Conversion of measured J_{3u} and J_{RMS} to A_{DD} and σ_{RJ}

Yasuo Hidaka, Credo

Junqing (Phil) Sun, Credo

IEEE P802.3ck Task Force Ad Hoc Meeting

April 14, 2021

Abstract

❖ Equation (163-2) and (163-3) convert measured J_{3u} and J_{RMS} to A_{DD} and σ_{RJ} for COM calibration in RX interference tolerance test.

❖ Re-constructed dual-dirac distribution with A_{DD} and σ_{RJ} by these equations does not match with the measured jitter distribution.

e.g. J_{3u} is different from the measured value.
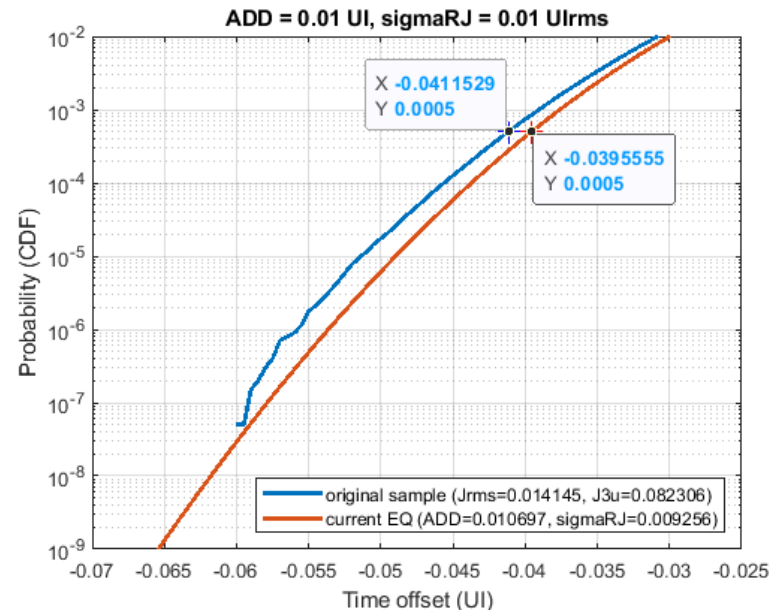
❖ We revised these equations.

Equation (163-2) and (163-3)

- $Q_3 \equiv 3.2905 \left(\approx Q^{-1}(0.5 \times 10^{-3}) \right)$; Q at probability of J_{3u}

- $D_3 = \left(Q_3{}^2 + 1 \right) \times J_{RMS}{}^2 - \left(\frac{J_{3u}}{2} \right)^2$; Implicit in Equation (163-2)

- $A_{DD} = \left(\frac{J_{3u}}{2} + Q_3 \sqrt{D_3} \right) / \left(Q_3{}^2 + 1 \right)$

- $\sigma_{RJ} = \left(\frac{J_{3u}}{2} - A_{DD} \right) / Q_3$

Re-constructed dual-dirac distribution does not match with original distribution. (e.g. does not have the same J_{3u}.)

ADD = 0.01 UI, sigmaRJ = 0.01 UIrms

X -0.0411529 Y 0.0005
X -0.0395555 Y 0.0005

original sample (Jrms=0.014145, J3u=0.082306)
current EQ (ADD=0.010697, sigmaRJ=0.009256)

Probability (CDF)

Time offset (UI)

Revised Equations

Based on <u>only the closer gaussian distribution</u> in dual dirac.

- Ignore the further gaussian distribution in dual dirac, because it is negligible.

- $Q_{3d} \equiv 3.0902 \left(\approx Q^{-1}(1 \times 10^{-3}) \right)$; Q at double probability of J$_{3u}$

- $D_{3d} = \left(Q_{3d}{}^2 + 1 \right) \times J_{RMS}{}^2 - \left(\frac{J_{3u}}{2} \right)^2$

- If $D_{3d} \geq 0$
  - $A_{DD} = \left(\frac{J_{3u}}{2} + Q_{3d}\sqrt{D_{3d}} \right) / (Q_{3d}{}^2 + 1)$
  - $\sigma_{RJ} = \left(\frac{J_{3u}}{2} - A_{DD} \right) / Q_{3d}$

- If $D_{3d} < 0$
  - $Q_x = \sqrt{ \left(\frac{J_{3u}}{2J_{RMS}} \right)^2 - 1 }$; A solution of $D_{3d} = 0$ in terms of Q_{3d}
  - $A_{DD} = \left(\frac{J_{3u}}{2} \right) / (Q_x{}^2 + 1)$
  - $\sigma_{RJ} = \sqrt{ J_{RMS}{}^2 - A_{DD}{}^2 }$

Evaluation: Current EQ vs Revised EQ

1. For given A_{DD} and σ_{RJ}, generate an original dual-dirac distribution (N=10^7 samples).
2. Measure J_{3u} and J_{RMS}.
3. Convert J_{3u} and J_{RMS} to A_{DD} and σ_{RJ}.
4. For converted A_{DD} and σ_{RJ}, re-generate a dual-dirac distribution.
5. Re-measure J_{3u} and J_{RMS}.

