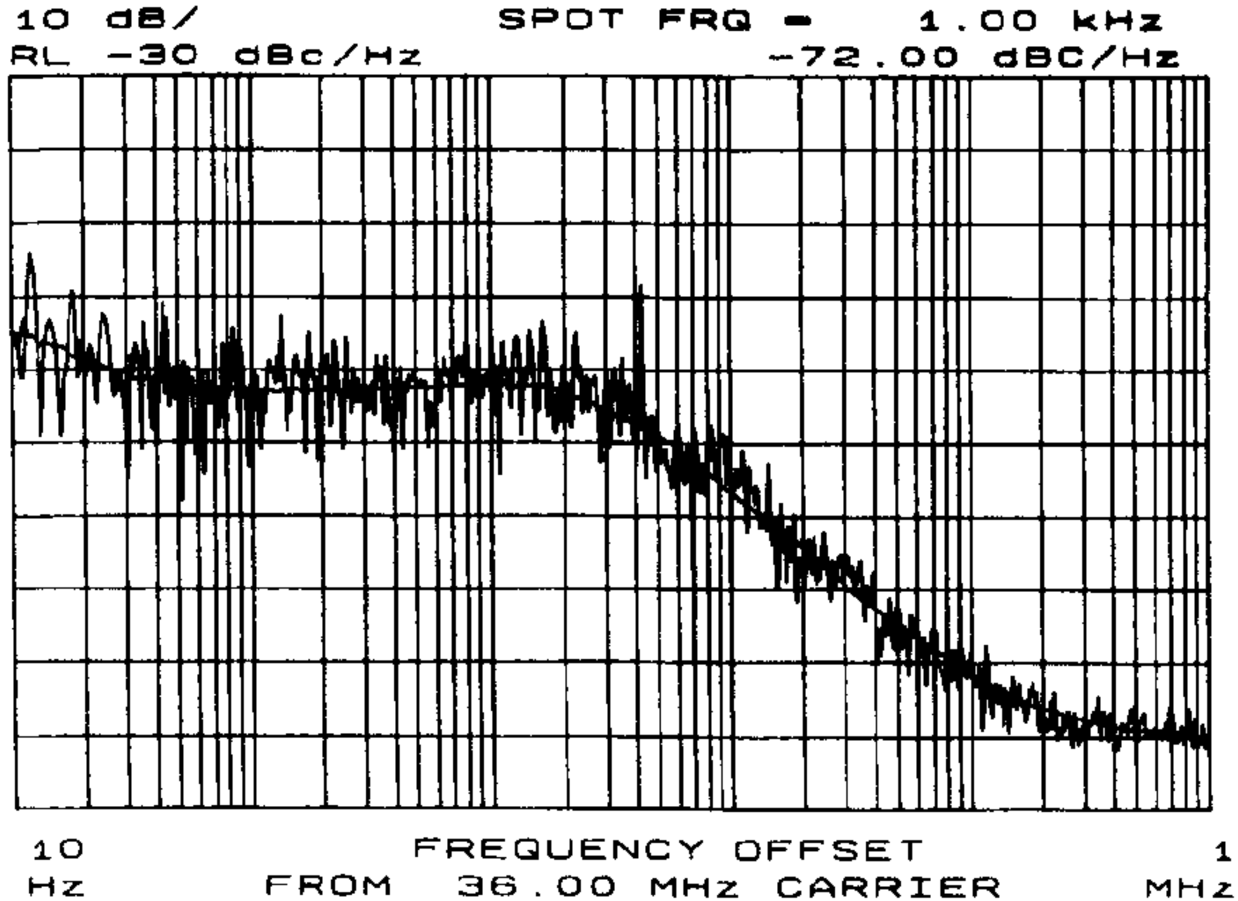
Phase Noise

Silicon DSP Corporation

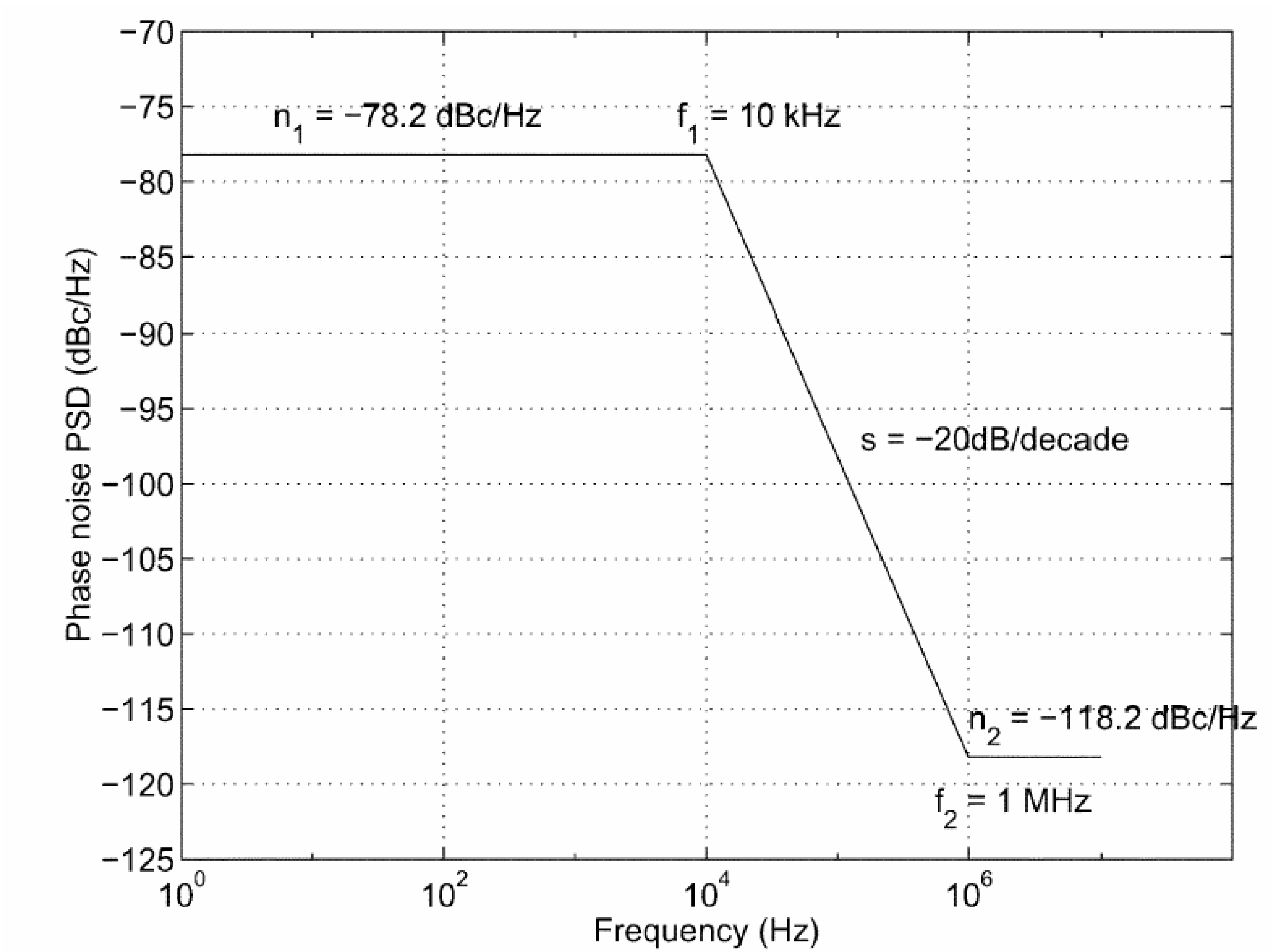
Direct Conversion Receiver





Phase-Noise Plot of improved VCO and PLL-System

Claus Muschallik, "**Influence of RF Oscillators on an OFDM Signal** ,"*IEEE Transactions on Consumer Electronics*, Vol. 41, No. 3 , August 1995



PSD of the phase noise model.

Jan Tubbax,et al.,**"Compensation of IQ Imbalance and Phase Noise in OFDM Systems,"** IEEE Transactions on Wireless Communications, VOL. 4, NO. 3, MAY 2005

$$u_{OSC}(t) = \hat{u}_{OSC} e^{j[2\pi(f_0+f_d)t]} e^{j\sigma(t)} + u_r$$

f_d Frequency deviation, time invariant or slowly changing

u_r considers the additive white noise

The phase noise is caused by $\sigma(t)$,
which is a time variant phase disturbance in radians.

