TI Analog Design Contest

2013 European Edition

TI university program
technology for tomorrow's innovators

Texas Instruments

what is Analog Design Contest?

Texas Instruments Analog Design Contest is an initiative to encourage system-level design within Universities. It is an opportunity for University students to show creativity and engineering skills whilst working on a design project using TI's broad range of high-performance analog Integrated Circuits (IC's). This contest allows students to gain experience and recognition in the analog field as well as competing against other teams for cash prizes!

what you can win?

First Round: In the first round there will be twenty winning teams. Each of these teams will be awarded a cash prize of US$ 1,000. These twenty winning teams will progress to the second round of judging.

Second Round: In the second round there will be four winning teams of the TI European Analog Design Contest.

The TOP 4 team prizes will be awarded as follows:

- **First place:** US$ 10,000
- **Second place:** US$ 5,000
- **Third place:** US$ 2,500
- **Fourth place:** US$ 2,500

Note: All cash prizes will be paid to the team leader of each winning team.

deadlines and important dates

- Registration deadline: 23:59 (GMT) on 28th February 2013
  (Registration form found at www.ti.com/ADC must be sent to: adc2013-emea@ti.com)
- Tools request deadline: 23:59 (GMT) on 30th April 2013
  (must be sent to: adc2013-emea@ti.com)
- Report submission deadline: 23:59 (GMT) on 31st July 2013
  (must be sent to: adc2013-emea@ti.com)
- First round winners announced by: 30th September 2013
- Second round winners announced by: 31st October 2013

ADC 2013 flowchart

tools

recommended evaluation modules

Some of our tools are stocked and ready to be shipped; therefore you will be able to start working with them very quickly!

How to get the tools? Find out here.

analog

tools

ADC (Analog to Digital Data Converters)

- ADS1258EVM, ADS8332EVM: The EVM provides a quick and easy way to evaluate the functionality and performance of this low power, high resolution, Analog to Digital Converter (ADC). The EVM provides a serial interface header to easily attach to any host microprocessor or TI DSP base system.
  $49

- THS1206M-EVM: This EVM can accommodate all eight devices of the THS1206 family of data converters. This family consists of high-speed, low power, 10 and 12-bit ADCs that operate from independent 5V, Avdd, and 3.0-5.25V, DVdd, supplies. Independent buffer supply, BVdd, eliminates the need for level-shifting circuitry when the device is used with low voltage host controllers.
  $49

DAC (Digital to Analog Data Converters)

- DAC8411EVM: Evaluation module designed for the prototyping and evaluation of the DAC8411, DAC8311, DAC7311, DAC6311 and DAC5311 digital to analog converters (DAC). These 8 to 16-bit, string DACs operate with a high speed serial clock (up to 50MHz) and offer excellent performance with power consumption as low as 2.5uW.
  $49

Power Management

- TPS60400EVM-178: The TPS60400EVM-178 is a evaluation tool for the TPS6040x family of SOT23-5 inverting charge pumps. These devices generate an unregulated negative output voltage from an input voltage in the range of 1.6 V to 5.5 V with an output current of up to 60 mA.
  $5

- TPS54233EVM-373: The TPS54233 dc/dc converter is designed to provide up to a 2 A output from an input voltage source of 3.5 V to 28 V. This evaluation module is designed to demonstrate the small printed-circuit-board areas that may be achieved when designing with the TPS54233 regulator. The high-side MOSFET is incorporated inside the TPS54233 package along with the gate drive circuitry.
  $10

- TPS2490EVM-001: Hot Swap Power Manager integrated circuits (ICs) ensure the hot-swap safety and add protection during fault conditions for boards or modules in +48-V hot swap environments. The ICs feature programmable current and power limiting, electronic circuit breaker, adjustable undervoltage-lock enable input, and power-good reporting output.
  $49

processors

(digital tools)

