CITCEA-UPC

Electronic Design for Power Control

www.citcea.upc.edu

Technology and Knowledge transferred from University to Industry

CITCEA-UPC

CITCEA-UPC is a centre for research and technology innovation born in 2001 inside the Technical University of Catalonia (UPC) supported by the Government of Catalonia.

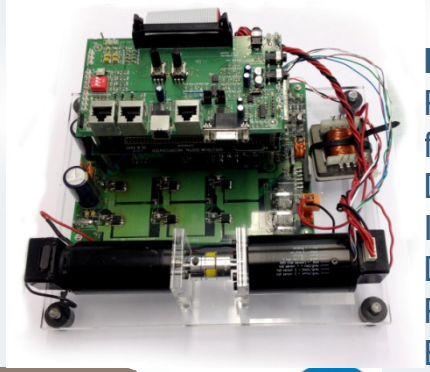
13 years' experience, 60 people, 110 customers, 200 projects, 9 M€ turnover, 10 patents, 1 spin-off (teknoCEA), more than 200 conference papers; more than 100 journal paper.

ACTIVITY FIELDS

MECHATRONICS:
Power electronics and electrical drives.
Automation, industrial ICTs.

ENERTRONICS:
Generation, transmission and distribution of electrical energy. Economics, market and regulation of electrical energy.

LIFE LONG LEARNING:
LLL Masters in Mechatronics and Enertronics. Courses and Seminars for professionals.



MECHATRONICS
Power electronics and converters, special for applications in wind and PV
Digital control with DSP
Industrial communications
Data acquisition and signal processing
Process automation and Motion control
Electric vehicles and battery chargers
Design of electrical machines

ENERTRONICS
Electrical generation from renewable and distributed generation
Wind generator design
Distribution and transmission grids
Control of wind generators and wind farms
Offshore wind farms and HVDC
Microgrids and smart grids
Condition monitoring and PQ

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teknoCEA

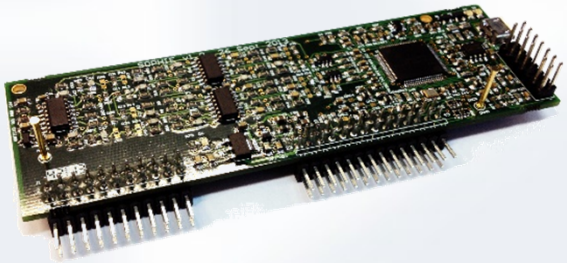
CITCEA-UPC

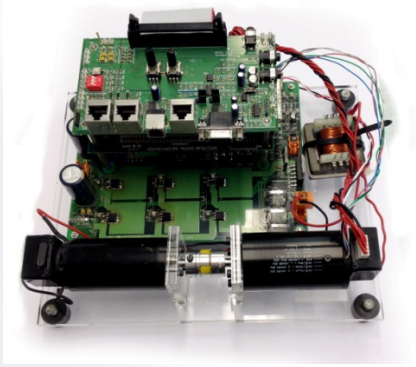
CITCEA-UPC Spin-off company

Custom power electronics systems for research labs

- Power converters from **10 kW to 120 kW**
- **Control** cards based on **TI DSP**
- PC embedded based **HMI**. Industrial **Communications**
- Application oriented **DSP starter kits**
- Educational test-benches

- Application examples:
  - **Emulators**: energy resources (Grid, PV, Wind, Diesel, Fuel-cell), storage and loads. Ready to be used.
  - Research and educational AC and DC **microgrids**
  - Battery and electrical vehicle chargers/dischargers.V2G





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www.teknocea.cat
teknocea@teknocea.cat

