IFEC 2024 Final Competition Metrics
Last updated 6/13/2024

Overall Top-level Scoring Breakdown:

The overall competition is broken down into the top-level categories and scoring weights below:

- [15%] Oral Presentations
- [60%] Electrical Tests
- [25%] Listening Tests

Below we provide a breakdown of how each category will be scored for each team.

Oral Presentation Scoring:

The Oral Presentation category, which is worth 15% of the overall competition score, is broken down as follows:

- [50%] Clarity of communication and overall professionalism of the presentation.
- [50%] Technical accuracy and completeness.

Presentation scores will be collected among members of the IFEC organizing committee and recruited judges. The scores will then be averaged into the Oral Presentation category score for each team.

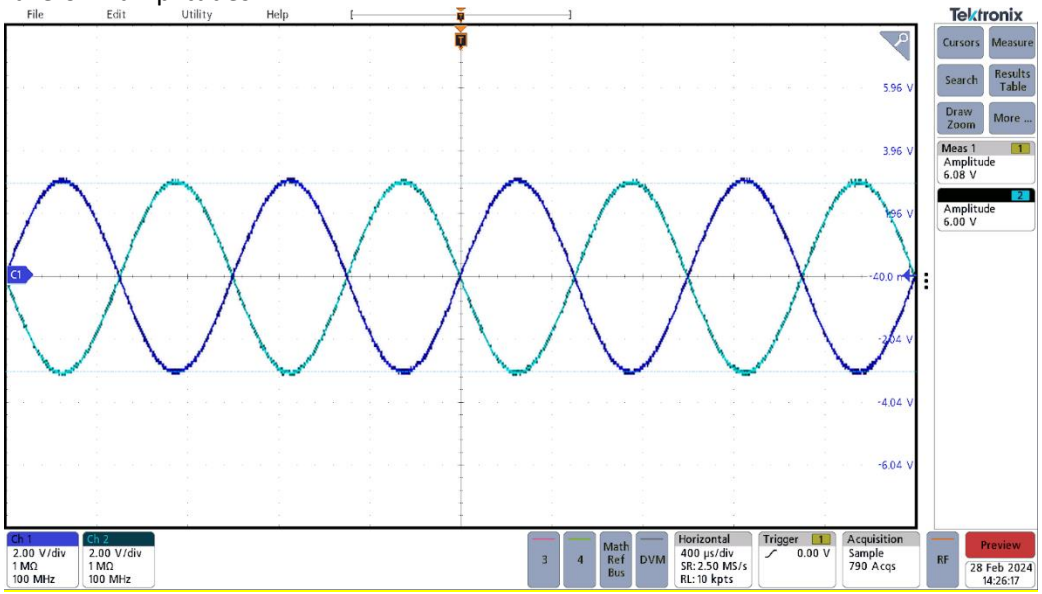
Electrical Tests Scoring:

The Electrical Tests category, which is worth 60% of the overall score, is broken down as shown in the table below. These tests will be conducted during the afternoon of Tuesday July 16th on the stage of the Mulva Auditorium in front of all attendees. Each team will be allocated approximately 30 minutes to carry these measurements and scores will be tabulated according to the table below.

Test Categories	**Category Weights**		**Test Weights**
Tests on Stereo Channel	40%	**Crosstalk amplitude sweep test**	20%
		THD+N versus frequency test	15%
		THD+N versus amplitude test	15%
		THD+N at low amplitude output	15%
		(Bonus) THD+N at high power stress test	**25%**
		Intermodulation distortion test	35%
		Category-level Total	**125%**
Subwoofer Tests	20%	**THD+N versus amplitude sweep test**	35%
		THD+N versus frequency sweep test	35%
		THD+N at low amplitude output	30%
		Category-level Total	**100%**
Other Tests	20%	**Idle Channel Noise**	75%
		Crossover Test	25%
		Category-level Total	**100%**
Efficiency Tests	20%	**Efficiency test up to 75% power**	100%
		(Bonus) Efficiency test at 100% power	**25%**
		Category-level Total	**125%**
Overall Total	**100%**		

Next, we provide a narrative description of each of the tests described above along with relevant details regarding amplitude/power scalings, equipment, and a calibration procedure.

