Sezione di Cagliari

Università di Cagliari

Design and test of a data acquisition system based on USB interface for the Medipix2 chip

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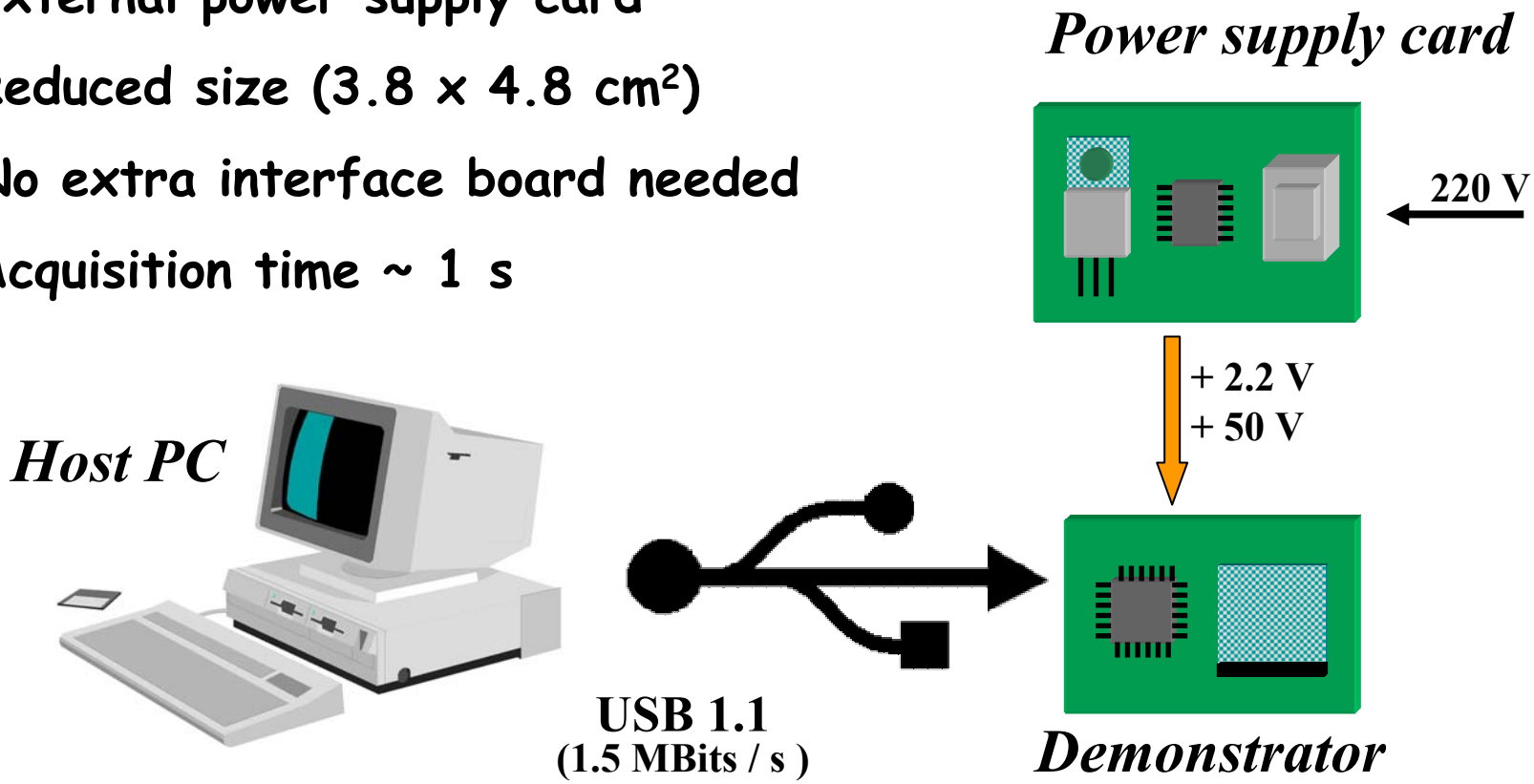
System outline

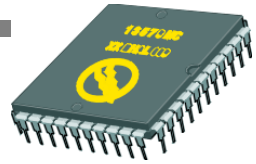
- Medipix2 serial readout port
- Universal Serial Bus v 1.1 interface
- External power supply card
- Reduced size (3.8 x 4.8 cm^2)
- No extra interface board needed
- Acquisition time ~ 1 s