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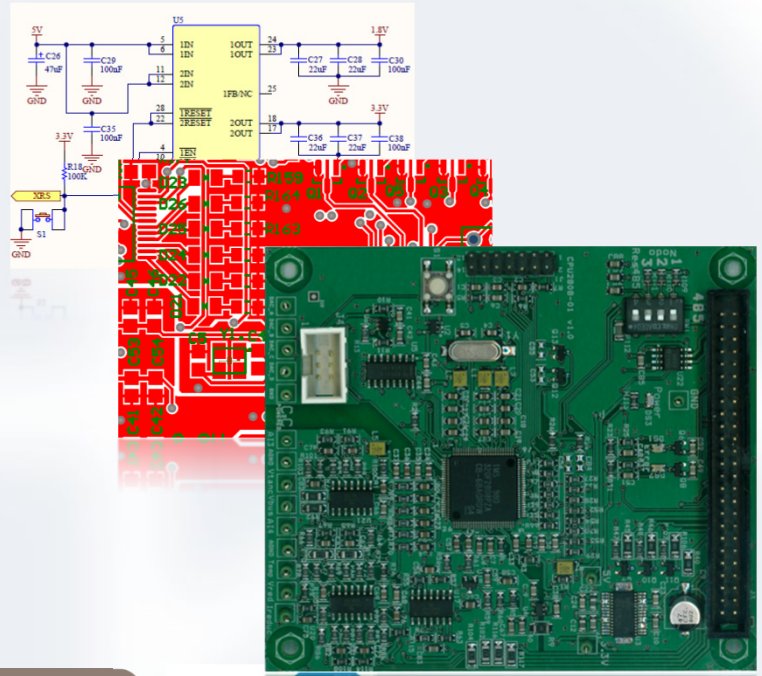
Electronic Design for Power Control

What we do:

- Design of PCB (Schematics + Layout)
- Mounting + testing of PCB (for prototypes)
- External mounting supervision (for series)
- Programming of control
- Test and validation of control



Applications:

- Power Converter control (From 100W to 1MW):
  - Motor/Generator control (Induction, PMSM, DC, Stepper)
  - Battery charger/discharger
  - PV inverter
  - UPS
  - Induction heating
  - AC-AC converter (Back-to-Back)
  - HF Isolated DC-DC converter (Dual-Active-Bridge)
  - Active filter
  - Multilevel NPC inverter
  - Plasma generation
  - Super capacitor storage
  - Fuel-cell storage
  - Emulators: PV-panel, Battery, EV, Grid, Microgrid, …
- Automation of machines with
  - Multiple motors/actuators/sensors
  - HMI
  - Communications
- Data sensing and monitoring

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Electronic Design for Power Control 2

Typical elements of our boards:

- The microcontroller
- Adapted analog inputs (unipolar/bipolar, voltage/current, …)
- HR ADC
- Adapted analog outputs.
- Adapted PWM outputs
- Adapted digital input/outputs (multiple formats)
- Adapted encoder/resolver input
- Communications:
  - RS-232, RS-485, USB
  - SCI, SPI, I2C
  - CAN
  - Ethernet
  - Wireless GPRS & 3G
  - Modbus
- Data storage:
  - EEPROM
  - Flash / SD Card
- Real Time Clock
- HMI: displays, buttons, LEDs…
- … anything the customer may need

Microcontrollers used:

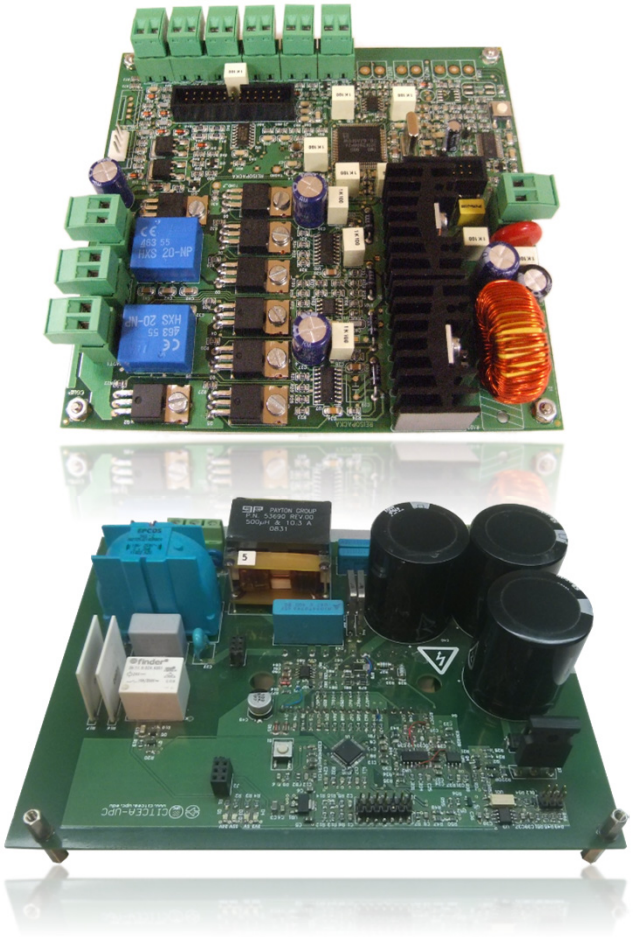
- Texas Instruments C2000 (recommended for real-time control)
  - C24xx (16bit, ≤40MHz, fix-point)
  - C280x/C281x/C282xx (32bit, ≤150MHz, fix-point)
  - C280xx Piccolo (32bit, ≤90MHz, fix/float-point)
  - C283xx Delfino (32bit, ≤300MHz, float-point, sing/doub-core)
  - C28Mxx Concerto (Dual: C28x + ARM, 32bits, ≤150MHz, float-point, Ethernet)
- Freescale:
  - HC08 (8 bit, ≤32MHz)
    ColdFire (32bit, ≤80MHz, Ethernet)
- FPGA
- Others

Electronic Design for Power Control 3

Some data:

- Over 14 years of experience designing and programming DSP/DSC boards
- Controls boards adapted to application if needed
- Control of multiple converter control with 1 DSP
  - 2x 3ph-motor inverter