- Overview: Tests will be carried on an Audio Precision AP2722 with an AUX-0025 unit and a laptop configured with appropriate software. Five complete setups (each setup includes one AP2722, AUX-0025, and laptop with AP software) will be provided and available for the teams to use during Monday afternoon and Tuesday morning of the competition. One test setup will be transported to the main stage of the Mulva auditorium to test all converters for the main Electrical Tests during the afternoon of Tuesday. Three resistors (6 Ohms for Left, 6 Ohms for Right, and 4 Ohms for Subwoofer outputs) will be connected to the outputs of your converter during these tests.
- Definition of Decibel Scale: All decibel scalings align with the signals provided by the iFi brand Zen DAC V2, and these will act as inputs to your converter. Specifically, all instances of 0 dB in the text below correspond to a balanced waveform with a 4.2 Vrms differential output. Below is a measurement of the L+ and L- pin voltages with respect to the ground pin on the Left channel XLR connector when the DAC is producing a full scale 4.2 Vrms output. In other words, this measurement corresponds to a 0 dB set of balanced waveforms on one of the input channels. The Audio Precision audio analyzer will be configured so that its amplitudes in decibels align with these waveform amplitudes.



Measured output of ifi Zen DAC V2 left channel balanced outputs with respect to ground.

- Calibration Step: First, the AP unit will be programmed to provide a 1 kHz sinusoidal input with a -10 dB amplitude. Next, the converter volume knobs will be adjusted until the output power produced by each channel is approximately 1/10th of the power rating (i.e., 135 W/10 = 13.5 W). Lastly, the amplitude produced by the AP unit will be fine-tuned until the output power is exactly 13.5 W. The output power will be inferred by measuring the RMS amplitude of the output waveform across the resistive load. After calibration is complete, the volume knobs will no longer be adjusted for the remainder of the electrical tests. The relationship between the input signal amplitude and output power may be approximated using the formula below. In this expression, P_{rated} = 135 W and A_{dB} is the amount by which the input signal is attenuated in dB.
    - $P_{out} = \mathrm{P}_{\text{rated}} 10^{\mathrm{A}_{\text{dB}}/10}$
- Left and Right Channel Tests:

- *Crosstalk amplitude sweep test:* This test will be fixed at 1 kHz. First, the Left channel input will be provided with fixed amplitude input at -10 dB while the Right channel input will be given zero input from the AP unit (approximately -99 dB). The right channel output will be measured and should ideally show minimal output. The test will be repeated by swapping the excitation signal to the Right channel input and measuring the Left channel output.
- *THD+N versus frequency test:* First, teams are encouraged to read this to gain a deeper understanding of what the THD+Noise (THD+N) metric is. Identical sinusoidal excitations will be given to both the Left and Right channel inputs. These input signals will be fixed at -10 dB while the frequency is swept from 20 Hz to 6 kHz. The THD+N will be measured at 100 Hz, 500 Hz, and 2 kHz.
- *THD+N versus amplitude test:* Identical sinusoidal excitations will be given to both the Left and Right channel inputs. Input signal amplitudes will be swept from -10 dB to -60 dB. This test will be conducted at 1 kHz, 3 kHz, and 6 kHz, and data will be collected at every 10 dB amplitude increment. THD+N will be measured during each of the tests at these three frequencies.
- *THD+N at low amplitude output:* This test is designed to assess performance when low amplitude output waveforms are generated by your converter. The amplitude of the signal produced by the AP unit will be adjusted until 1 W of power is delivered to the Left and Right outputs. THD+N will be measured from 20 Hz to 20 kHz and the judges will pay special attention to the measurements at 1 kHz, 3 kHz, and 6 kHz.
- *(Bonus points test) THD+N at high power stress test:* This test is designed to assess performance when your converter delivers relatively high power. The amplitude of the signal produced by the AP unit will be adjusted until exactly 135/2 W (half power) is delivered to both the Left and Right outputs. THD+N will be measured at 1 kHz, 3 kHz, and 6 kHz. This test introduces risk that may lead to converter failure with improper thermal management. Accordingly, this test is optional and teams that successfully complete it will be given bonus points. Teams must carefully weigh the risk of this test before proceeding since converter damage may hinder your ability to participate in the rest of the competition.
- *Intermodulation distortion test:* The AP unit will be configured to create a superposition of 1 kHz and 1.1 kHz sinusoids at the same time with -10 dB amplitude. The 100 Hz frequency component will be measured at the output. Ideally, the 100 Hz component should be highly attenuated. Read this page to learn more about intermodulation distortion.

