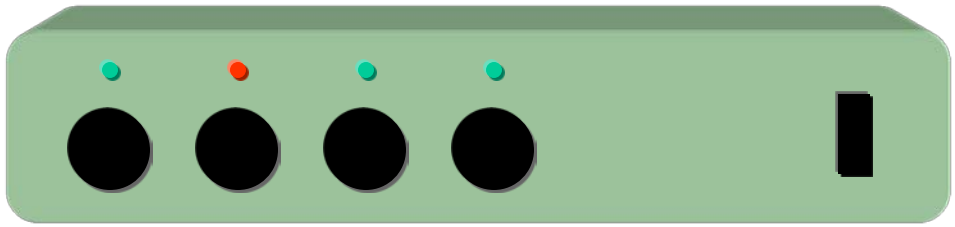
Integrated circuits for audio, by way of example

The MicBric



?

Contents

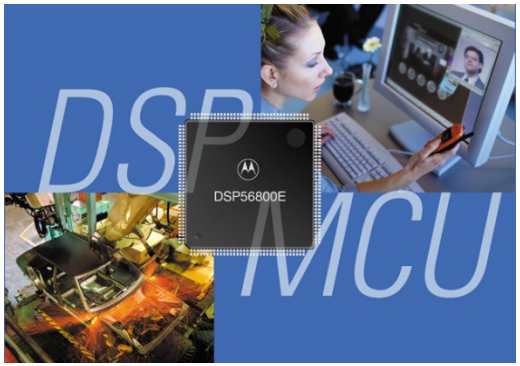
- Lecture notes (Powerpoint)
- Description of the **I²S bus**
- Promotionals and spec sheets for some audio chips

On the side, also the brochure *Audio Guide*
from Texas Instruments (1Q2012)

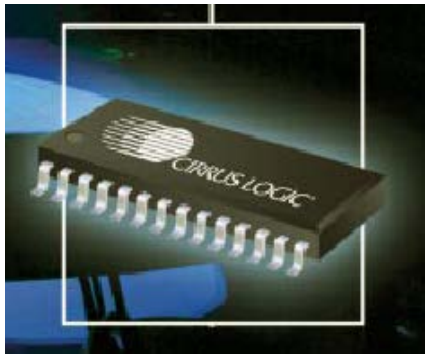
In this session

Using as an example a microphone preamp box for computers, we will show

- examples of how IC's are used as building blocks in audio devices
- the standardised I^2S serial bus that is used between audio chips
- what characterises a digital signal processor, DSP



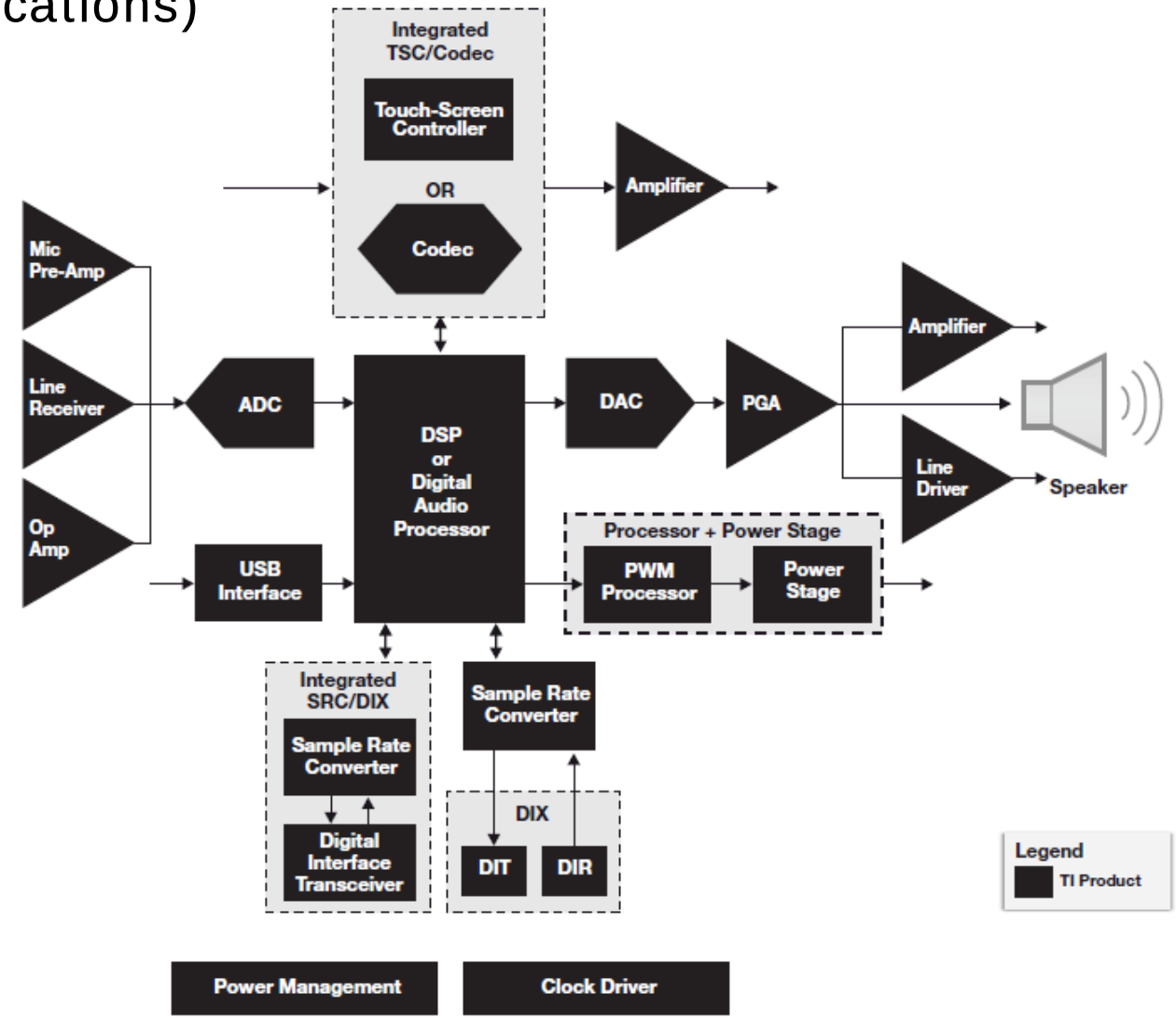
24-bits fixed point DSP (Motorola)