  - 3ph Back-to-Back converter
  - 3x H-Bridge single phase inverter
  - PFC + battery charger
  - Dual Active Bridge converter
  - Multiple DC-motors & actuators
  - … others
- Distributed control
- Multiple converters communicated
- PWM Synchronization: optic fiber or Ethernet
- 4-leg inverter for 3ph+N grid
- NPC multi-level inverter
- JTAG emulator trough USB integrated onboard
- Mother-Boards to adapt evaluation modules to application

- Boards with control and power/sensing elements integrated
- Conversion with high-frequency isolation
- Insulation of input/outputs if needed



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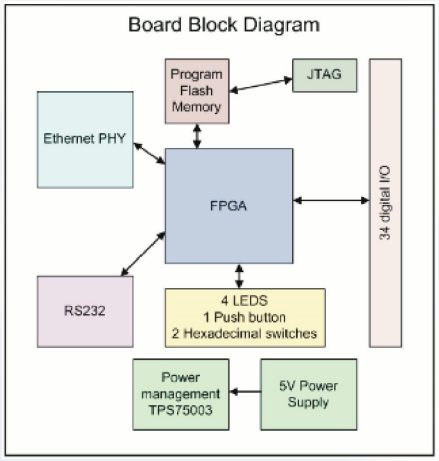
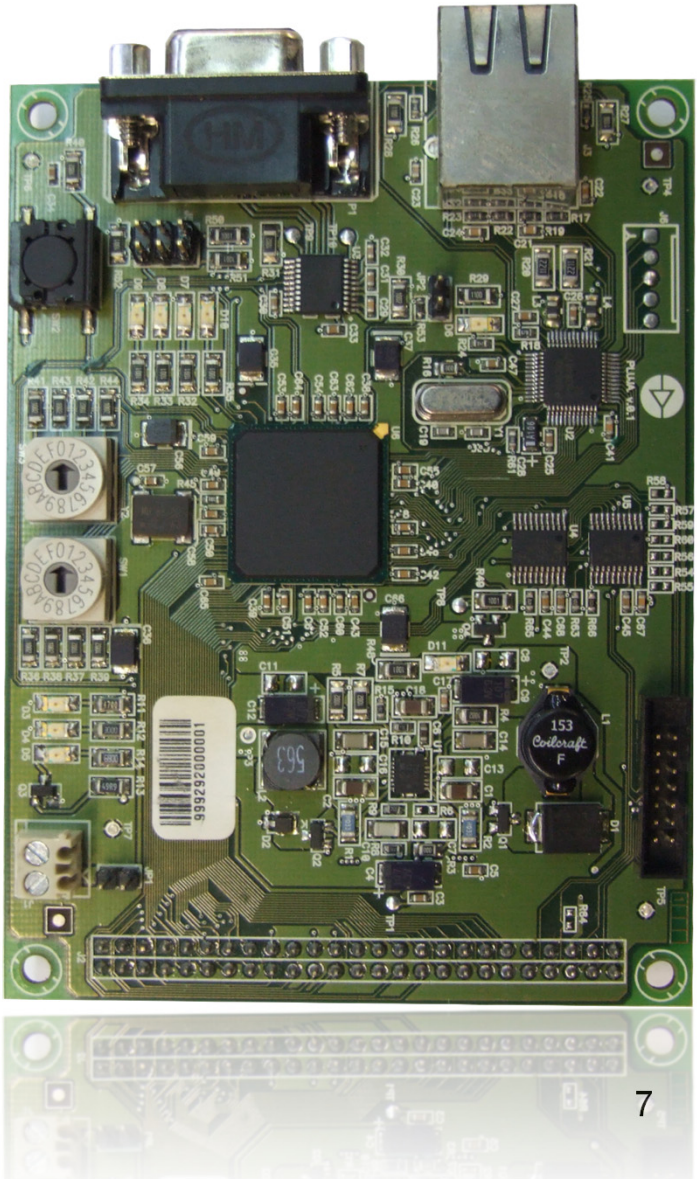
Example board 1: customer specific