Original Dual Dirac (N=10^7)				Dual Dirac converted by Current Equation				Dual Dirac converted by Revised Equation				
A_{DD}	σ_{RJ}	J_{3u}	J_{RMS}	A_{DD}	σ_{RJ}	J_{3u}	J_{RMS}	D_{3d}	A_{DD}	σ_{RJ}	J_{3u}	J_{RMS}
0.00	0.01	0.066257	0.010004	0.005385	0.008431	0.063418	0.010007	-4.165E-5	0.003021	0.009537	0.066004	0.010005
0.00	0.02	0.132011	0.020007	0.010987	0.016720	0.125863	0.020007	-1.339E-4	0.006064	0.019066	0.131495	0.020008
0.00	0.03	0.197773	0.030010	0.016583	0.025012	0.188330	0.030011	-2.775E-4	0.009108	0.028595	0.196987	0.030011
0.01	0.01	0.082306	0.014145	0.010697	0.009256	0.079111	0.014147	4.172E-4	0.009884	0.010119	0.082814	0.014147
0.01	0.02	0.144376	0.022367	0.013496	0.017837	0.137750	0.022367	6.657E-5	0.009233	0.020373	0.145263	0.022369
0.01	0.03	0.207350	0.031633	0.017935	0.026057	0.197475	0.031633	-1.926E-4	0.009652	0.030124	0.207587	0.030124
0.10	0.01	0.262306	0.100499	0.100054	0.009451	0.259021	0.100499	8.935E-2	0.099992	0.010084	0.262800	0.100499
0.10	0.02	0.324120	0.101982	0.100236	0.018789	0.317101	0.101982	8.345E-2	0.099984	0.020088	0.324618	0.101982
0.10	0.03	0.385887	0.104406	0.100560	0.028076	0.375142	0.104406	7.777E-2	0.099978	0.030084	0.386388	0.104406

