IBIS Open Forum Minutes

Meeting Date: November 14, 2023
Meeting Location: Hybrid Asian IBIS Summit – Tokyo, Japan and online

VOTING MEMBERS AND 2023 PARTICIPANTS

Altair	(JuneSang Lee)
AMD (Xilinx)	(Bassam Mansour)
Ansys	Curtis Clark, Wei-hsing Huang, Minggang Hou, Xi Hu, Satoshi Endo*
Applied Simulation Technology	(Fred Balistreri)
Aurora System	Dian Yang, Raj Raghuram
Broadcom	(Yunong Gan)
Cadence Design Systems	Kyle Lake, Jared James, John Philips, Kristoffer Skytte, Dingru Xiao, Jianping Kong, Shengli Wang, Shiying Fang, Zuli Qin, Tadaaki Yoshimura*, Ryo Sato*, Masahiro Nakahara*, Takahiro Midorikawa*, Hideyoshi Sugaya*
Celestica	(Sophia Feng), Echo Lv, Lurker Li
Cisco Systems	(Stephen Scearce), Hong Wu, Sally Yang
Dassault Systemes	Stefan Paret, Longfei Bai
GE Healthcare Technologies	(Balaji Sankarshanan)
Google	(Hanfeng Wang)
Honeywell	Bavish Vazhayil
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Instituto de Telecomunicações	(Abdelgader Abdalla), Joana Catarina Mendes
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Marvell	Steven Parker
MathWorks	Graham Kus, Walter Katz, Kerry Schotz
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Synopsys	Ted Mido*, (Tushar Pandey), Wael Dghais, Jinghua Huang, Kevin Li, Xuefeng Chen

Teraspeed Labs	Bob Ross*
Waymo	[Zhiping Yang], (Ji Zhang)
ZTE Corporation	(Shunlin Zhu), Changgang Yin, Jian Huang, Ming Zheng
Zuken	[Michael Schäder], Markus Bücker, Ralf Brüning, Hongmin Li, Zhi Yin, Kensuke Yoshijima*, Shinji Takahashi*, Hirohiko Matsuzawa*
Zuken USA	Lance Wang*

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Advantest Corporation	Hiiroaki Takeuchi*
AET, Inc.	Chihiro Ueda*
Alibaba	Wenzhi Wang
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Ningbo DeTooLIC Technology	Zhifei Xu*
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Nuvoton Technology Corp.	Nobufusa Iwanishi*
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Socionext, Inc.	Raymond Yakura, Hajime Ohmi*, Yoshito Uchihashi*, Sizue Kato*
Sohwa & Sophia Technologies	Tomoki Yamada*

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Sony Semiconductor Solutions Corp.	Toru Fujii*, Takashi Mizoroki*
Tankers Superintendent Group Co., Ltd.	Keiichi Hanada*
Techtronix and Fluke Corp.	Katsuhiko Suzuki*
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TEQ Consulting Ltd.	Tadashi Aoki*
Tokyo Drawing Ltd.	Naoya Iisaka*, Masahiko Nakamura*
Toshiba Corporation	Yasuki Torigoshi*
Toshiba Development & Engineering Corp.	Nobuyuki Kasai*
Toshiba Electronic Devices & Storage Corp.	Motochika Okano*, Toshihiro Tsujimura*
University of Illinois Urbana-Champaign	Jose Schutt-Aine
University of Tunisia, Electronic Laboratory	Malek Souilem
Unaffiliated	Will Hobbs, Mike LaBonte, Jon Powell, Stephen Peters
Xiangdixian Computing Technology	Lili Dai
Xidian University	Xiuqin Chu, Yajun Lv
Xpeedic	Guangmeng Ji, Jessie Zhang
Yamaha Corp.	Hiroyuki Kai*
Zhejiang University	Ling Zhang

In the list above, attendees present at the meeting are indicated by "*." Those submitting an email ballot for their member organization for a scheduled vote are indicated by "^." Principal members or other active members who have not attended are in parentheses "( )." Participants who no longer are in the organization are in square brackets "[ ]."