General features

- Serial readout of Medipix2 chip
- Test pulse input
- Readout of Medipix2 internal DACS with an 8-bit ADC
- USB v. 1.1 low speed interface (data rate up to 1.5 Mbits/s)
- Reduced size (3.8×4.8 cm^2)

Project overview



- One Medipix2 readout chip
- One Microchip® PIC16C675-I/NP microcontroller
  - USB v. 1.1 interface (up to 1.5 Mbits/s)
  - one channel 8-bit ADC for internal DACs readout
  - Bidirectional Serial Communication Interface between PIC and Medipix2 chip
- Two LVDS driver/receiver (DATA_IN/OUT, FCLOCK_IN/OUT signals)
- One voltage ref. circuit for internal DACs reference (1.324 V)
- Three power lines: 2.2 V, 50 V (adj), 5 V (USB)

Something about USB …

1. **USB** stands for Universal Serial Bus
2. **Data rate** supported:
   - (v 1.1) 1.5 Mbit/s (low speed) - 12Mbit/s (high speed)
   - (v 2.0) 12Mbit/s (full speed) - 480Mbit/s (high speed)
3. **USB controller** is required to control bus and data transfer.
4. **Plug &Play** and **Hot-Swap** connection
5. Cable up to 5 m (4-wire cable).
6. Up to 127 devices supported.
7. Power supply to external devices is 500 mA/5V (max).

1.5 Mbit/s means a readout time equal to ~600 ms

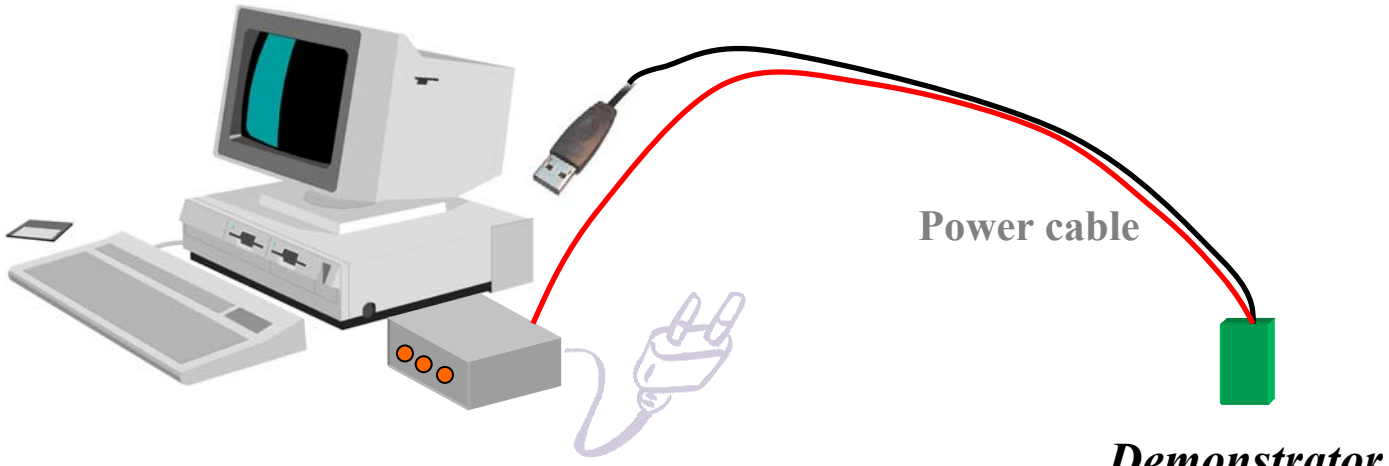
Something about PIC16C765

1. **USB Connectivity 1.1v (Low Speed)**
2. **8-bit microcontroller 24 MHz int. frequency**
3. **5 channels of 8 -bit Analog-to-Digital converters**
4. **Serial communication interface (USART)**
5. **Program memory size = 14336 bytes**
6. **RAM size = 256 bytes**
7. **CMOS One Time Programmable (OTP) ☹!**