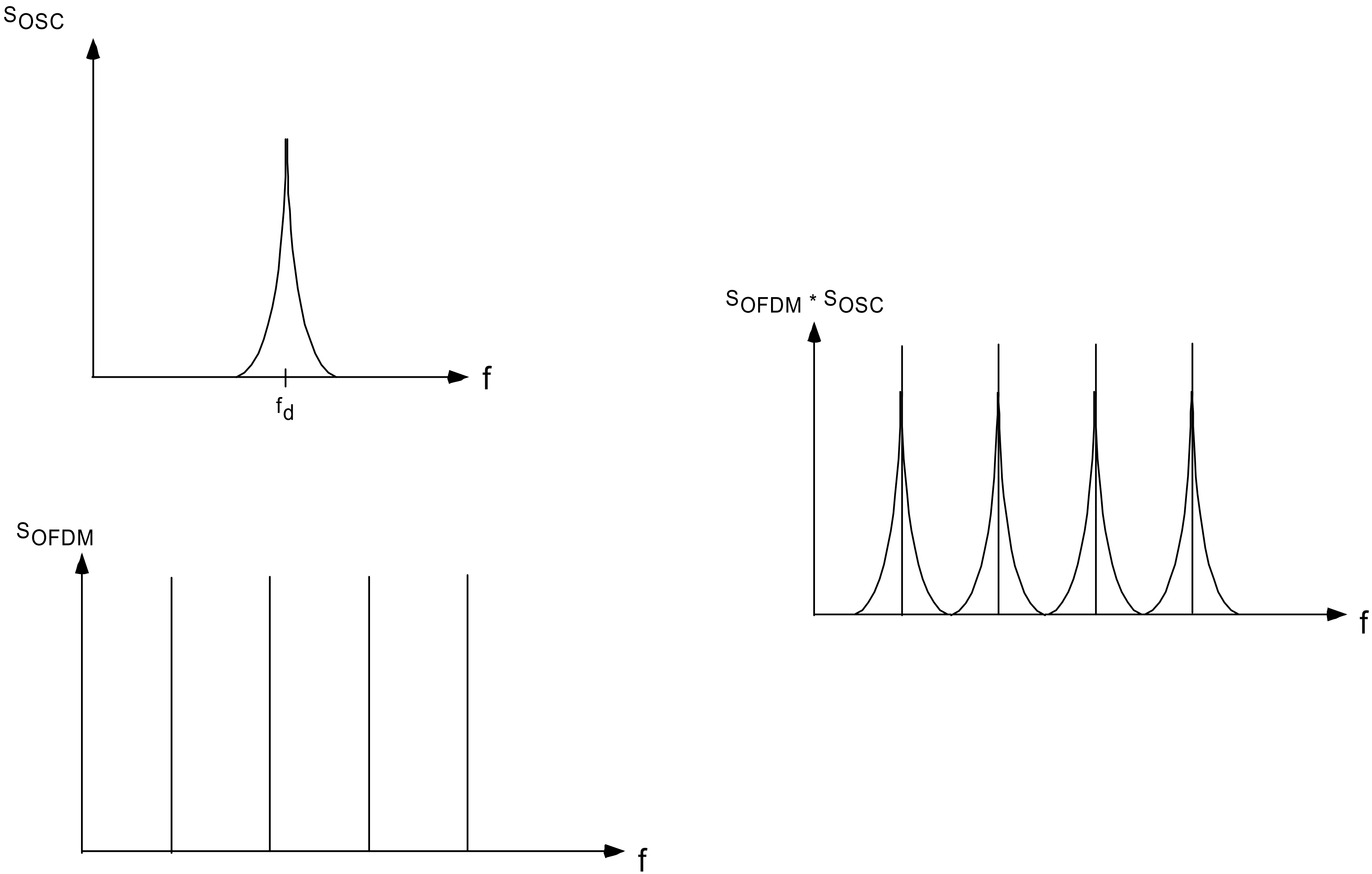
For small angles, the approximation

$$e^{j\sigma(t)} \approx 1 + j\sigma(t) \quad \sigma(t) << 1$$

is valid.

