

Minutes: TC-10 Subcommittee on ADCs
Boulder, CO – February 3-4, 1999

Attendance:	Suresh Babu	David Hansen	Fred Irons
	Dan Kien	Tom Linnenbrink	Tom Meyer
	Pierre-Yves Roy	Steve Tilden	

Wednesday, February 3, '99:

- Steve Tilden told us that an extension had been granted until December 2000. This was based on our request to have more time to coordinate our standard with IEC. We all agreed that the extension was helpful, but that we should not relax our efforts to get a draft completed.
- Tom Linnenbrink gave a review of the morning meeting of 1057 User's Guide committee.
 - Got 1241 extension. Still want to finish by end of '99.
 - Deferred IMTC Venice (May 23-28) special sessions (May 26, 11:00-1:00) until this meeting of ADC sub-committee.
 - Got 20 page review of 1241 from IMEKO TC-4, EUPAS group. Tom stressed that our work is well regarded even though there are substantial criticisms. EUPAS does not have a draft at this point. If we can get something in the queue soon, then it will at least be advancing toward becoming an IEC standard which make it highly elevated above IEEE standards.
 - Tom and Steve Tilden are submitting a paper titled: IEEE 1241 Overview: An Update for the IMEKO TC-4 ADC workshop in Sept. '99 in Bordeaux, FR
 - Pierre-Yves Roy from Thomson-CSF gave a presentation on the DYNAD project which is focused on generating an ADC (and S/H) standard within four years. They are very interested in the 1241 draft and would like to come up with something that is a combination of 1241 and DYNAD.
 - Pierre-Yves also explained how the organizations are related in Europe.

<p>EC – European Community is the top-level technical organization IMEKO – An International Engineering Organization TC-4 – Working group on A/D and D/A Converter Metrology EUPAS – European Project for ADC-based devices Standardization. DYNAD – A working group of 6 members, 3 from EUPAS and 3 from Industry to develop a standard for ADCs. Funded by EC. Their work product will be submitted to ... IEC – International Electronic Commission. <u>Expectation: TC-10 ADC & DYNAD can combine into a single international standard.</u></p>

(Please note that the secretary expects appropriate corrections to the above organizational information)

- Third International Conference on Advanced A/D and D/A Conversion Technologies and Their Applications will be July 26-28, 1999 in Glasgow, UK. Since Fred Irons is going to this already, we will probably have our "1241 Overview" paper reworked and presented at this conference also.
- The journal, "Computer Standards & Interfaces" has solicited papers on 1057 and also on the 1241 draft. This request was sent to Tom Linnenbrink. They are requesting manuscripts by March 30, '99. There is some concern about whether or not a reshaped version of the 1241 overview can be used since this is a refereed journal.
- Tom told us that the 1057 User's Guide group is considering putting the guide on a web site instead of going through IEEE publication and distribution.
- A question has arisen as to whether our group should take on the inclusion of DACs in our draft. We may do this later, but will not attempt to include DACs at this point.
- Tom reminded us that TC-10 was going to suggest graduate student projects. This was brought up at the 1057 meeting and Bill Boyer volunteered to re-energize that effort.

- Next meeting: We decided to have a 1241 special meeting on March 29-30 in Tucson at Burr Brown. The following meeting will probably be in September.
- Papers:
 - Tom Linnenbrink/Steve Tilden: Intro to Standard (After meeting, Philip Green's name was added as author.)
 - Jerry Blair: Sinefit Test Methods
 - Dan Kien: DFT Test Methods
 - Babu: Characterizing a State-of-the-Art ADC
 - Fred Irons: Noise Power Ratio
- Demos:
 - Blair and Tilden: Sinefit, FFTs, etc. Jerry Blair and Steve Tilden will coordinate this at the March meeting. Steve will write an abstract to describe demonstrations.
- Discussion of what needs to be done to be sure the IMTC papers are in:
 - Looked over Fred Irons paper, "Noise Power Ratio." It appeared to be in final form.
 - To get in proceedings: Hard copy of paper to Bob Myers, electronic text version of abstract to IMTC email site (see IMTC web page), and electronic copy of paper is ftp'd to the IMTC ftp site. This is all due by February 1, but Bob Myers has given an extension of a week.
 - Babu discussed his paper. It involves characterization of 15-bit ADC.
 - Steve Tilden initiated discussion of the content of "Introduction to 1241" paper. The focus was on how to illustrate the usefulness of the standard in only 20 minutes.
 - Dan Kien went through the DFT Test Methods paper.
- First day meeting adjourned at 5:45 PM.