An easy-to-use system

A personal computer

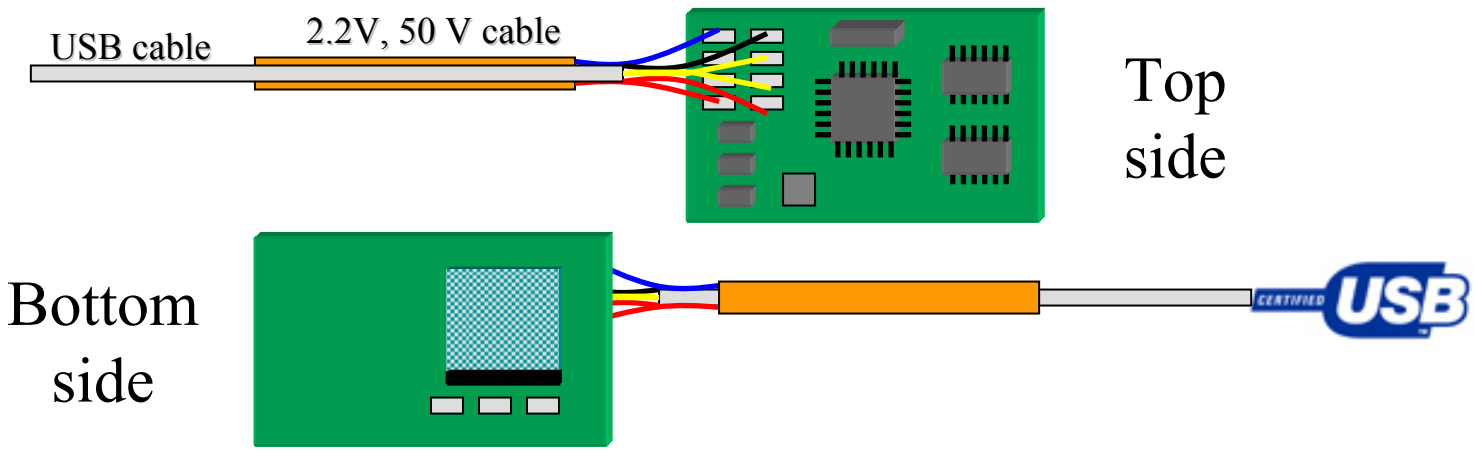
Plug & Play device – The demonstrator is auto detected from the PC like as a general HID device