DSP

- TMDX5515EZDSP: The TMDX5515eZDSP is a small form factor, very low cost USB-powered DSP development tool which includes all the hardware and software needed to evaluate the industry's lowest power 16-bit DSP
  $79

MCU (Microcontrollers)

- TMDS28027USB: The innovative Piccolo controlSTICK allows quick and easy evaluation all of the advanced capabilities of TI's new Piccolo microcontroller for just $39. Slightly larger than a memory stick, the Piccolo controlSTICK features on board JTAG emulation and access to all control peripherals. Example projects walk the user through the advanced functionality of Piccolo, from simply blinking an LED to configuring the high resolution ePWM peripherals.
  $39

- MSP430 LaunchPad Value Line Development Kit: The LaunchPad is an easy-to-use flash programmer and debugging tool. It features everything you need to start developing on a MSP430 microcontroller device, with an on-board emulation for programming and debugging and features a 14/20-pin DIP socket, on-board buttons and LETs & BoosterPack-compatible pinouts that support a wide range of plub-in modules for added functionality such as wireless, displays & more.
  $4.30

- MSP-EXP430FG4618: This versatile MSP430 Experimenter Board features a MSP430F2013 and a MSP430FG4618 and is compatible with TI's wireless evaluation modules. Two JTAG headers are accessible to program and debug each MSP430 individually and allows for communication to external devices or between the two MSP430s. Power may be supplied over the USB FET or from the included AAA batteries.
  $99

- MSP-FET430UIF: The MSP-FET430UIF is a powerful flash emulation tool to quickly begin application development on the MSP430 MCU. It includes USB debugging interface used to program and debug the MSP430 in-system through the JTAG interface or the pin saving Spy Bi-Wire (2-wire JTAG) protocol. The flash memory can be erased and programmed in seconds with only a few keystrokes, and since the MSP430 flash is ultra-low power, no external power supply is required.
  $99

MCU & LPRF (low-power RF)

- EZ430-CHRONOS-868, EZ430-CHRONOS-433: The eZ430-Chronos is a highly integrated, wearable wireless development system based for the CC430 in a sports watch. It may be used as a reference platform for watch systems, a personal display for personal area networks, or as a wireless sensor node for remote data collection.
  $49

- EZ430-RF2500: The eZ430-RF2500 is a complete wireless development tool for the MSP430 and CC2500 that includes all the hardware and software required to develop an entire wireless project with the MSP430 in a convenient USB stick. The tool includes a USB-powered emulator to program and debug your application in-system and two 2.4-GHz wireless target boards featuring the highly integrated MSP430F2274 ultra-low-power MCU.
  $49

recommended parts

The amount of different ICs from TI can be overwhelming. Please see the following list for short overview of recommended devices.

How to get the ICs? Find out here.

data converters ICs

General-Purpose ADC

- THS1206M: 12-bit, 6-MSPS A/D converter, quad-channel, integrated 16x FIFO, channel autoscan, low power.

Instrumentation ADC

- ADS1258: 24-bit, fast channel cycling ΔΣ ADC

High-Speed ADC

- ADS1605: 16-bit, 5-MSPS ΔΣ A/D converter
- ADS1606: 16-bit, 5-MSPS single-channel ΔΣ ADC with FIFO

General-Purpose DAC

- DAC8554:16-bit, quad channel, ultra-low glitch, voltage output D/A converter Projects: Portable instrumentation, closed-loop servo-control.

High-Precision DAC

- DAC8534: 2.7-V to 5.5-V, quad-channel, 16-bit, serial input DAC Projects: Portable instrumentation, programmable attenuation, and PC peripherals.

High-Speed DAC

- DAC8581: 16-bit, high-speed, low-noise, voltage output D/A converter Projects: CRT projection/TV digital convergence, waveform generation and ultrasound projects.

power management ICs

Low-Dropout Regulator (LDO)

- TPS73501: Single-output LDO, 500-mA, adjustable, low quiescent current, low noise, high PSRR

Multi-Cell Li-Ion Charger

- bq24750A: Host-controlled, multi-chemistry battery charger w/integrated system power selector. Projects: Notebook PCs, portable DVD players.