$$u_{OSC(LP)}(t) \approx 1 + j\sigma(t) \;\; when \;\; \sigma(t) << 1$$

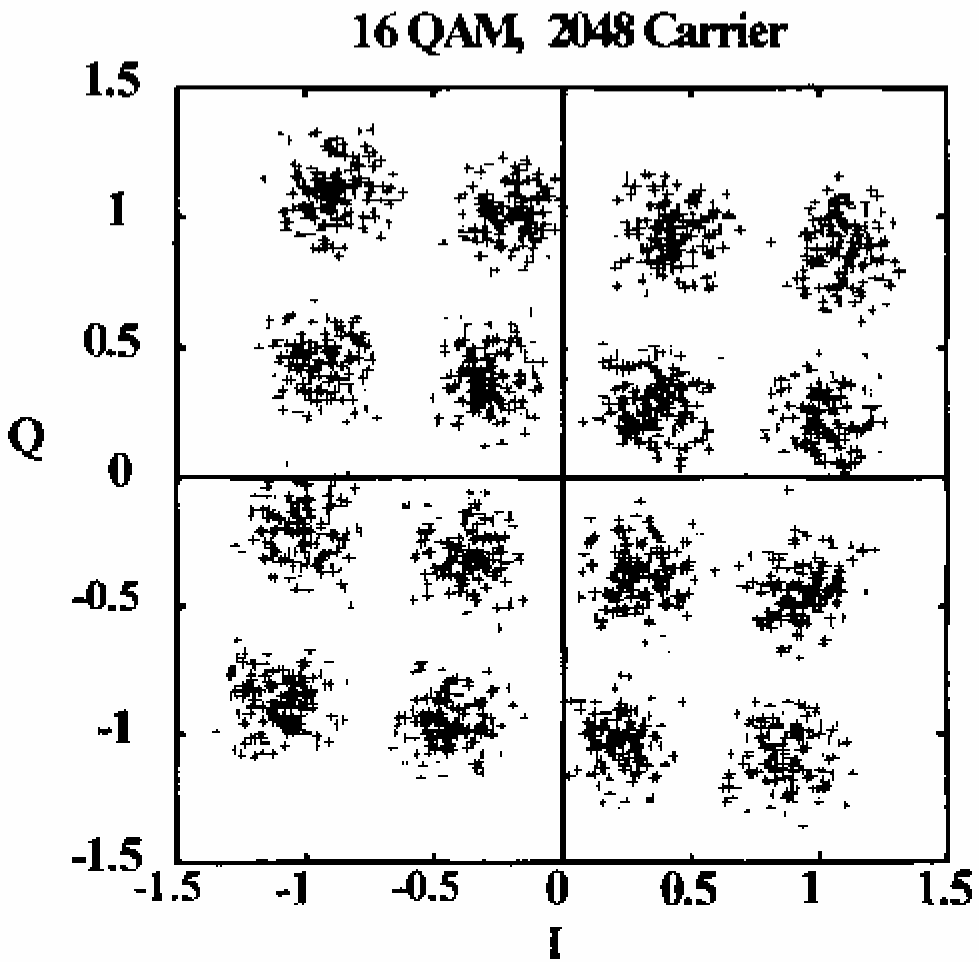
$u_{OSC(LP)}$ is the lowpass representation of the noisy oscillator.



Claus Muschallik, "**Influence of RF Oscillators on an OFDM Signal** ,"*IEEE Transactions on Consumer Electronics*, Vol. 41, No. 3 , August 1995

