163.9.3.5 Receiver interference tolerance Note 2: “*If this does not hold, a different transmitter should be used in the test setup*”

John Calvin/ Yasuo Hidaka/ Varun Garg

Employed and Affiliated with Keysight Technologies and Credo

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KEYSIGHT TECHNOLOGIES

CREDO

Problem Background: Note 2 in clause 163.9.3.5 (Receiver interference tolerance) is being encountered by customers using Keysight M8040 BERT’s with increased regularity.

$$A_{DD} = \frac{\frac{J3u}{2} + Q3d\sqrt{(Q3d^2+1)\times J_{RMS}^2 - \left(\frac{J3u}{2}\right)^2}}{Q3d^2+1} \qquad (162\text{–}7)$$

Discriminant can be negative with precision laboratory grade BERT’s. A solution other than sourcing a different BERT has to be outlined here

NOTE 2—Calculation of A_{DD} requires that $(Q3d^2+1)\times J_{RMS}^2 \geq \left(\frac{J3u}{2}\right)^2$. If this does not hold, a different transmitter should be used in the test setup.

Since D2.0 (March 2021) we have observed an increased occurrence of concerns related to this Note 2 condition.   The problem got worst at D2.0 comment resolution.

Short review of Hidaka/Sun

https://www.ieee802.org/3/ck/public/adhoc/apr14_21/hidaka_3ck_adhoc_01_041421.pdf (Pg-5)

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}.

Revised Equations

Based on only the closer gaussian distribution in dual dirac.

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

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

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

If A_{DD} is small in comparison to σ_{RJ}, discriminant D_{3d} will be likely negative.

IEEE P802.3ck Task Force

5

https://www.ieee802.org/3/ck/comments/draft2p0/8023ck_D2p0_final_closedcomments_sortedByNumber.pdf (Pg-33/55)

Cl 163 *SC* 163.9.3.4 *P* 192 *L* 34 # 134
Hidaka, Yasuo Credo Semiconductor, Inc.
Comment Type TR *Comment Status* A *RIT jitter (CC)*

Equation (163-2) and (163-3) are not accurate, because the dual-dirac jitter distribution estimated by these equations does not match well with the original distribution even if the original distribution is pure dual-dirac distribution as presented at ad hoc meeting (see hidaka_3ck_adhoc_01_041421). For instance, J3u of the estimated dual-dirac jitter distribution is always significantly smaller than the measured J3u. I propose to change these equations.

Since the proposed equations never break, we do not need Note 2.

I propose similar changes to clause 162.9.4.3.3.

SuggestedRemedy

Replace Equation (163-2) and (163-3) with the following set of equations:

D3d = (Q3d^2 + 1) * (J_RMS^2) - (J3u / 2)^2

If D3d >= 0,
A_DD = (J3u / 2 + Q3d * sqrt(D3d)) / (Q3d^2 + 1)
sigma_RJ = (J3u / 2 - A_DD) / Q3d

If D3d < 0,
Qx = sqrt((J3u / 2 / J_RMS)^2 - 1)
A_DD = (J3u / 2) / (Qx^2 + 1)
sigma_RJ = sqrt((J_RMS^2) - (A_DD^2))

Comment #134 provided a remedy for $D_{3d} < 0$.

where
Q3d = 3.0902

Change Note 1 as follows:

Note 1 -- Q3d is an approximated solution of Q(Q3d) = 1 x 10^(-3), where the Q function is defined in Equation (95-1).

Remove Note 2.

Apply the same changes to Equation (162-7), Equation (162-8), Note 1, and Note 2 in clause 162.9.4.3.3.

Change the references to Equation (162-7) and (162-8) in Note 2 of Table 162-15 in clause 162.9.4.4.2 with the updated equations.

Response *Response Status* C

ACCEPT IN PRINCIPLE.

Resolve using the response to comment #209.