Power Sequencer

- UCD9080: Power supply sequencer and monitor. Projects: Telecommunications switches, servers, networking equipment and test equipment

LED Driver

- TLC5940: 16-channel LED driver w/EEprom dot correction and grayscale PWM control Projects: Mono-color, multi-color, and full-color LED displays, LED signboards and display backlighting

AC/DC Controller

- UCC28600: 8-pin quasi resonant flyback green-mode controller
  Projects: Supplies for LCD monitors, LCD-TV, PDP-TV and set-top boxes, AC/DC adapters and offline battery chargers

Buck/Boost for Portable Applications

- TPS63000: 96% buck-boost converter with 1.8-A current switches in 3x3 QFN
  Projects: Portable audio players, PDAs, cellular phones and personal medical apps
- TPS62400: Dual, adjustable, 400-mA and 600-mA, 2.25-MHz step-down converter with 1-wire interface in QFN
- TPS61200: 0.3-V input voltage boost converter with 1.3-A switches and down mode in a 3x3 QFN
  Projects: Portable media players, digital radio, digital cameras, fuel cell- and solar cell-powered projects

Wide-Input Buck

- TPS5430: 5.5-V to 36-V, 3-A, 500-kHz step-down SWIFT™ converter
- TPS40200: Wide input non-synchronous buck DC/DC controller
  Projects: Set-top boxes, DVD, industrial and car audio power supplies, distributed power systems and DSL/cable modems

High-Current Buck

- TPS54010: 2.2-V to 4.0-V, 14-A synchronous step-down SWIFT™ converter
- TPS40055: Wide input (8V-40V) up to 1-MHz frequency synchronous buck controller, source/sink
  Projects: Broadband, networking, optical communications infrastructure and industrial servers

MOSFET

- CSD16413Q5A: N-channel NexFET™ power MOSFET

Amplifiers ICs

Instrumentation Amp

- INA118: Precision, low-power instrumentation amp

Op Amps

- OPA277: High-precision op amp, single
- OPA2277: High-precision op amp, dual
- OPA4277: High-precision op amp, quad

Switches ICs

- TS12A4517: Low-voltage, low on-state resistance SPST CMOS analog switches

Low-Power RF ICs

LPRF devices cover 2 frequency ranges:

- CC10XX/CC11xx - Sub 1GHz, ISM (Industrial, Scientific and Medical) and frequency bands at 315, 433, 868 and 915MHz
- CC24xx and CC25xx -2.4GHz, ISM and SRD band: 2,400 - 2,483.5MHz

Processors

ICs

MSP430 Ultra-low Power MCUs

- MSP430FG4618: Integrated signal chain: ADC, DAC, op-amps, 16MHz, LCD controller
- MSP430F5438: Next-generation MSP430, ADC, 256-KB memory, 25MHz
- MSP430F169: General-purpose MCU, ultra-low power, 64-KB memory
- MSP430F2013: DIP package available, ultra-low power, smallest MSP430, easy to use

C2000 Real-Time Control MCUs

- TMS320F28335: Floating point, 150MHz w/ hi-res PWMs

recommended software

There are several software tools that could be useful in your project. You can download software (limited versions) for free from the TI website. Just follow the links by clicking on the software name.

software

Design

- Code Composer Studio: Integrated development environment for Texas embedded processor families. CCStudio comprises a suite of tools used to develop and debug embedded applications. Please use time-limited or code-limited license.
- WEBENCH Power Designer: You can use WEBENCH to create customized power supplies or DC-DC converters for your circuits. This environment gives you end-to-end power supply designs and prototyping tools.
- SmartRF Studio: Can be used to evaluate and configure Low Power RF-ICs from Texas Instruments. The application will help designers of RF systems to easily evaluate the RF-ICs at an early stage in the design process.