UPCOMING MEETINGS

The connection information for future IBIS teleconferences is as follows:

Microsoft Teams meeting
Join on your computer or mobile app
Click here to join the meeting

Join with a video conferencing device
106010980@teams.bjn.vc
Video Conference ID: 114 666 897 5
Alternate VTC dialing instructions

Or call in (audio only)
+1 267-768-8015,554664847#   United States, Philadelphia
Phone Conference ID: 554 664 847#
Find a local number | Reset PIN
Learn More | Meeting options

All teleconference meetings are 8:00 a.m. to 9:55 a.m. US Pacific Time. Meeting agendas are typically distributed seven days before each Open Forum. Minutes are typically distributed within seven days of the corresponding meeting.

NOTE: "AR" = Action Required.

OFFICIAL OPENING
(Start 00:08:00, Duration 4:15)

The Hybrid Asian IBIS Summit – Japan was held both online and in-person in Tokyo, Japan. About 136 individuals representing 84 organizations attended.

The notes below capture some of the content and discussions. The meeting presentations and other documents are available at:

https://ibis.org/summits/nov23b/

A summit recording has been uploaded and is available by direct link:

https://ibis.org/summits/nov23b/summit_recording.mp4

Lance Wang introduced himself as the Chair of the IBIS Open Forum welcomed attendees both in-person and joining online. Lance expressed thanks to ANSYS, Apollo Giken Co., Keysight Technologies, Seiko Epson Corporation, Toshiba Corporation, and Zuken for their sponsorships of the meeting. He especially thanked JEITA and the JEITA members for making the meeting possible. He noted this is the 19th Asian IBIS Summit held in Japan. He added the meeting is intended to promote the exchange of ideas among users and developers of IBIS models. Due to the inconvenience for people in Japan to attend the regular IBIS Open Forum teleconference, it is important for IBIS to have a meeting in Japan.

ASIAN IBIS SUMMIT – JAPAN, 2023 MEETING WELCOMES
Hayato OGAWA (Keysight Technologies, Japan)
Chair, JEITA EDA Model Specialty Committee
(Start 00:12:20, Duration 7:40)

The presentation was done in a pre-recorded video. Hayato Ogawa-san thanked everyone for joining us at the Asian IBIS Summit (Japan) again this year. Due to the spread of COVID-19 , it has continued to be held online, but due to recent circumstances, this year's IBIS Summit will be held as a hybrid face-to-face and online meeting. We are very happy to have supported the holding of the Summit by the IBIS Open Forum in Japan for 18 years. We would like to thank the IBIS Open Forum officers, speakers, and JEITA / EC Center staff for their great cooperation in preparing for this summit.

We received several comments about the volume and sound quality below in last year's survey.

- The volume fluctuates a lot.
- Sound quality needs improvement.

We apologize for the inconvenience. Taking this as a point of reflection, we reviewed our audio equipment and other equipment to avoid a similar situation this year. We will continue to strive to improve, so we appreciate your continued support.

Since the establishment of the EDA Standard WG in 2004, and then the IBIS Promoting WG, we are today the EDA Model Specialty Committee. We work under the JEITA/EC Center for the purpose of improving utilization technologies for the EDA Model, including the IBIS Model, and promoting their distribution.

The EDA models and their specifications will be continually revised with the advent of new technologies and will also become more and more complex. Considering this situation, we will work to continue broadly providing information to all users of the EDA Model. We will introduce

our website and YouTube channel on the following pages. We are putting out a broad invitation to anyone who is interested in working together with us on committee activities of the EDA Model Specialty Committee. If you are interested in joining the committee, please contact us. We hope to hear from you.