Cl 162 *SC* 162.9.4.3.3 *P* 163 *L* 6 # 209
Healey, Adam Broadcom Inc.
Comment Type TR *Comment Status* A *RIT jitter (CC)*

For values of J3u/Jrms where the condition stated in NOTE 1 is satisfied, The Q3 value should be derived from 10^(-3) and not 10^(-3)/2. The A_DD and sigma_RJ derived for the given value of Q3 will correspond to a dual-Dirac distribution with a smaller value of J3u than what is measured from the pattern generator. The calibrated interference amplitude (based on COM) will in turn be somewhat higher resulting in a level of overstress. This issue has been pointed out in <https://www.ieee802.org/3/ck/public/adhoc/apr14_21/hidaka_3ck_adhoc_01_041421.pdf>.

SuggestedRemedy

6% reduction from 3.2905 (previous value)

Change the value of Q3 to 3.0902. Change NOTE 1 to begin "Q3 is an approximated solution of Q(Q3) = 10^(-3), where…". Make a similar change to 163.9.3.4 (page 192, line 14). In 120F.3.2.3 (page 224, line 2), note that Q4 (an approximated solution of Q(Q4) = 10^(-4)) is 3.719 as an exception to the use of Equation (120D–10) and Equation (120D–11).

Raised chance to make discriminant negative.

Response *Response Status* C

ACCEPT IN PRINCIPLE.

The following presentations were reviewed by the task force:
https://www.ieee802.org/3/ck/public/adhoc/apr14_21/hidaka_3ck_adhoc_01_041421.pdf.
https://www.ieee802.org/3/ck/public/21_05/li_3ck_02c_0521.pdf

[Editor's note: CC: 162, 163, 120F]

Implement the suggested remedy with editorial license with the exception to change the variable names Q3 to Q3d and Q4 to Q4d.

It was noted that some explanation of this approach might be helpful. Further work is encouraged in this regard.

Straw Poll #4 (Chicago rules)
Straw Poll #5 (Pick one)
For calculation COM parameters A_DD and sigma_RJ I would support adopting the method as follows:
A: per suggested remedy in comment #209 (Adam Healey)
B: per suggested remedy in comments #134 and #135 and hidaka_3ck_adhoc_01_041421 (Yasuo Hidaka)
C: hybrid approach proposed in li_3ck_02c_0521 (Mike Li et al)
D: Need more information
E: No changes.
#4: A: 25 B: 19 C: 15 D: 11 E: 3
#5: A: 15 B: 12 C: 3 D: 7 E: 1

Adopted A that does not provide a remedy for $D_{3d} < 0$.
This was adopted before we have many experiences.
If we take Straw Poll now, result may be different.

Proposed Comment Resolution

Draft Amendment to IEEE Std 802.3-2018
IEEE P802.3ck 100 Gb/s, 200 Gb/s, and 400 Gb/s Electrical Interfaces Task Force

IEEE *Draft* P802.3ck/D2.0
10th March 2021

$$\sigma_{RJ} = \frac{\frac{J3u}{2} - A_{DD}}{Q3} \qquad (162\text{–}8)$$

where

$Q3 = 3.2905$

NOTE 1—Q3 is an approximated solution of $Q(Q3) = 5 \times 10^{-4}$, where the Q function is defined in Equation (95–1).

NOTE 2—Calculation of A_{DD} requires that $(Q3^2 + 1) \times J_{RMS}^2 \geq \left(\frac{J3u}{2}\right)^2$. If this does not hold, a different transmitter should be used in the test setup.

- Option A (suggested remedy in comment i-124 for D3.0)

Proposed alternate wording of Note 2 as follows:

The Calculation of ADD may under certain conditions pose a negative discriminant. If this condition occurs, the recommended solution is to increase DJ (SJ or BUJ) to increase the ADD parameter.

- Option B (Re-open discussion on comment #134/#135/#209 for D2.0)

Implement the suggested remedy in #134 and #135 for D2.0 and hidaka_3ck_adhoc_01_041421 (Yasuo Hidaka).