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 Thursday, February 4, '99:

We began the task of editing the latest draft of Standard 1241.

- Fred Irons will rewrite 4.4.6 to include IMD and come up with a reference.
- We collectively did extensive edits to Table 1.4.4
- Clause 3.1: We agreed to change the definition format according to Dan Kien's suggestions. We will state the item being defined, include the acronym, if appropriate, in parentheses, and give the definition. Also, we will allow redundant acronyms in the symbols section.
- We walked through a number of edits in 4.1.1.1 involving figure captions and references to those figures.
- We still do not have an electronic version of figure 4.1.3.1. Steve Tilden will encourage Sol Max to make such a drawing.
- We noted that section 4.1.2 is a generic description of "taking a record of data." However, much of its content is revisited in other clauses. It would clean up the draft to make sure 4.1.2 is substantial and refer to it when needed in the remainder of the draft. For example, much of the information of 4.1.2 is repeated in 4.1.6.3.1. Dan Kien will take an action to work on this.
- Pierre-Yves Roy brought up the fact that different noise occurs with different record lengths. This needs to be addressed in 4.1.2 also.
- Phil Green, text editor, needs to go through the document and change all phrases, DFT-frequencies, -resolution, etc. to the common phrase, "DFT bins".
- After much discussion of clause 4.4.5.1, we agreed to change remove the "^" from above THD.

Pierre-Yves Roy gave a presentation of review comments from DYNAD regarding 1241. The items are detailed below:

- Section 4.1.3: (Equivalent time sampling) – The equivalent time record should not be used for ADC characterization because the evaluation of RMS noise is underestimated.
 - Action: Pierre-Yves will provide some data and Steve Tilden will send it out for review.
- Section 4.1.4.3-4: (3 parameters least squares fit to sine wave data) – The maximum deviation between the input frequency value and the value used that the algorithm can accept is not specified.

- We looked at Jerry Blair paper on sine fitting. Possibly can include some clarifying comments from that source.
- Section 4.1.4.4: (4 parameters least squares fit to sine wave data) – The algorithm does not use classical methods (Newton, Levenberg-Marquadt...). Explanations on the choice of this algorithm would be interesting (e.g. initial value criterion).
- Section 4.1.5.1: (Comments on windowing) – It could be interesting to specify the maximum deviation between the ideal input frequency and the real input frequency beyond which windowing is necessary.
 - Dan Kien and Pierre-Yves will coordinate a response to this.
- Section 4.1.6.3.1: (“Comment on the selection of the sine wave frequency and the data record length”) – It is preferable to make reference to the uncertainty $\Delta\rho$ in the frequency ratio $\rho = f_i/f_s$ as in the original work by Blair.
 - Steve will ask Jerry Blair about using $\Delta\rho/\rho$ instead of $\Delta f/f$.
- Section 4.1.6.3.2: (Comment on the amount of overdrive and the number of records required) – Sampling jitter is not explicitly considered. For the one-count uncertainty used in eq. 4.1.6.3.2.3 it is preferable to use a worst case variance than an average variance.
 - Again, Jerry Blair will be consulted. Sampling jitter is discussed in the DYNAD work, page 54, eq. 6.8. David Hansen will review some references and coordinate a response with Pierre-Yves.
- Section 4.4: (Linearity Error) – For the comparison of DNL and INL results, the knowledge of some additional parameters is important (e.g. test method and confidence level, absence of random noise, number of samples....)
 - Discussion but no action at this time.
- Section 4.4.5: (Harmonic and Spurious Distortion) – No comment on the choice of averaging (complex averaging vs magnitude averaging).
 - Substantial discussion but the group could not come up with an example where magnitude averaging was deficient. Pierre-Yves will bring us an example.
- Section 4.5: (Noise) – No frequency domain evaluation of SINAD, SNHR, ENOB.
 - Discussion but no action at this time.
- Annex A: -Additional explanation for eq. A4 would be appreciated.
 - We agreed that further explanation would be helpful.
- Long discussion took place at the end of the day regarding 4.1.6.1.1. We were able to understand the new figures introduced, but felt that, in general, the material was well beyond the scope of most test method descriptions. We hope to find a way to touch on the key points regarding the trade-offs between step size and number of samples required for a given standard deviation value and reference the reader to a substantial source for further clarification or to add the material as an annex. We certainly expect to get help from Sol Max and Mike Souders on how to accomplish this.
- Tom Linnenbrink asked us to carefully study the IMEKO TC-4 EUPAS review of 1241 for the next meeting.
- We adjourned at 5:30 PM.