FPGA based control card

- Xilinx Spartan XC3S1500 (1.5M gates)
- Ethernet
- Program Flash
- JTAG
- RS232
- 34 digital inputs
- 2 Hex-Digit Address selection inputs

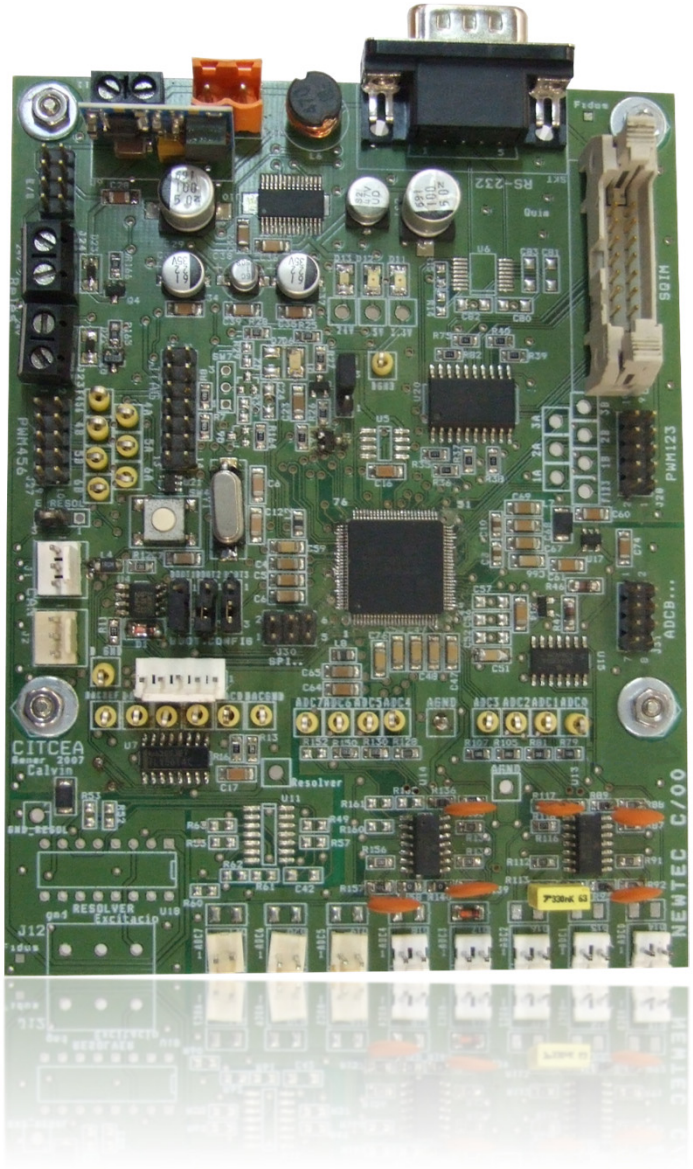




Example board 2: Calvin

General purpose control card

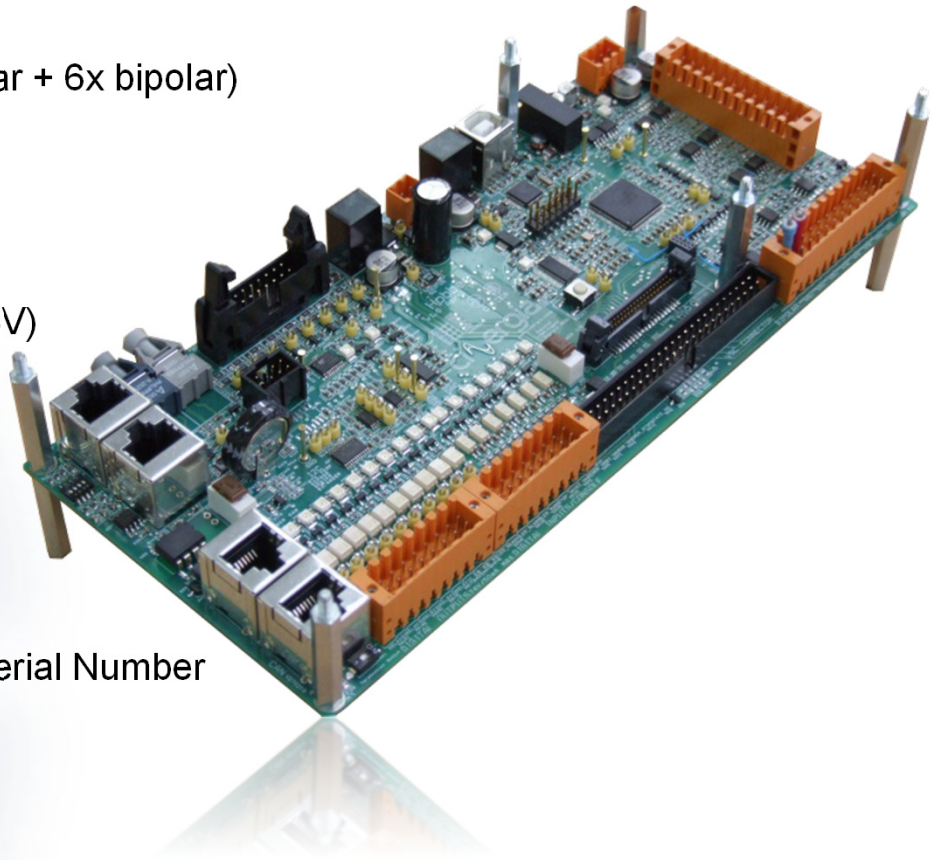
- Texas Instruments F2808 microcontroller: 100MHz, 32bit, 64k Flash, 18k RAM
- 8 analog inputs (12bit, 6.25Msps, unipolar/bipolar)
- 14 PWM outputs
- 4 analog outputs (12bit)
- Resolver excitation + lecture
- Communications:
  - CAN
  - RS-232
  - I2C
  - SCI
  - SPI
- 32k EEPROM