Tools

- GRACE: GUI-based configuration tool for setting up ADCs, OpAmps, Timers, Clocks, GPIO, Comparators, Serial Communication, and other MSP430 peripherals. Generates easy-to-understand C code that properly configures your device
- Stellaris PinMux Utility: Allows a Stellaris developer to graphically configure the device peripherals in an intuitive and rapid manner. The tool provides an easy-to-use interface that makes setting up alternate functions for GPIOs easy and error-free.

Simulation

- TINA TI: Easy-to-use, powerful circuit simulation tool based on a SPICE engine. TINA-TI is a fully functional version of TINA, loaded with a library of TI macromodels plus passive and active models.

Software & Code Packages

- MSP430 Ware (already part of CCS installation): Collection of code examples, datasheets and other design resources for ALL MSP430 devices delivered in a convenient package - essentially everything developers need to become MSP430 experts!
- Stellaris Ware: Extensive suite of software designed to simplify and speed development of Stellaris-based microcontroller applications. All StellarisWare software has a free license and royalty-free use to allow the creation of full-function, easy-to-maintain code.
- Control Suite: Cohesive set of software infrastructure and software tools designed to minimize software development time. From device-specific drivers and support software to complete system examples and technical training, controlSUITE™ provides libraries, examples, and support at every stage of development and evaluation.

how to order tools and samples?

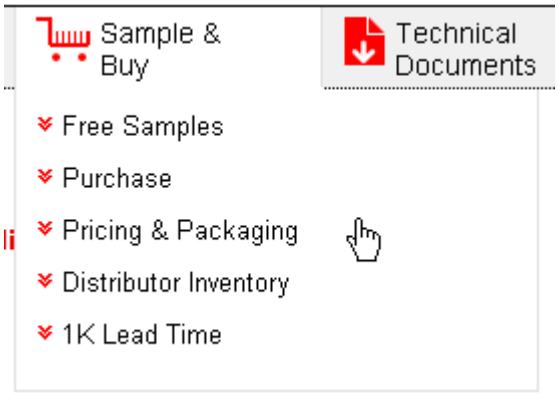
- Samples - chips produced by TI
- Tools - development boards sold by TI to evaluate its chips

Both samples and tools are different products and must be ordered differently.

ordering samples

Please ask your **Professor** to order samples for your team as students may face problems. You will find a guideline for ordering tools in the next section of this document. The European University Program does not send any samples. All samples are provided through TI's sampling program and the standard TI sampling rules apply.

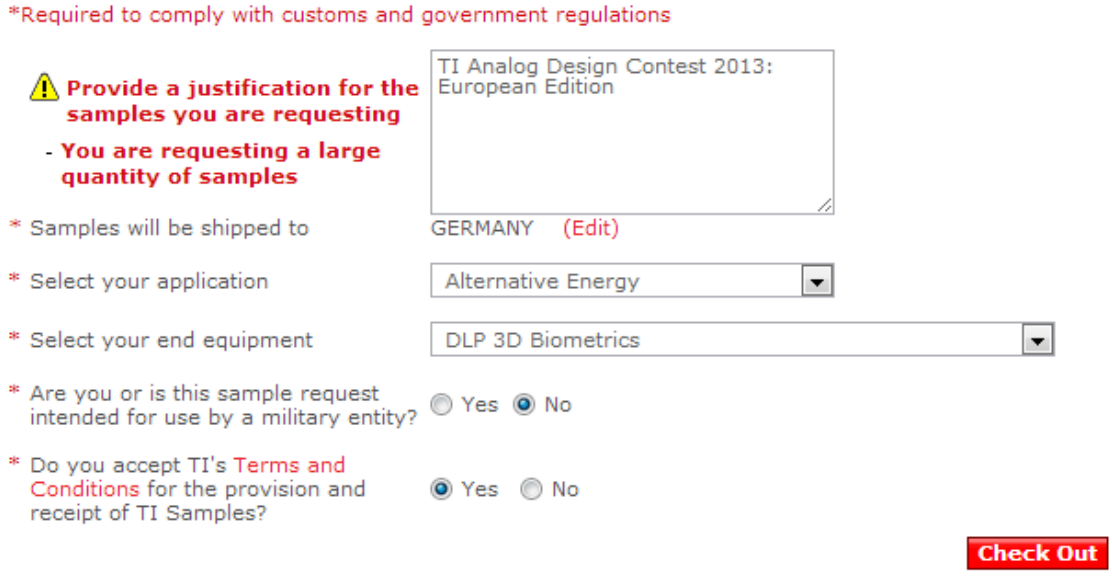
1. If your Professor is not registered on my.ti.com, they must register with a university .edu email address.
2. Find a product page on ti.com. Click Free Samples under Sample & Buy button.