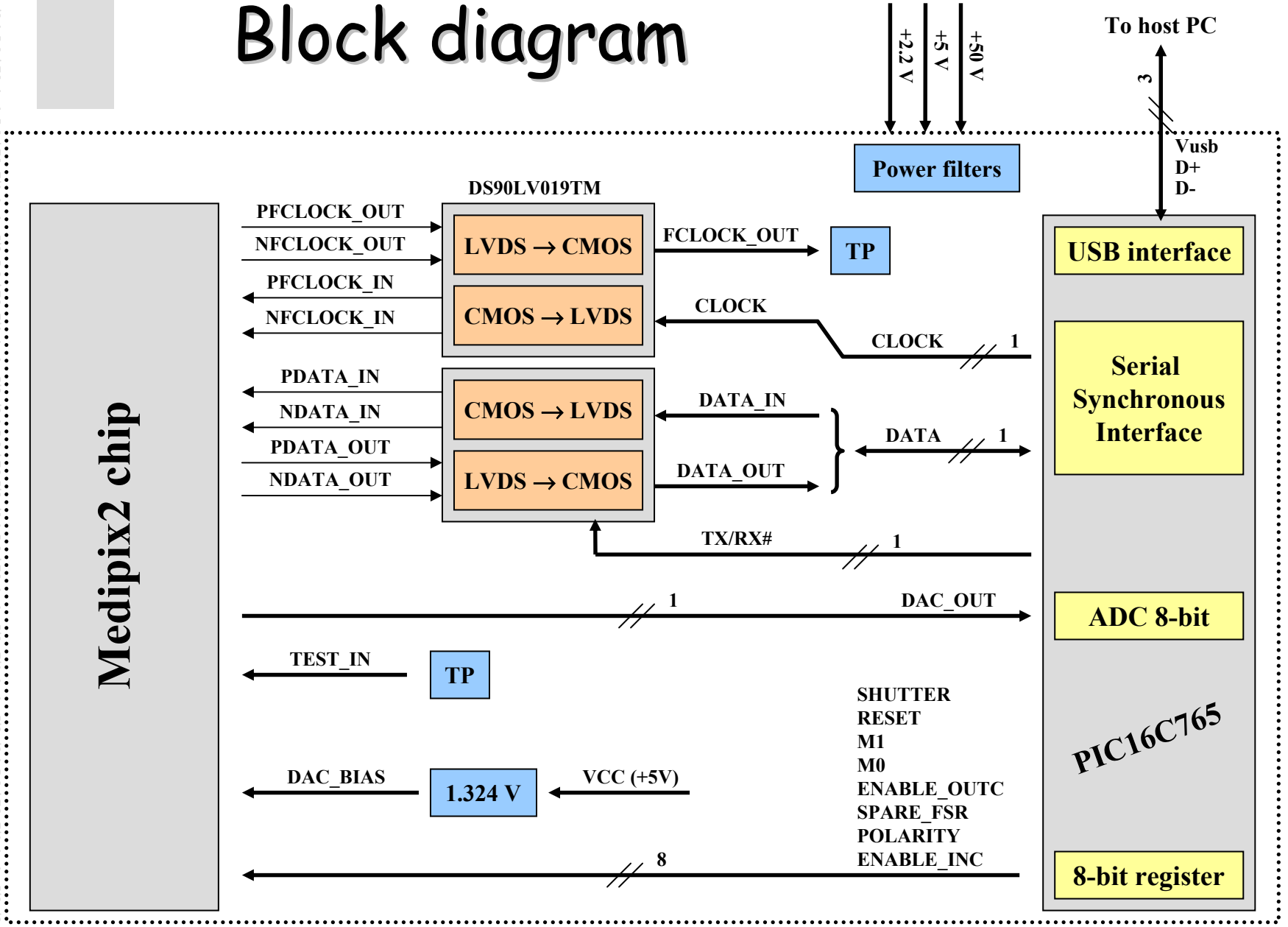
HID = Human Interface Device

Demonstrator card

- Flexible and easy connection
- Based on a single chip PIC Microcontroller
- Reduced size (dental application ?)