Common Phase Error (CPE) Effects all Carriers

Inter-Carrier-Interference (Phase Noise ICI) Contribution

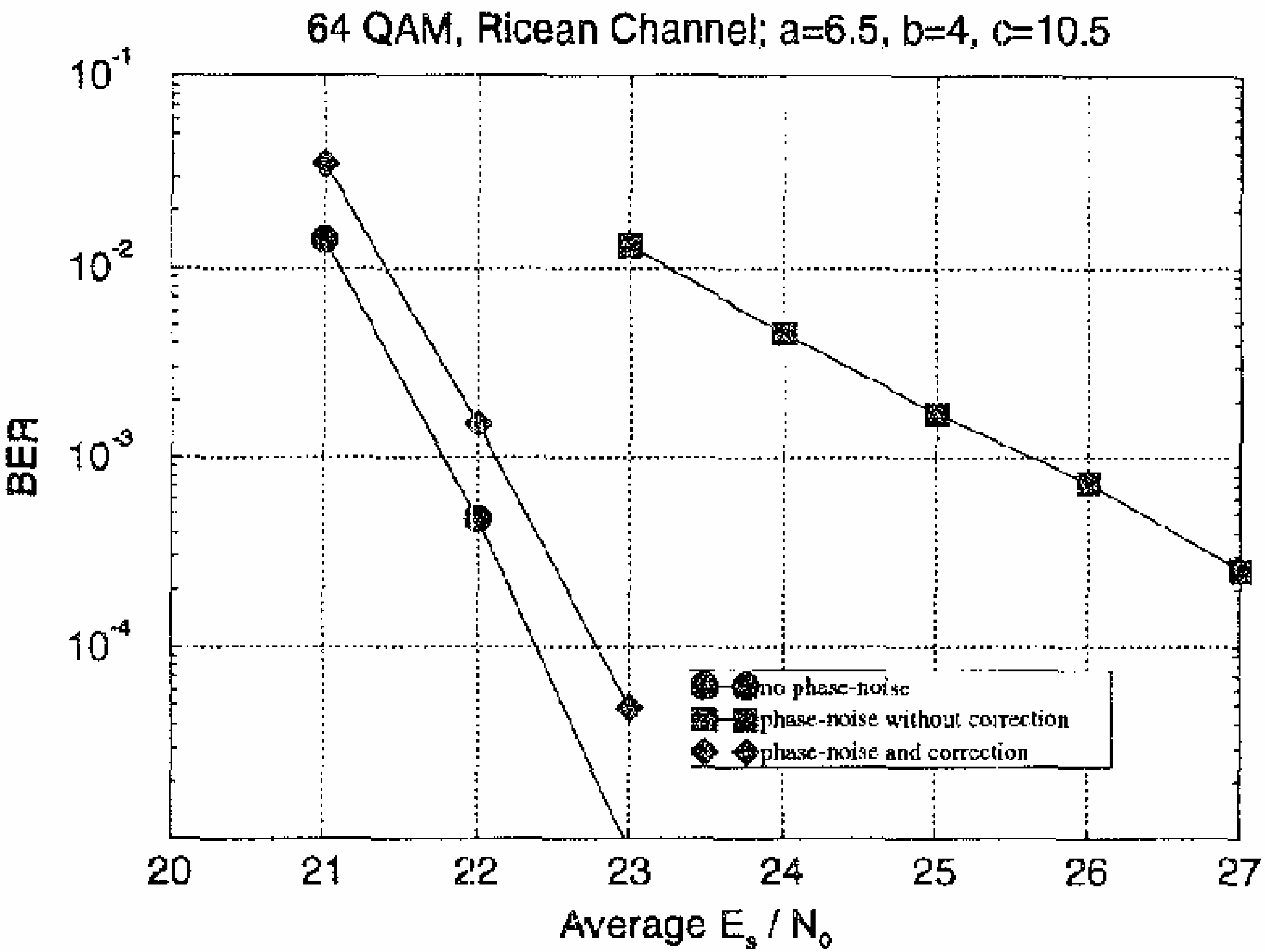


Claus Muschallik, "**Influence of RF Oscillators on an OFDM Signal** ," *IEEE Transactions on Consumer Electronics*, Vol. 41, No. 3 , August 1995

Accounting for total phase noise, at 10^{-5} on coded (R=3/4) 64-QAM with channel estimation show a degradation of 4 dB.

If ***common phase error*** is compensated the degradation can be reduced to 0.3 dB

Jan Tubbax,et al.,**"Compensation of IQ Imbalance and Phase Noise in OFDM Systems,"** IEEE Transactions on Wireless Communications, VOL. 4, NO. 3, MAY 2005



Robertson, P.; Kaiser, S. ,"**Analysis of the effects of phase-noise in orthogonal frequency division multiplex (OFDM) systems,"** *IEEE International Conference on Communications*, 1995. ICC 95 Seattle, Gateway to Globalization, 1995 on Volume 3, Date: 18-22 Jun 1995, Pages: 1652 - 1657 vol.3

“For optimal tuner design, the maximal allowable ICI power should be set several dB below the channel noise level, otherwise a BER floor will be the result; the technique proposed here can be used in such a trade-off between tuner complexity and performance.”

“The most important factor -for a fixed phase-noise model and total system bandwidth- governing the ICI power is the number of OFDM sub-carriers. The ICI level increases as the number of sub-carriers increases, and will pose a serious problem if, for instance, **8k** sub-carriers are used in conjunction with high order modulation, such as multi-resolution modulation.”

Robertson, P.; Kaiser, S. ,”**Analysis of the effects of phase-noise in orthogonal frequency division multiplex (OFDM) systems,”** *IEEE International Conference on Communications*, 1995. ICC 95 Seattle, Gateway to Globalization, 1995 on Volume 3, Date: 18-22 Jun 1995, Pages: 1652 - 1657 vol.3