- The main activities of this committee are as follows. IBIS Summit held in Japan (**Today!!**)
- Planning other events
- Management of our website (Spread information)

We held the 9th JEITA/IBIS Seminar online in September of last year. More than 150 people participated and lively discussions took place in the Q&A. Each session of the IBIS seminar can be viewed on demand through YouTube. These are published on our YouTube channel, which was opened due to many requests.

https://www.youtube.com/channel/UC6FZyi9_IGD3cC9h2M6HMng

We have launched our new website in order to provide the latest information in EDA models centered on IBIS. It also contains a message from the chair of the IBIS Open Forum, and technical information. We will frequently update our website. Stay tuned!

The Summit offers a platform to present information on new IBIS specifications. It is also a platform to discuss and exchange views with the IBIS Open Forum. We hope everyone here today will make the most of this opportunity.

IBIS CHAIR'S REPORT

Lance WANG (Zuken, USA)
(Chair, IBIS Open Forum)
(Start 00:19:20, Duration 18:00)

The presentation was done in a pre-recorded video. Lance Wang reported IBIS Open Forum membership as 29 Organization Members and showed a graph indicating relatively consistent level of membership since 1995 to present.

For the Term of Office for June 2023- May 2024, officers are as follows:

- Chair – Lance Wang, Zuken USA
- Vice-Chair – Randy Wolff, Siemens EDA
- Secretary: Graham Kus, The MathWorks
- Treasurer: Bob Ross, Teraspeed Labs
- Librarian: Zhiping Yang, MST
- Postmaster: Curtis Clark, ANSYS
- Webmaster: Steve Parker, Marvell
- University Relations: Chulsoon Huang, MST EMC Lab
- IEEE DASC, IBIS Open Forum Liaison: Michael Mirmak, Intel

Lance continued to introduce the IBIS task groups and their topics of activity as follows:

Weekly teleconferences:

- Quality Task Group (Tuesdays 9:00am PT)
- Advanced Technology Modeling (ATM) (Tuesdays 12:00pm PT)

- Interconnect task group (Wednesdays 8:00am PT)
- Editorial task group (suspended)
- IBIS Open forum is every 3 weeks (Friday 8PT)
- IBIS Summit meetings (USA and international)
  - DesignCon USA, IEEE SPI Europe, IEEE EMC+SIPI USA, IBIS Summit Shanghai, China, and IBIS Summit Tokyo, Japan (JEITA-organized).
- Total Participants have been approximately 280 in 2022

Lance shared that the SAE-ITC is the parent organization for the IBIS Open Forum. The IBIS Open Forum is assisted by SAE employees in matters pertaining to legal, business, and working with organizations as a formal Specification.

Link to SAE-ITC: https://www.sae-itc.com/

Lance introduced IBIS Milestones slide highlighting certain topics.

IBIS Quality Specification:

IBIS developed a quality specification which adds power-aware models. Before 2.0 only covered other IBIS features. This has been mainly done by Weston Beal of Siemens EDA, and Lance thanked him for the effort and contributions.

The new Version 3.0 Specification has been approved and is now found under:

https://www.ibis.org/quality_ver3.0/

What's next for IBIS:

- Expanded system level perspective
  - Clock-Data relationships, timing information, equalization training
- Power integrity focused modelling
  - Chip-level
- Multi-level analog buffer modeling
- Interconnect modeling
  - Touchstone 3.0 with Pole/Residue and port mapping support
  - IBIS-ISS expansions
- What else should we be looking at, bring your ideas! Contributions and suggestions welcome as this is an Open Forum format committee.

Participation in IBIS:

Lance related that the success of IBIS depends on active participation and volunteering- and encouraged everyone to participate as it is an Open Forum.