Block diagram

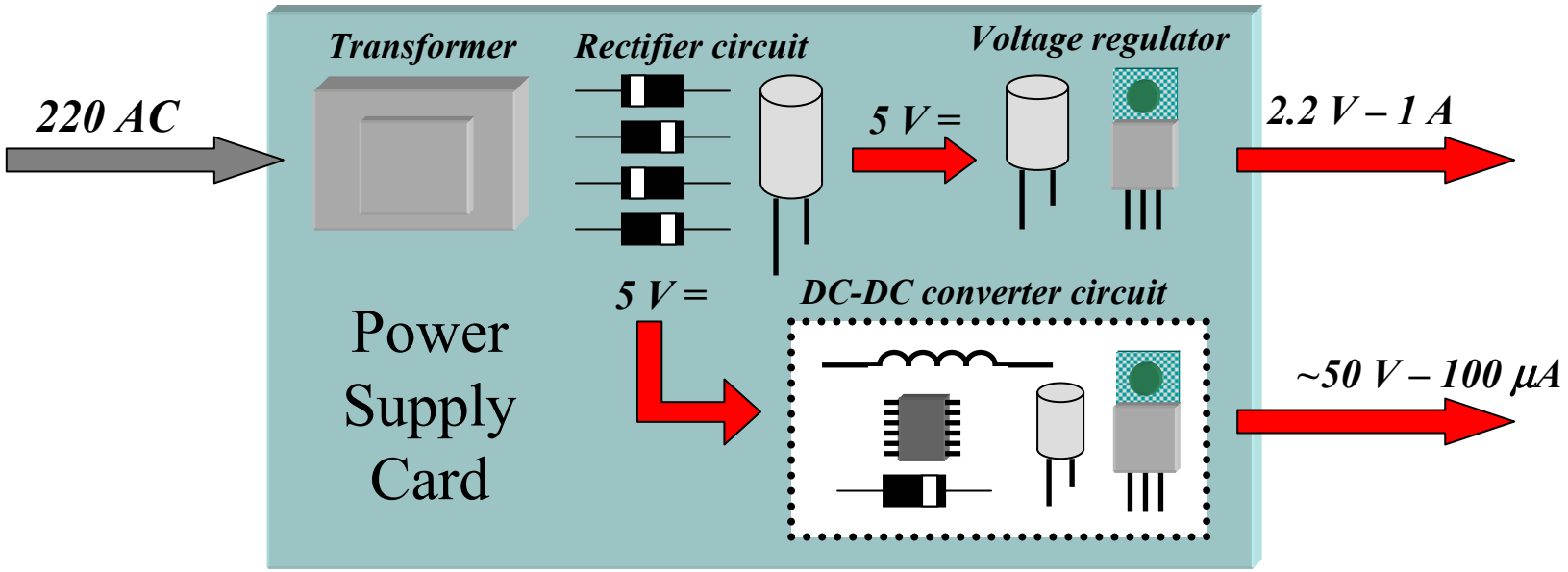


The power supply card

220 V – 50 Hz power plugged

50 V (adj.) – 100 μA output for sensor polarization

2.2 V - 1 A output for Medipix2 chip power supply



Some questions…

Why such a little card?

We think it is a good opportunity so use this project for some special applications (ex. dental radiography?)

So why USB v 1.1 ?

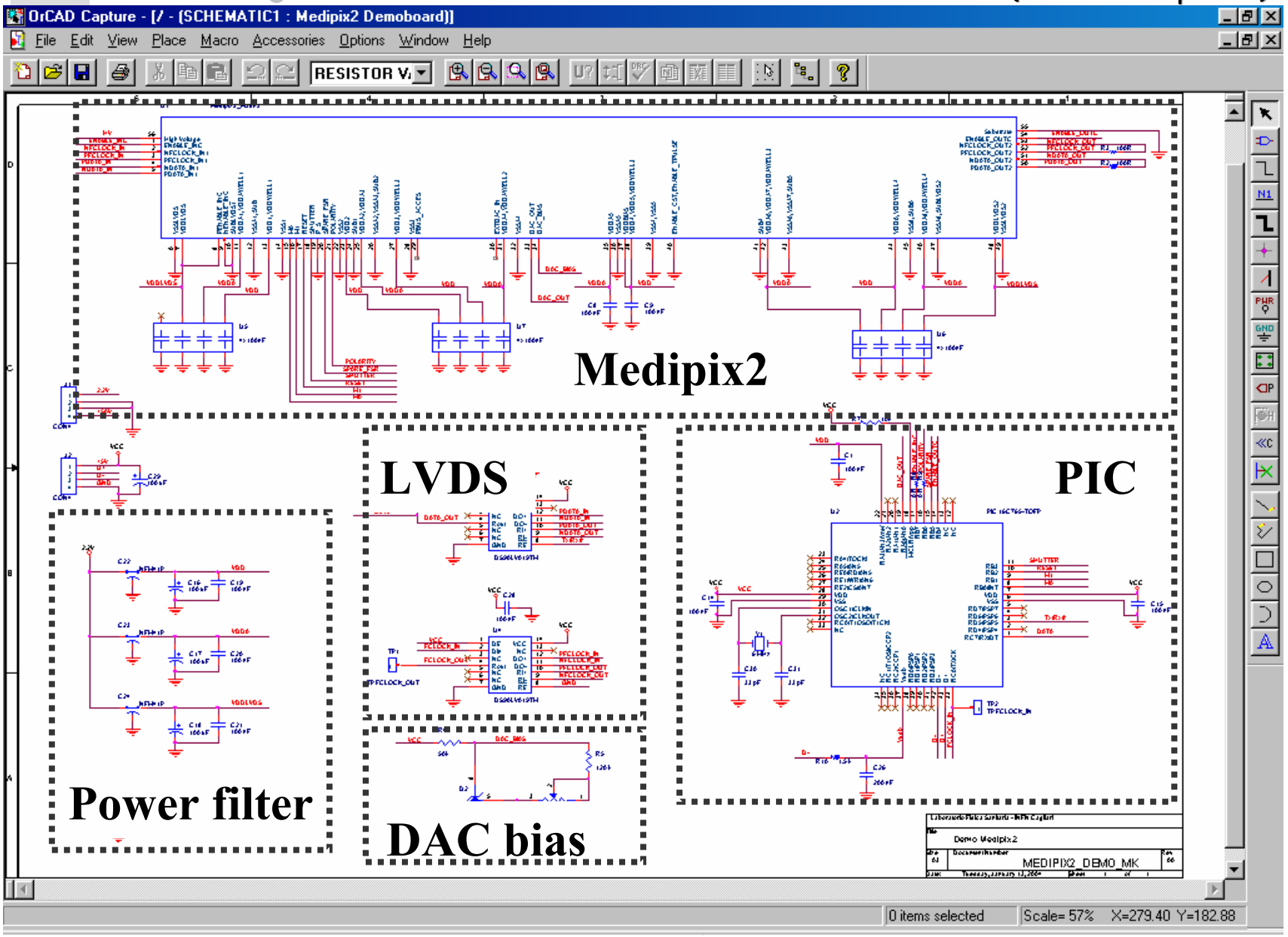
Microchip does not yet produce microcontrollers with USB 2.0 interface

Why do we need an external power supply card ?