Example board 3: Hobbes

General purpose control card

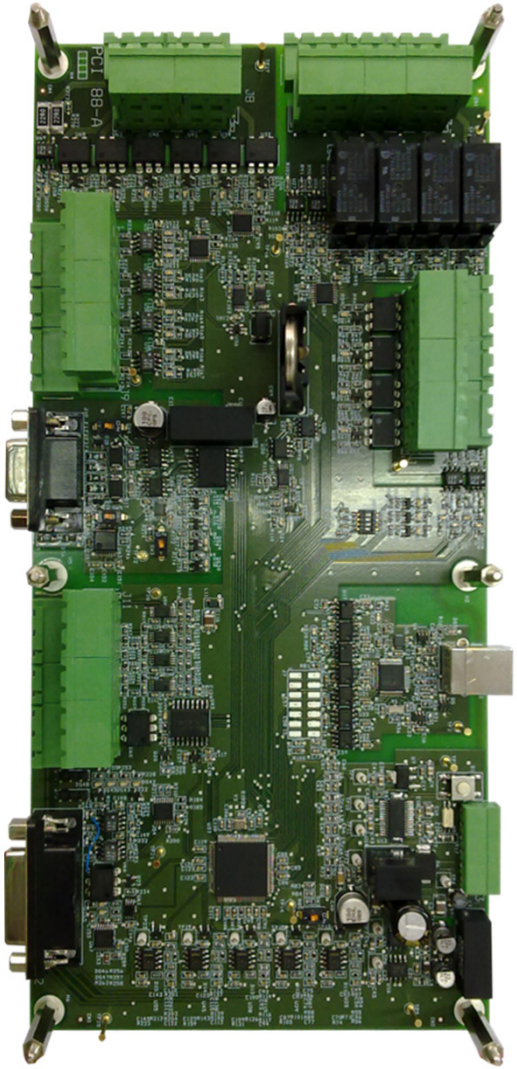
- Texas Instruments F2809 microcontroller: 100MHz, 32bit, 128k Flash, 18k RAM
- 12 analog inputs (12bit, 12.5Msps, 6x unipolar + 6x bipolar)
- 4 analog outputs (12bit)
- 8 PWM outputs + 2 Error inputs
- Optic Fiber PWM sync I/O
- 7 isolated digital inputs + 11 relay output (24V)
- Communications
  - Isolated CAN
  - RS-485
  - USB
  - SCI
  - SPI
- RTC, 32k EEPROM, Temperature sensor, Serial Number
- Encoder input
- All GPIO pins accessible directly



Example board 4: customer specific

General purpose control card

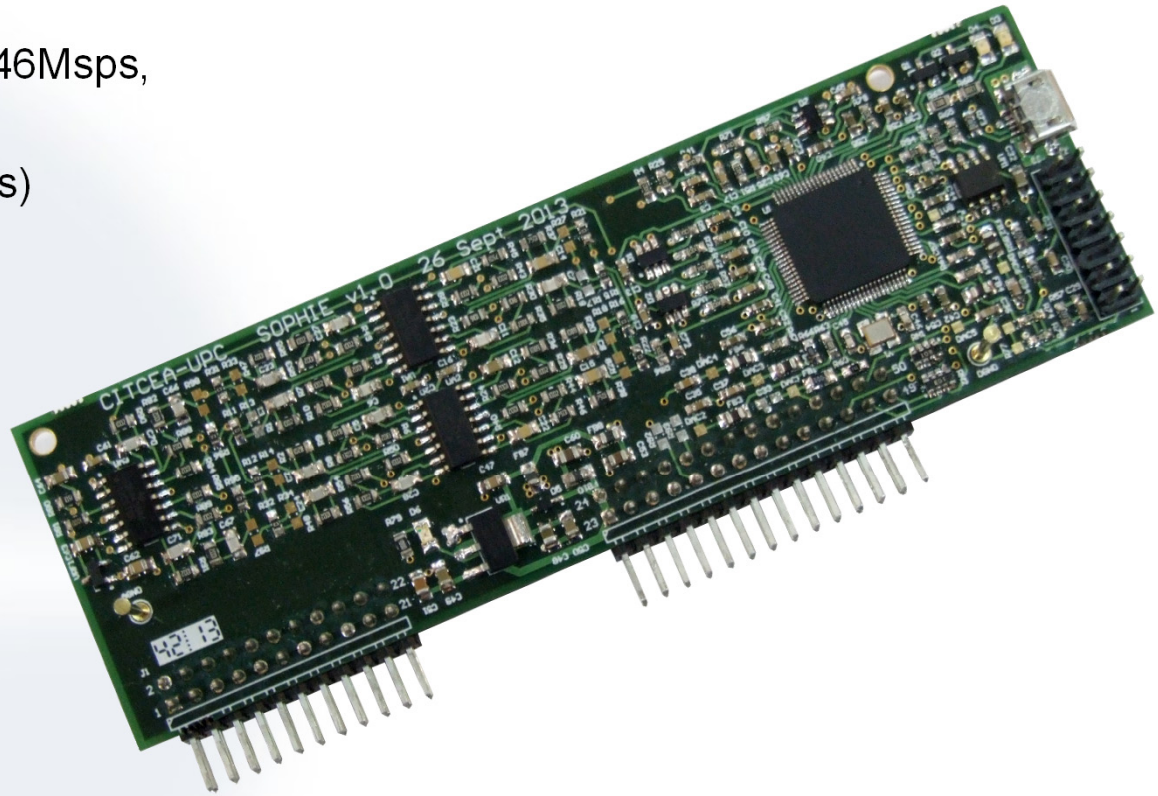
- Texas Instruments F2809 microcontroller: 100MHz, 32bit, 128k Flash, 18k RAM
- 5 analog inputs (12bit, 12.5Msps, unipolar)
- 7 analog outputs (8bit)
- 4 isolated digital inputs + 4 relay output (GPIO)
- 17 isolated digital inputs + 4 relay output + 8 digital output (trough I2C expander)
- 256k SPI SRAM + Battery + Monitor Circuit = Nonvolatile SRAM
- 256k I2C EEPROM
- RTC
- Communications
  - Isolated CAN
  - Isolated USB
  - Isolated RS-232 / RS-485
- Isolated JTAG Emulator
- Supply UVLO detection