Lance presented a slide on how to bring ideas and talents to IBIS as a member or participant:

- Task Groups
- IBIS email reflectors
- Open Forum teleconference for event planning and voting
- Summit presentations
- IBIS Board and task group volunteering

- Writing BIRDs – Buffer Issue Resolution Documents
    o Official method for submitting a proposed change

Information about the IBIS .org Website:

- IBIS summits

- Regional forum information

- Task group info

- Member FAQ

- Specification documents

- *IRDs

- Email support

- Syntax Parser Downloads

Lance Wang discussed the IBISCHK parser as being available for free use, but for source code is required, that is available under license purchase for download.

MATRIX PARAMETERS IN TOUCHSTONE

Bob ROSS (Teraspeed Labs, USA)
(Start 00:45:30, Duration 16:00)

The presentation was done in a pre-recorded video. Bob Ross introduced the agenda for the presentation:
- Goals
- Touchstone V1.0, V1.1, V2.0, V2.1 differences
- Reference Impedances (resistances)
- n-Port matrices (S, Y, Z)
    o Conversions and mathematics
- 2-port matrices (H, G)
    o Conversions
- Conclusion

Bob showed features for an upcoming Touchstone Version 2.1 document and showed conversion mathematics for different per-port reference impedances (resistances) for TSCHK2.1 parser development.

INVESTIGATE EMD MODEL SPECIFICATION

Masaki KIRINAKA (FICT Limited, Japan)
(Start 01:03:15, Duration 28:15)

Masaki Kirinaka-san introduced the agenda for the presentation:
- Motivation
- What is EMD?
- EMD FILE STRUCTURE
- Understand EMD through IBIS V7.2 examples
- Improvements from EBD model to EMD model
- Summary

We think there will be opportunities to use EMD models in the future. Therefore, this time, we tried to understand the EMD model specifications. We also considered the advantages over conventional EBD based on EMD specifications.

- EMD is an abbreviation for Electrical Module Description
- IBIS standard for modeling modules such as DIMMs.
- Added from IBIS V7.1 (ratified on December 10, 2021)
- Can analyze more electrical problems than EBD (traditional module description).
- Consists of two types of files (XXX.emd, YYY.ems) (YYY.ems may not exist.)

He showed the EMD file structure and described examples of EMD from the IBIS 7.2 specification. He described improvements in EMD compared to the EBD models.

EMD model can be modeled with IBIS-ISS (Rs, Gd of W-element) and Touchstone, so high frequency loss model is possible. EMD model can model multi-line using IBIS-ISS (W-element) and Touchstone, so crosstalk modeling is possible. Since the EMD model can also model PDN, Power-aware simulation (including Vdd noise) is possible. From the above, the EMD model can be expected to produce results with higher analytical accuracy than the EBD model.

STANDARD COMPLIANT IBIS AMI MODEL FOR SYSTEM SIGN OFF WITH USB4 GEN2 AS AN EXAMPLE

Zhifei XU (Ningbo DeTooLIC Technology Co., China)
Zhiping YANG (Missouri S&T EMC Lab, USA)
[Presented by Zhifei XU]
(Start 01:38:30, Duration 29:00)

The presentation was done in a pre-recorded video. Zhifei Xu started with the background about why a compliant IBIS-AMI model is needed for USB4 Gen2 compliant tests. Then, he introduced how to build Standard Tx and RX compliant IBIS-AMI models. He also demonstrated the automatic verification results using standard IBIS-AMI compliant models.

Takahashi-san asked if IBIS-AMI models can model a spread-spectrum clocking mechanism. Ted Mido-san responded that any algorithms can be included in the IBIS-AMI executables.

Yasuki Torigoshi-san asked whether the whole frequency range was used for the model or just a single frequency point. Zhifei answered that he looked at the whole frequency band using bit-by-bit simulation. Mido-san asked how he came up with the reference channel. Zhifei said it is referred to the reference channel. He downloaded the reference cable model from the USB website. For the PCB model, a channel model was created to exhibit the reference loss in dB at a specific frequency. We do not know the behavior of the channel at other frequencies, but the loss is mostly linear in dB. Zhiping Yang added that channel insertion loss, crosstalk, and return loss specifications are given in the USB specification. There is also an insertion loss curve in the specification.