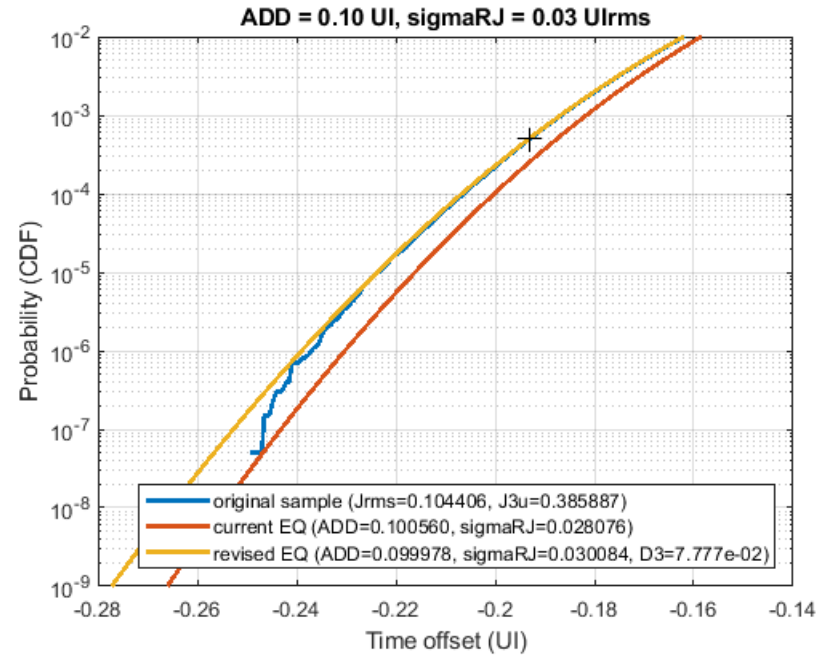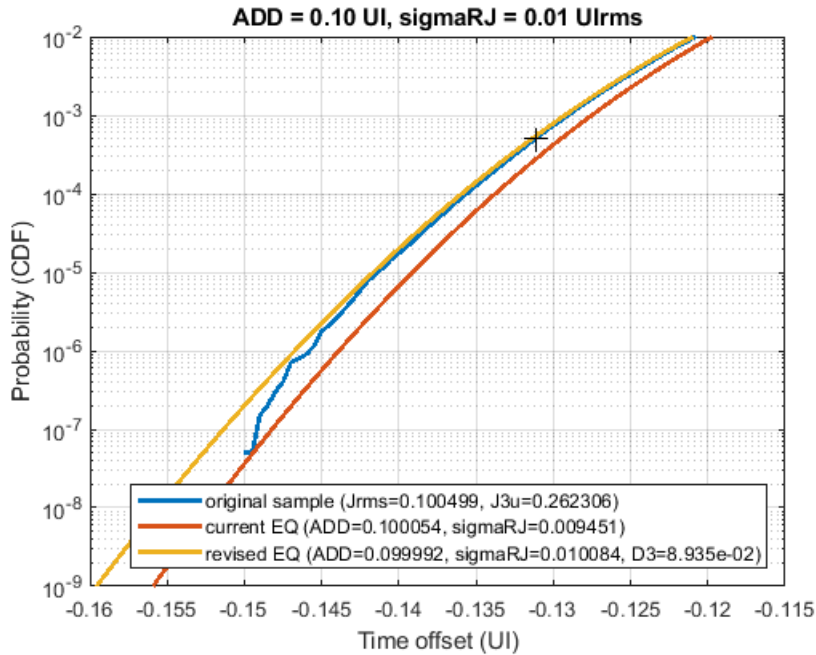# Zero DJ Cases (A_{DD} = 0.00 UI)
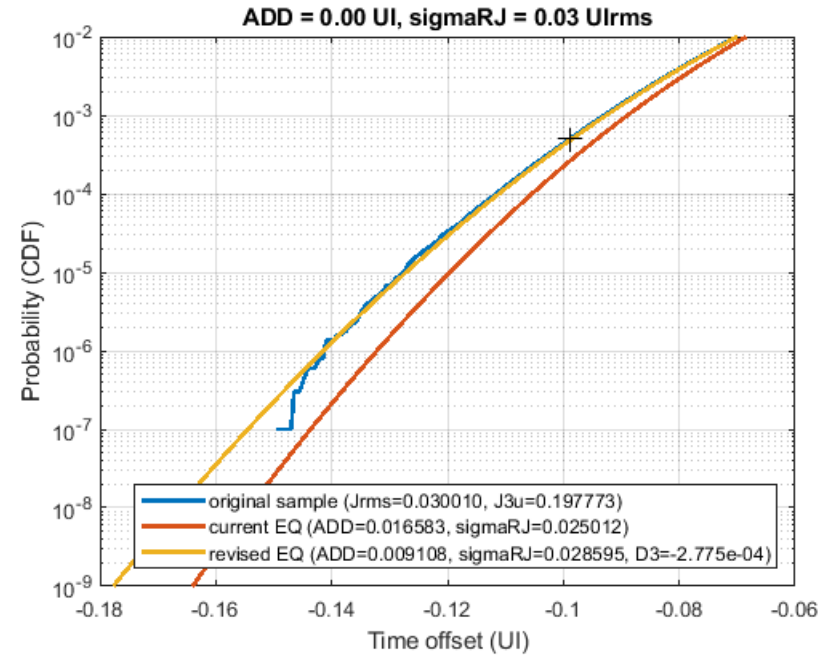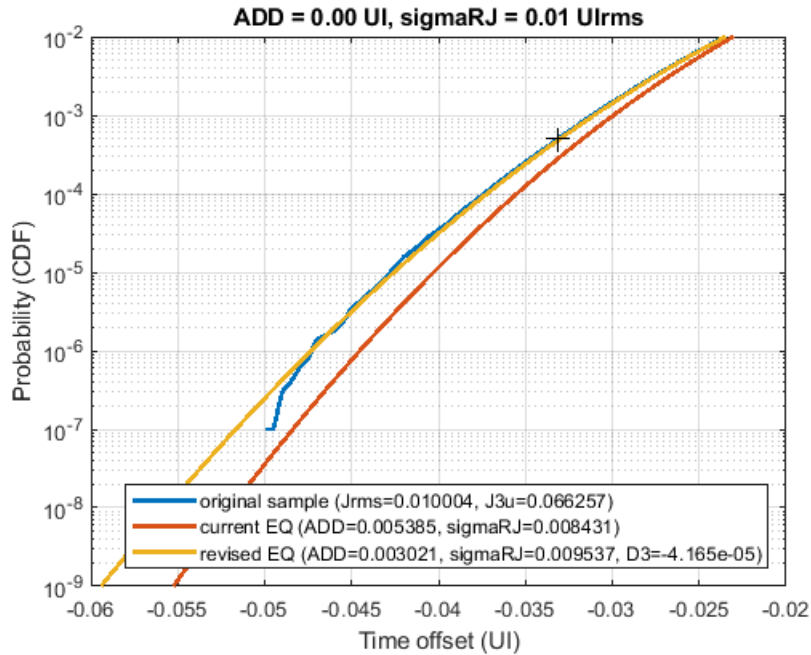
Small DJ Cases (A_{DD} = 0.01 UI)
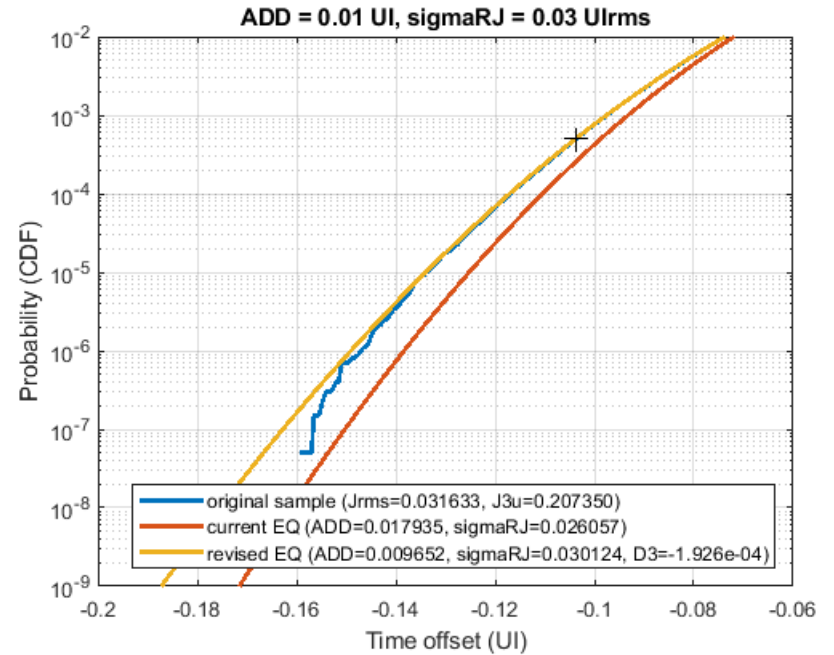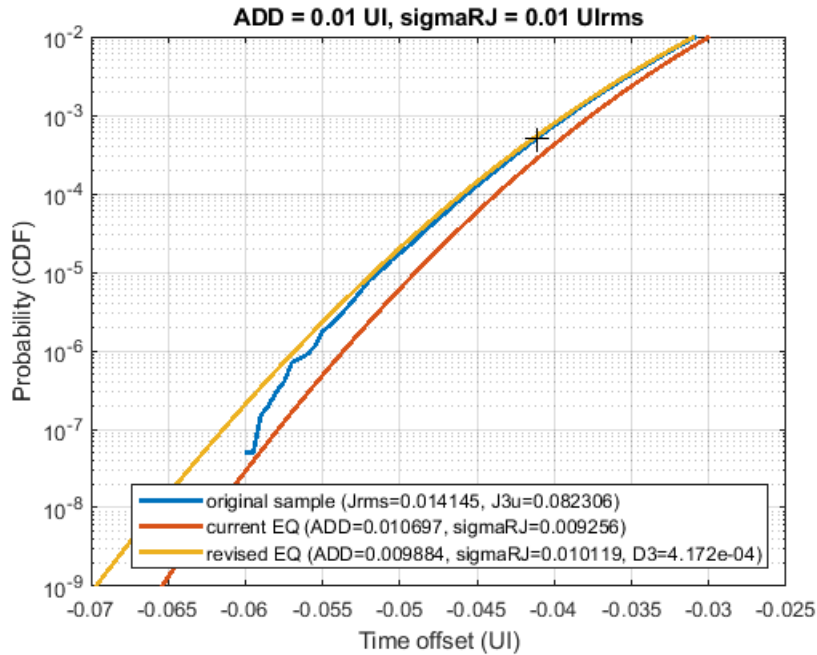
Large DJ Cases (A_{DD} = 0.10 UI)

Proposals

❖   Change Equation (163-2) and (163-3) with equations in slide 4.

❖   Same change for Equation (162-7) and (162-8).

❖   Change Annex 120F.3.2.3 to use a variant of equations in slide 4 but for J_{4u}.