3. Select a preferred device package and click Free Sample

4. You can order up to 5 units of 8 different items. Ensure that the number in QTY column is correct. Remember to click Update.

5. In the Justification field type "TI European Analog Design Contest 2013: *European Edition*".



6. Save your order number! It might be needed if you will experience any issues.

ordering tools

To order tools, please send an email to adc2013-emea@ti.com using the following template. Please take some time on choosing the right tools as each team can request tools only once. Please ensure that tools are only requested up to the value of 100 US$.

This request must be sent before the **Tool Request Deadline: 23:59 (GMT) on 30th April 2013.**

address adc2013-emea@ti.com

subject ADC 2013 >> Tool Request >> [Country], [University] >> [Team Leader Name]

body

Team Leader:
[Team leader name]
[Address: street name]
[Address: postal code, city]
[Country]

University:
[Full University name in English]

Project name:
[Your team's project name]

Tools:

- [Quantity]x [Product Number] [Product site] [Cost]
  Ex:
- 1x EZ430-CHRONOS http://www.ti.com/tool/ez430-chronos 49$
- 1x ADS1256EVM http://www.ti.com/tool/ads1256evm 49$

Notes:

- No PO Box Addresses will be accepted.
- Do not order samples this way.
- Copy-paste the preceding template into your email to adc2013-emea@ti.com.

http://www.ti.com/tool/ ← This is a valid tool page.
http://www.ti.com/product/ ← This is not a valid tool page. Requests from such pages will be rejected.

non-EU participants

import charges?

TI ships tools from its European (EU) warehouse. This means that for non-EU participants, shipments of tools could be subject to local import duties (such as VAT) and customs clearance charges on arrival in your country. These charges are your responsibility. **They will not be paid by TI under any circumstances!**

what can you do to avoid import charges?

In order to try to avoid such charges we recommend the following:

- Use your professor and your University as the shipping address, rather than your home or lodging address.
- Purchasing the tools you need from a Local Distributor in your country may be easier for some items and avoids all import charges (We do not give teams cash. You will have to pay for the tools yourself).

help

1. We encourage you to have a discussion with your professor.
2. TI E2E™ community e2e.ti.com

report

You can use software of your choice in order to write your report but your report **must** be submitted in PDF format. Many word processors have an ability to create PDF files. An alternative way to create a PDF file is to use a virtual printer and "print" your report into PDF. Reports must be submitted to adc2013-emea@ti.com before the **Report Submission Deadline: 23:59 (GMT) on 31st July 2013.**

We recommend following structure:

1. Title page
2. Introduction
3. Motivation for project
4. Theoretical background
5. Implementation
6. Experimental results
7. Conclusions
8. Summary
9. Future plans
10. Bill of materials

technical requirements

Please remember that projects that do not meet the requirements may be disqualified.