HARDWARE AND AI/ML: APPLICATIONS OF SIPI & IBIS

Zhiping YANG (Missouri S&T EMC Lab, USA)
(Start 02:09:30, Duration 28:00)

Zhiping Yang started from mentioning hardware plays a critical role in AI/ML. He also showed a chart that human brain is still more powerful compared with machines we invented. He also showed SI/PI demands and challenges in recent technology developments. He discussed how

to have Gen N hardware to Gen N+1 hardware using AL/ML as a helper. He talked about a few examples and case studies from AI/ML global efforts. He explained few recent studies for decap location optimization, high-speed channel modeling. and eye-diagram prediction using AI/ML technologies. He mentioned the possibility of using IBIS and AI/ML for SI/PI design and simulation.

Q&A SESSION

(Start 02:39:30, Duration 27:00)

Bob Ross commented to Hayato Ogawa-san that the model website of JEITA is very good.

In response to a question, Ted Mido-san explained the advantage of EMD with use of W-elements and other modeling with no limitation on bandwidth. The accuracy of the models is dependent on how high the frequency dependent loss is modeled.

Tadashi Arai-san thanked the IBIS Open Forum for the great event. He asked about Zhifei Xu's presentation. Recent high speed interface specifications define channel compliance. We can check the channel compliance without the device model. On the other hand, the IBIS specification is pursuing the most accurate device model, describing the complex behavior. What is the main motivation to developing the accurate device model if we can design based on the channel compliance specification?

Zhiping Yang commented that typical standards have 1) non-conclusive information such as channel specifications. You can design to the standard channel model, but you cannot complain if it doesn't work. 2) the frequency domain specs do not translate directly to eye diagrams where you can analyze margin in performance. This could help you design for lower cost. Mido-san said that the reason for the IBIS-AMI model is to be a practical replacement for the transistor-level model, allowing for simulation of millions of bits and equalization modeling before the design may even be finalized. Zhiping added that AMI models can be available well before the design to allow for architectural exploration.

Mido-san presented the question from Masaki Kirinaka-san about the usage of bus_label in EMD. Also, there is usage of bus_label in EMD examples for VDD but not for VSS.

Bob Ross commented that there are topologies where VDD is split, for example in stacked dies where VDD goes to multiple chips, and IBIS allows for documenting the unique paths. That is an example for usage of bus_label. VDD is split into several paths. Bob added that bus_label can be used for VSS if necessary. Lance Wang clarified, based on the slide 16 in Kirinaka-

san's presentation, U1 and U2 use different VDD (based on physical locations), but they share the signal_name VDD, since eventually they are tied together.

DISCUSSION ROOM WITH IBIS OPEN FORUM

(Start 03:06:30, Duration 22:30)

This discussion was led by the JEITA EDA Model Specialty Committee.

- **■ Background**
- Currently, electronics engineers in Japan do not have sufficient opportunities to obtain information on IBIS model standards.
- The sources of information on the IBIS model for engineers are EDA vendors, this committee, FAQs of the IBIS Open Forum, and a few books.
- In order to make the Summit even more meaningful, it would be extremely meaningful to receive accurate comments from the IBIS Open Forum, which is developing IBIS standards.

- **■ Objective**
- To provide a forum for communication between Japanese engineers and the IBIS Open Forum at the IBIS Summit Japan to increase understanding of the IBIS model and to promote the spread of the IBIS model in Japan.
- To promote the development and use of the IBIS model worldwide by sharing and discussing issues faced by Japanese engineers with the IBIS Open Forum.

Ted Mido-san commented that he thought this was a great idea. The IBIS Summit is a place to exchange ideas and questions. JEITA is trying to host the one session for this. JEITA will

collect questions, share ideas, and increase knowledge to the Japanese engineers to eventually see Japanese engineers develop IBIS BIRDs.