Example board 5: Sophie

Low cost compact control card

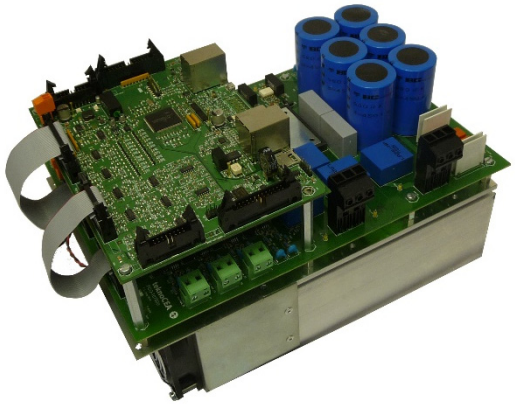
- Texas Instruments Piccolo F28069 microcontroller: 90MHz, 32bit, 256k Flash, 100k RAM, DMA, CLA
- 8 analog inputs (12bit, 3,46Msps, unipolar/bipolar)
- 7 HRPWM outputs (150ps)
- 6 analog outputs
- Communications:
  - CAN
  - I2C
  - SCI
  - SPI
  - USB
- 32k EEPROM

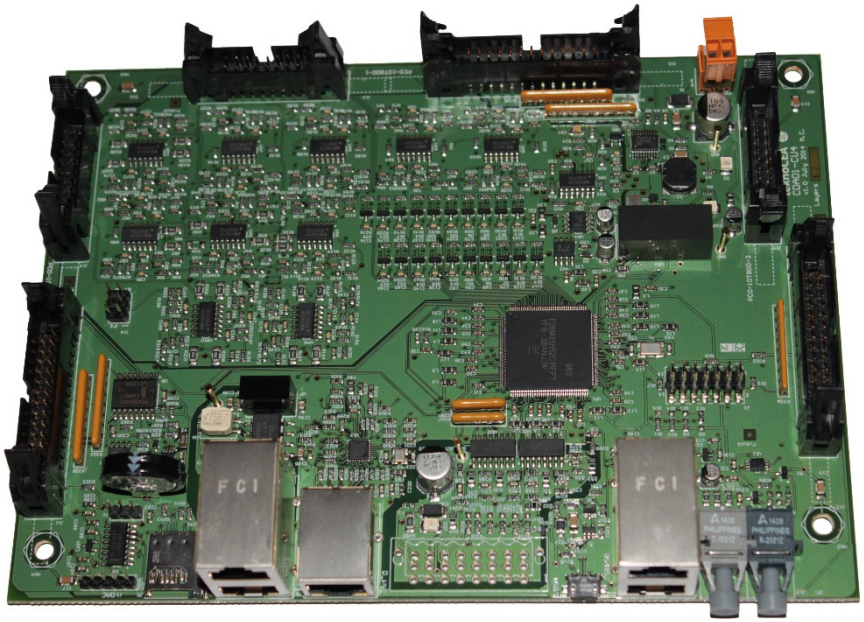


Example board 6

High performance control board

- Texas Instruments Concerto F28M35 microcontroller: 150 MHz, 32bit, 1Mb Flash, 136 kb RAM, DMA, CLA
- 20 ADC analog inputs (12 bit, unipolar/bipolar)
- 4 DAC analog outputs (12 bit)
- 14 PWM outputs. 3 error inputs. HRPWM
- Fiber optic PWM sync I/O
- 8 isolated digital inputs
- 8 isolated digital outputs
- Bridged and isolated RS-485 and CAN