- Subwoofer Test:
  - *THD+N versus amplitude sweep test:* The Left and Right channel inputs will be provided with an identical 40 Hz sinusoid that is swept across the amplitude range of -60 dB to -10 dB. THD+N will be measured at every 10 dB amplitude increment.
  - *THD+N versus frequency sweep test:* The Left and Right channel inputs will be provided with an identical sinusoid fixed at -10 dB amplitude. The input signal will be swept across the frequency range of 20 Hz to 200 Hz. THD+N will be measured across the amplitude range at 20 Hz, 50 Hz, 100 Hz, and 200 Hz.
  - *THD+N at low amplitude output:* This test is designed to assess subwoofer channel performance when a low amplitude output waveform is generated by your converter. The amplitude of the signal produced by the AP unit will be adjusted until 1 W of power is delivered to the subwoofer output channel. THD+N will be measured at 40 Hz.
- Idle Channel Noise: The AP unit will be configured to produce the minimal possible input signal (approximately -99 dB) to your converter inputs. The amplitude of the outputs will be measured using the A-weighted scale. This test will be carried out on the Left, Right, and Subwoofer channels.

- Crossover Test: A fixed amplitude identical sinusoid will be provided to both the Left and Right inputs and fixed at a -20 dB amplitude. The frequency will be swept from 20 Hz to 20 kHz. The outputs will be measured on the Left, Right, and Subwoofer channels. Results should verify that the crossover filters have been properly implemented so that frequencies above approximately 200 Hz and above are routed to the Left and Right channels. Frequencies below approximately 200 Hz should go to the Subwoofer channel.
- Efficiency Test:
    - *Efficiency test up to 75% power:* Efficiency will be measured with a 1 kHz input signal. The AP input signal amplitude will be adjusted until the output power levels are 25%, 50%, and 75% (i.e., 135/4 W, 135/2 W, 3×135/4 W) of the converter power rating. Power will be delivered into resistive loads (6 Ohms for Left, 6 Ohms for Right, and 4 Ohms for Subwoofer outputs) for each channel.
    - *(Bonus points test) Efficiency test at 100% power:* Efficiency will be measured with a 1 kHz input signal. The amplitude of the signal produced by the AP unit will be adjusted until the full rated power of 135 W is delivered to every output channel. Efficiency will be computed at this operating point. This test introduces risk that may lead to converter failure with improper thermal management. Accordingly, this test is optional and teams that successfully complete it will be given bonus points. Teams must carefully weigh the risk of this test before proceeding since converter damage may hinder your ability to participate in the rest of the competition.

Listening Tests Scoring:

This category will account for 25% of the overall competition score. These tests will be carried out the morning of Wednesday July 17th where each team will be allocated 30 minutes for their tests. The studio will be prepared with a laptop, iFi ZEN DAC unit, stereo speakers, subwoofers, and speaker cables. The laptop will be preloaded with the audio file which will be played through your converter. This time slot will be used as follows:

- 10 minutes: This time slot will be used to set up your converter and carry out an acoustic intensity calibration. The DAC unit will be configured to produce 0 dB full-scale signals and your volume knobs will be turned down completely to zero. White or pink noise will be provided by the DAC to your converter and the volume knobs will be adjusted until the acoustic level is 75 dB from the listening seated position.
- 15 minutes: Listening tests will be carried out during this time interval where a consolidated single audio file will be started and played from start to finish without interruption. This consolidated audio file will have multiple songs of various styles combined into one track so that each song plays one after the other. The precise list of songs will be released soon. For now, assume the songs will have a mix of styles (classical, jazz, piano, modern pop/rock).
- 5 minutes: The last part of your time will be used to disconnect your converter and ensure that the system is ready for the next team to arrive and test their circuit.

The listening room is a studio space located in the UT Butler School of Music building. This space can seat approximately 20 people. Approximately 15 seats are reserved for judges and IFEC committee members. The judges for this portion of the competition are experienced audio professionals who are accustomed to listening for audio performance. The approximately 5 seats that remain may be used by the student team whose converter is being evaluated. The judges and committee will provide subjective scores that reflect perceived dynamic range, attack/transient response, and overall tonal balance. A more precise metric table will be released shortly. After each judge enters their scores, these will be averaged into a single score for the Listening Test category for each team.