Lance Wang commented that he sees a lack of questions in the IBIS Summit meetings in Asia, and this may be culturally related. If questions are collected, IBIS experts could have meetings with people in Asia more regularly to review and answer those specific questions.

- Discussion Room with IBIS Open Forum (Draft)

    *Starting next year. Kick-off this year

- Date: Within ASIAN IBIS Summit Japan

- Room: Hybrid of face-to-face and online (similar to IBIS Summit)

- Management Method:

    1. Solicit requests and questions about the IBIS model before the IBIS Summit Please let us know the question and the background of the question.

    2. Pick up questions that are of high interest and may provide useful information from the collected questions and send them to IBIS Open Forum.

    3. IBIS Open Forum will select 2 or 3 questions from the list in advance.

    4. Open discussion on the selected questions/requests will be held in the IBIS Summit.

Mido-san commented that this is the idea about how to move forward.

Already collected questions include:

- Request Description:

- We would like you to provide a standardized Example of the IBIS model.

    - Sample of IBIS model corresponding to the latest keywords.

- Background:

- We would like to use the IBIS model as a reference for pre-verification study of new standards and the validity of the models provided by semiconductor vendors. We also want to check the operation of EDA tools.

Mido-san commented that more examples of IBIS models would be useful.

- Request Description:

- We would like to quickly check whether there is a discrepancy between the [Ramp] characteristics and the [Rising /Falling Waveform] characteristics.

- Background:

- Whether [Ramp] or [Waveform] is used differs depending on the EDA tool, so if there is a discrepancy between these, the results will vary greatly depending on the EDA tool. If you know in advance whether the [Ramp] characteristics and the [Rising /Falling Waveform] characteristics diverge, you can easily find the cause.

Mido-san commented that some models have a discrepancy between [Ramp] and the waveforms. Bob Ross commented that [Waveform] overrides [Ramp], so EDA tools should prioritize use of [Waveform]. Waveforms may describe more switching conditions than [Ramp].

- ■ Request Description:
- • Users would like the priority to be clearly described when both C_comp and [C Comp Corner] are defined.
- ■ Background:
- • Since the values used differ depending on the EDA tool, differences will occur in the simulation results.

Bob commented that the description should be clear in the specification. Lance Wang commented that the extraction of C_comp values from the transistor-level model gives you three values. These values as reported in numerical ordering may not align with the typ/min/max corner of the rest of the IBIS model. Bob added that [C Comp Corner] should override C_comp.

CLOSING REMARKS

(Start 03:29:15, Duration 01:00)

Lance Wang thanked everyone for attending. He thanked the sponsors, and he thanked JEITA for organizing the meeting. He hoped to see everyone again next year in person.

NEXT MEETING

The next IBIS Open Forum teleconference meeting will be held on November 17, 2023. The following IBIS Open Forum teleconference meeting is tentatively scheduled for December 8, 2023.

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NOTES

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This meeting was conducted in accordance with SAE ITC guidelines.

All inquiries may be sent to info@ibis.org. Examples of inquiries are:

- To obtain general information about IBIS.
- To ask specific questions for individual response.
- To subscribe to or unsubscribe from the official ibis@freelists.org and/or ibis-users@freelists.org email lists (formerly ibis@eda.org and ibis-users@eda.org):
  - https://www.freelists.org/list/ibis
  - https://www.freelists.org/list/ibis-users
- To subscribe to or unsubscribe from one of the task group email lists: ibis-macro@freelists.org, ibis-interconn@freelists.org, ibis-editorial@freelists.org, or ibis-quality@freelists.org:
  - https://www.freelists.org/list/ibis-macro
  - https://www.freelists.org/list/ibis-interconn
  - https://www.freelists.org/list/ibis-editorial
  - https://www.freelists.org/list/ibis-quality
- To inquire about joining the IBIS Open Forum as a voting Member.
- To purchase a license for the IBIS parser source code.
- To report bugs or request enhancements to the free software tools: ibischk7, tschk2, icmchk1, s2ibis, s2ibis2 and s2iplt.