- Total 10 pages maximum (plus 1 page extra, only for complete bill of materials).
- Font size must be equal to or greater than 12pt (except for the abstract where the minimum is 10pt.)
- Language: English
- Page size: A4 (ISO 216)
- Margins: Top, Bottom, Left and Right: 1" (Normal)
- File format: PDF
- Must include:
    - Detailed written description of the design and a specific description of how each Texas Instruments analog IC or processor benefited the overall design.
    - Clear block diagram of device
    - List of **all** components used in your project (part manufacturer, part number and quantity)
- File must be under 10 MB of size

Your project should follow typical guidelines for technical paper: clear & simple technical language, schematics & plots should be properly marked. Remember that visual appearance is important.

title page

The title page **must** include:

- Team leader name and email address
- Project title
- Assistant Professor name and email address
- Team member names and email addresses
- University name and Country
- Project abstract under 250 words (cannot be located even partially beyond title page)
- Part number with quantity and embedded link to product page at www.ti.com
- Date of submission
- Picture of the team and picture of the project

We recommend using a **template** that is available to download at www.ti.com/adc. You are free to change the layout as long as the requirements remain unaffected.

judging criteria

The Analog Design Contest involves two rounds of judging:

- **First Round:** Each design report will be judged by at least two competent TIers, who are experienced in analog and systems design. There will be twenty winning teams selected from Round 1.
- **Second Round:** The top twenty winning teams from the first round will automatically proceed to the second round of judging. These top twenty teams will compete against each other to win the "Engibous Prize For Innovation In Analog" ("Engibous Prize"). Each of these twenty design reports will be judged by a panel of three judges: two university professors and a competent non-TI industrial professional.

In both rounds, the total score that the judges give each design report will determine the winning teams. All judges for the contest are required to be fair and impartial.

Below are the judging criteria which each design report will be marked against during both rounds of the contest. Each criterion is worth a maximum of 10 points, with 10 points being exceptional, 5 points being average and 0 points being no competence.

The six judging criteria are:

- **Idea/Concept/Originality**:
  - **10 Points**: A unique idea.
  - **5 Points**: An average idea that other people have used before but new ideas have been added.
  - **0 Points**: An idea used many times in the past with well-known applications.
- **Engineering**:
  - **10 Points**: High quality of engineering displayed. A deep analysis of the methods and tools chosen. Clear analysis of the results with the best approach being used to achieve the results.
  - **5 Points**: Good engineering skills displayed with some analysis of the methods and tools chosen. The methods chosen were not the best way to achieve the desired result.
  - **0 Points**: Poor engineering skills displayed with no analysis of the methods and tools chosen. No analysis of the results provided.
- **Analog:**
  - **10 Points:** High competence and ability in the Analog field. Appropriate tools have been used in the design report. Excellent understanding of analog principles.
  - **5 Points:** Some competence in the Analog field displayed. Some use of appropriate tools. Some understanding of key analog principles.
  - **0 Points:** No ability or understanding demonstrated in the Analog field and appropriate tools were not used.
- **Benefits of chosen TI tools/devices:**
  - **10 Points:** Excellent analysis of TI tools/devices chosen and the benefits that they provide. Tools/devices chosen are the most appropriate available.
  - **5 Points:** Good analysis of TI tools/devices chosen. Tools/devices chosen are a good choice but better alternatives could have been used.
  - **0 Points:** No discussion of the benefits of TI tools/devices chosen. Poor choice of tools/devices and not suitable for application.
- **Practicality**:
  - **10 Points:** Design developed and built by the team. Design worked and successfully met the objectives set out.
  - **5 Points:** Design did not fully work. Clear analysis provided as to why the design did not work or meet the desired objectives.
  - **0 Points:** Design is not built or is built but does not work. No analysis is proved as to why the design did not work or meet the desired objectives.

- **Report Quality**:
  - **10 Points:** High quality design report that clearly conveys the chosen idea and work carried out. Relevant diagrams and illustrations are used. Design report is well structured and easy to understand.
  - **5 Points:** Average quality design report with limited structure. Some diagrams and illustrations are used.
  - **0 Points:** Low quality design report which is poorly written and structured. No diagrams or illustrations are used and design report is hard to understand.