The maximum current intensity which USB power line can supply is 500 mA.

Project schematic

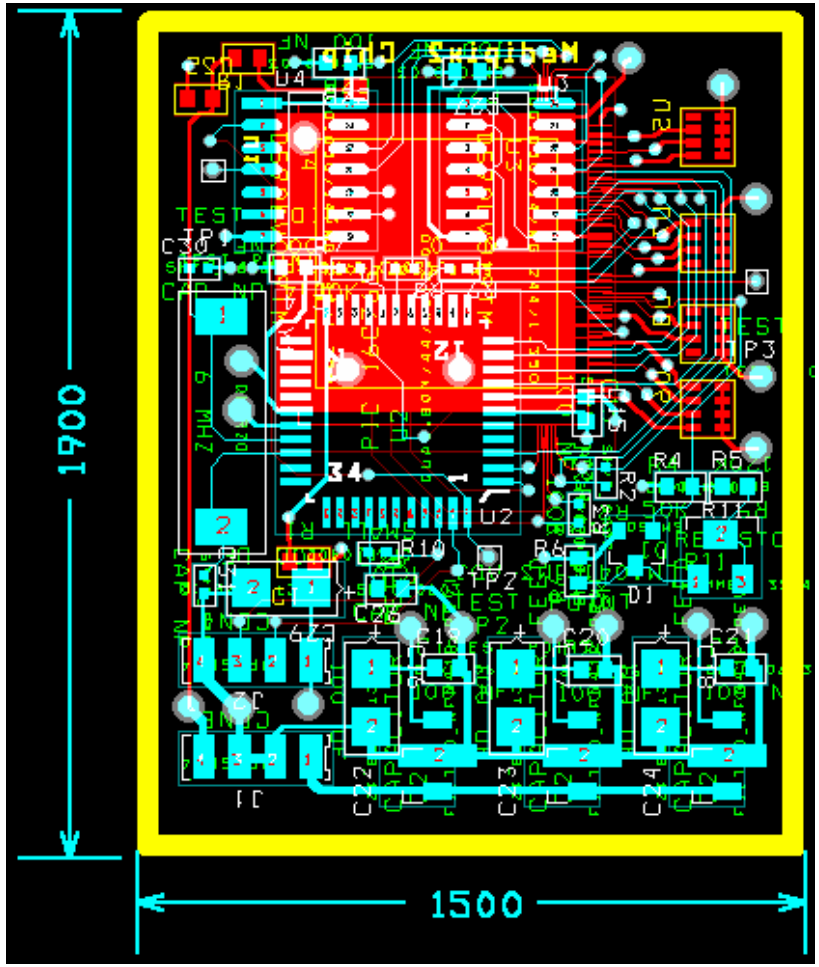
(Orcad® Capture)



Layout (1)

Eight layers board:

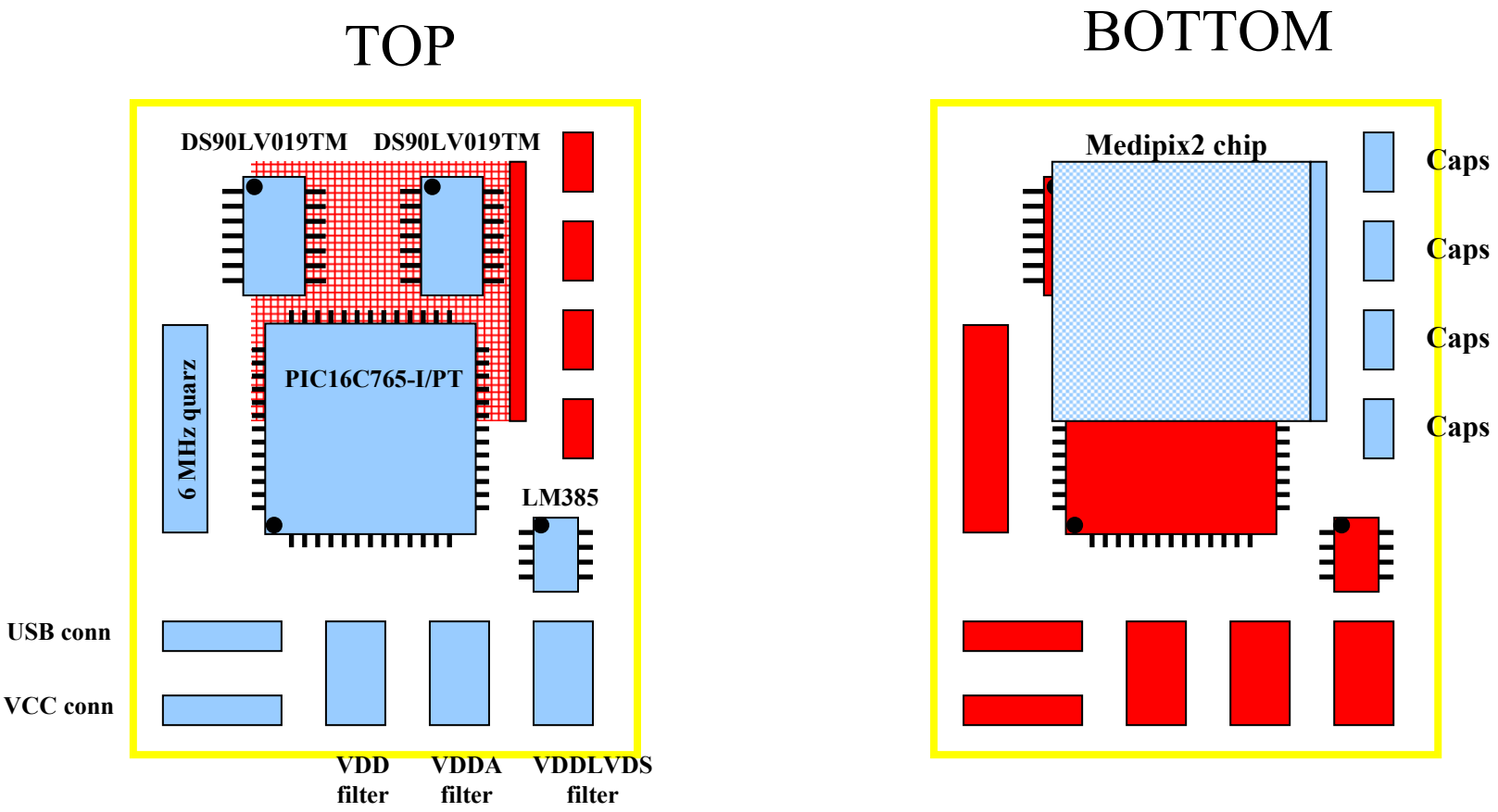
- Top layer: components
- Bottom layer: Medipix2 chip
- Inner layer 1: routing
- Plane layers VCC (5 V), GND
- Plane layers VDD, VDDA, VDDA LVDS (2.2V)



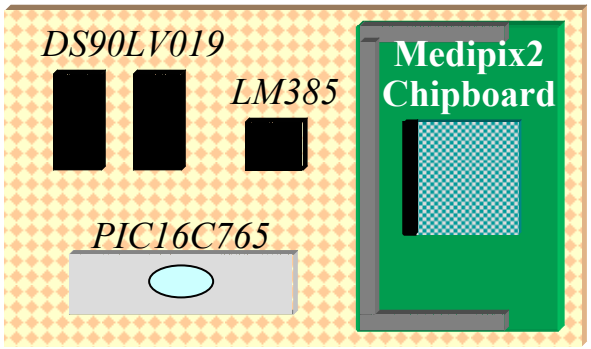
(Orcad® Layout)

Dimensions: 4.8 × 3.8 cm^2 (H × W)

Layout (2)


TOP
BOTTOM
DS90LV019TM
DS90LV019TM
PIC16C765-I/PT
6 MHz quarz
LM385
USB conn
VCC conn
VDD filter
VDDA filter
VDDLVDS filter
Medipix2 chip
Caps
Caps
Caps
Caps