- USB and Ethernet
- RTC, EEPROM and microSD

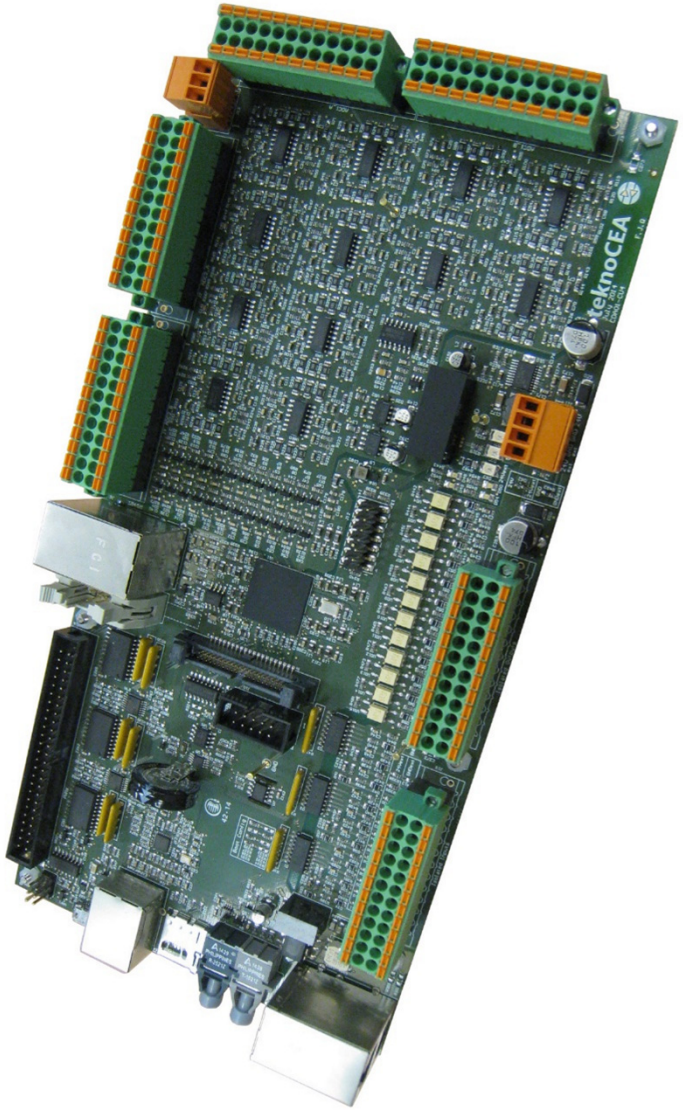




Example board 7: Gaia

Ultra-high performance control board

- Texas Instruments Concerto F28M36 microcontroller: 150 MHz, 32bit, 1Mb Flash, 136 kb RAM, DMA, CLA
- 24 ADC inputs (12 bit, unipolar/bipolar)
- 4 DAC outputs (12 bit)
- 24 PWM outputs + 12 fault inputs + 1 reset output
- Fiber optic PWM sync I/O with programmable WD
- 12 isolated digital inputs
- 12 isolated digital outputs + 4 LEDs
- Bridged and isolated CAN
- Bridged RS-485
- USB, Ethernet and microSD
- RTC, EEPROM and environment temperature sensor
- Access to external peripheral interface (EPI)



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No fun, no innovation

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