The BUG Report Form for ibischk resides along with reported BUGs at:

   http://www.ibis.org/bugs/ibischk/
   http://www.ibis.org/ bugs/ibischk/bugform.txt

The BUG Report Form for tschk2 resides along with reported BUGs at:

   http://www.ibis.org/bugs/tschk/
   http://www.ibis.org/bugs/tschk/bugform.txt

The BUG Report Form for icmchk resides along with reported BUGs at:

   http://www.ibis.org/bugs/icmchk/
   http://www.ibis.org/bugs/icmchk/icm_bugform.txt

To report s2ibis, s2ibis2 and s2iplt bugs, use the Bug Report Forms which reside at:

   http://www.ibis.org/bugs/s2ibis/bugs2i.txt
   http://www.ibis.org/bugs/s2ibis2/bugs2i2.txt
   http://www.ibis.org/bugs/s2iplt/bugsplt.txt

Information on IBIS technical contents, IBIS participants and actual IBIS models are available on the IBIS Home page:

http://www.ibis.org/

Check the IBIS file directory on ibis.org for more information on previous discussions and results:

http://www.ibis.org/directory.html

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SAE STANDARDS BALLOT VOTING STATUS (attendee X; absent -)

Organization	Interest Category	Standards Ballot Voting Status	Oct 6, 2023	Oct 27, 2023	Nov 10, 2023	Nov 14, 2023
Altair	User	Inactive	-	-	-	-
AMD (Xilinx)	Producer	Inactive	-	-	-	-
Ansys	User	Active	X	X	X	-
Applied Simulation Technology	User	Inactive	-	-	-	-
Aurora System	User	Inactive	-	-	-	-
Broadcom Ltd.	Producer	Inactive	-	-	-	-
Cadence Design Systems	User	Active	X	-	X	X
Celestica	User	Inactive	-	-	X	-
Cisco Systems	User	Inactive	-	-	X	-
Dassault Systemes	User	Inactive	-	-	-	-
GE Healthcare Technologies	User	Inactive	-	-	-	-
Google	User	Inactive	-	-	-	-
Huawei Technologies	Producer	Inactive	-	-	X	-
Infineon Technologies AG	Producer	Inactive	-	-	-	-
Instituto de Telecomunicações	User	Inactive	-	-	-	-
Intel Corp.	Producer	Active	X	X	X	-
Keysight Technologies	User	Active	-	-	X	X
Marvell	Producer	Inactive	-	-	-	-
MathWorks	User	Inactive	X	X	-	-
Micron Technology	Producer	Active	-	-	X	X
MST EMC Lab	User	Active	X	-	X	X
SerDesDesign.com	User	Inactive	-	-	-	-
Siemens EDA	User	Active	X	X	-	X
STMicroelectronics	Producer	Inactive	-	-	-	-
Synopsys	User	Active	X	X	X	X
Teraspeed Labs	General Interest	Active	X	X	-	X
Waymo	User	Inactive	-	-	-	-
ZTE Corp.	User	Inactive	-	-	X	-
Zuken	User	Active	X	-	X	X

= Temporarily not a voting member

Criteria for SAE member in good standing:
- Must attend two consecutive meetings to establish voting membership.
- Membership dues current
- Must not miss two consecutive meetings (voting by email counts as attendance)

Interest categories associated with SAE standards ballot voting are:
- Users - members that utilize electronic equipment to provide services to an end user.
- Producers - members that supply electronic equipment.

General Interest - members are neither producers nor users. This category includes, but is not limited to, government, regulatory agencies (state and federal), researchers, other organizations, and associations, and/or consumers.