Prototype card



Prototype card layout

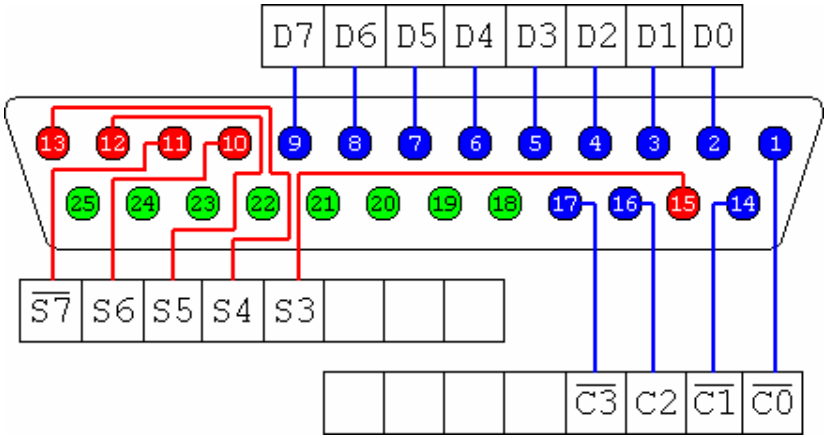
- Reproduce the demonstrator board on larger scale (15 × 20 cm^2)
- All components are mounted on a prototype board and connected by wire wrap technique
- Medipix2 chipboard with 128 pin DIL connector
- PIC16C765 with 44 DIL package (reprogrammable!)

The simplest and cheapest Medipix2 interface

We are testing another interface competitive to the USB one: the parallel port

Three software-controlled registers:

- Data register: 8 bits I/O
- Control register: 4 output bits
- Status register: 5 input bits



Interfacing Medipix2 with parallel port

Why parallel port?

- Available in all PCs

- Easy to use and to debug

- Enough I/O lines to fit requirements of Mpx2

- No other electronics needed (just three LVDS-CMOS converters)

But:

- Slow (1 – 5 s acquisition time)

- Deserialization and derandomization must be done by software

Using the parallel port registers

- Data register

Used to define the I/O operation modes

Parallel port DR	Medipix2 control lines
D0	M0
D1	M1
D2	RESET
D3	SHUTTER
D4	EN. TPULSE
D5	POLARITY
D6	SPARE FSR
D7	ENABLE_INC

- Control register

Used to send clock and serial data

Parallel port DR	Medipix2 control lines
C1	FCLOCK*
C3	DATA_IN*

*Through CMOS – LVDS converter

- Status register

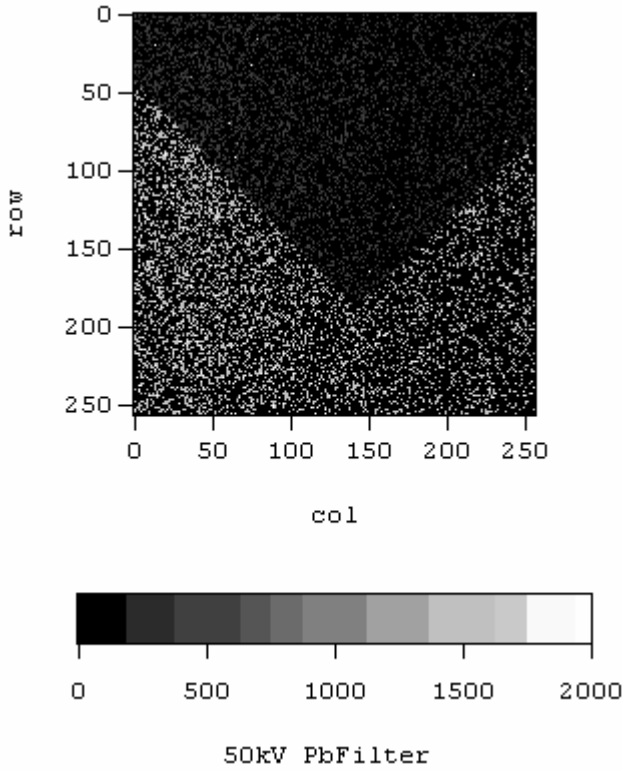
Used to read serial data and status bit

Parallel port DR	Medipix2 control lines
S3	DATA_OUT*
S4	ENABLE_OUTC

*Through LVDS – CMOS converter

In spite of its simplicity it works!

Shadow of a lead filter
(X-ray 50 kV)



Sr 90 beta source
pointing on the
upper right corner