Stereo A/D converter (Cirrus Logic)

System block diagram

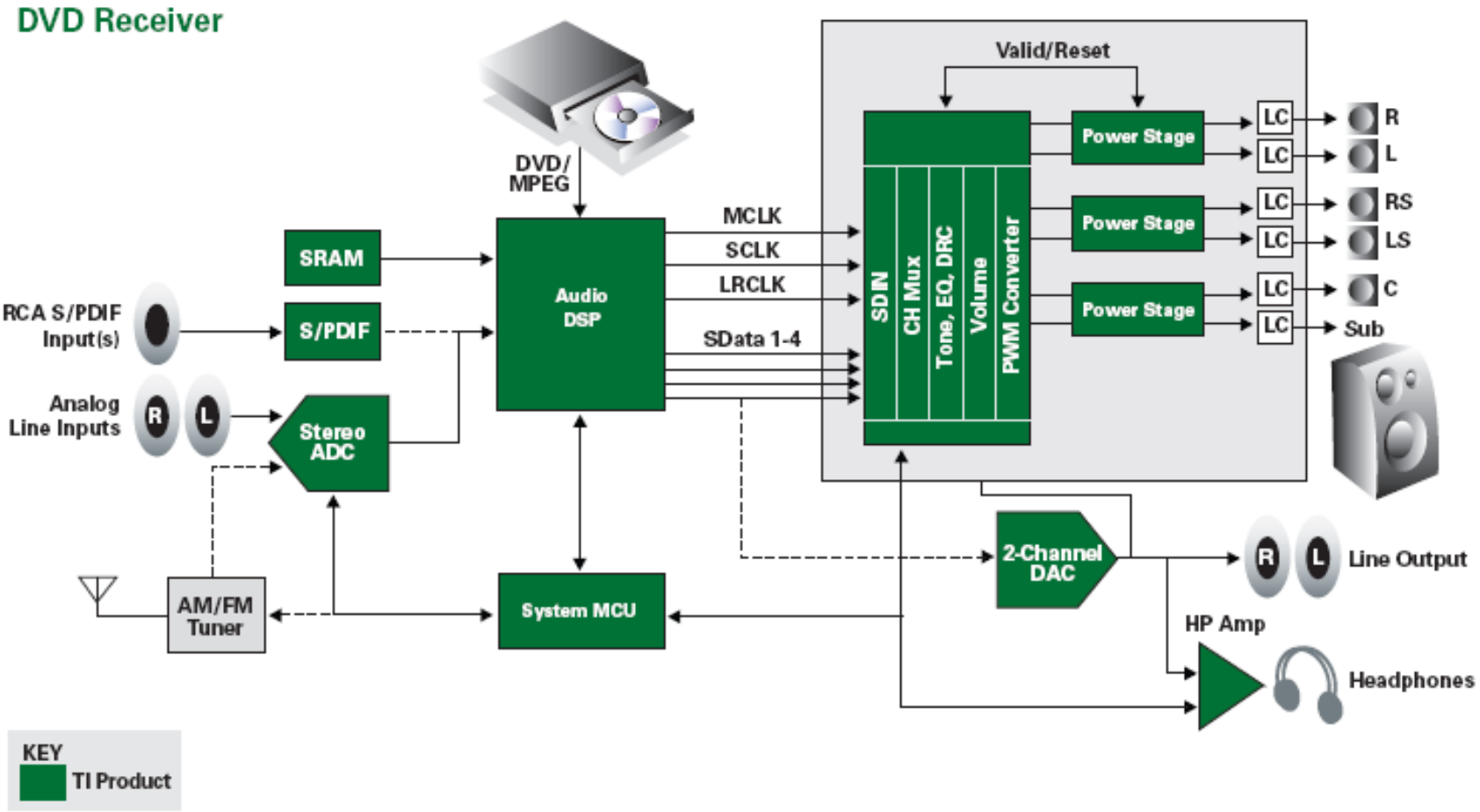
(general audio applications)



Audio systems require a wide array of analog and digital support components.

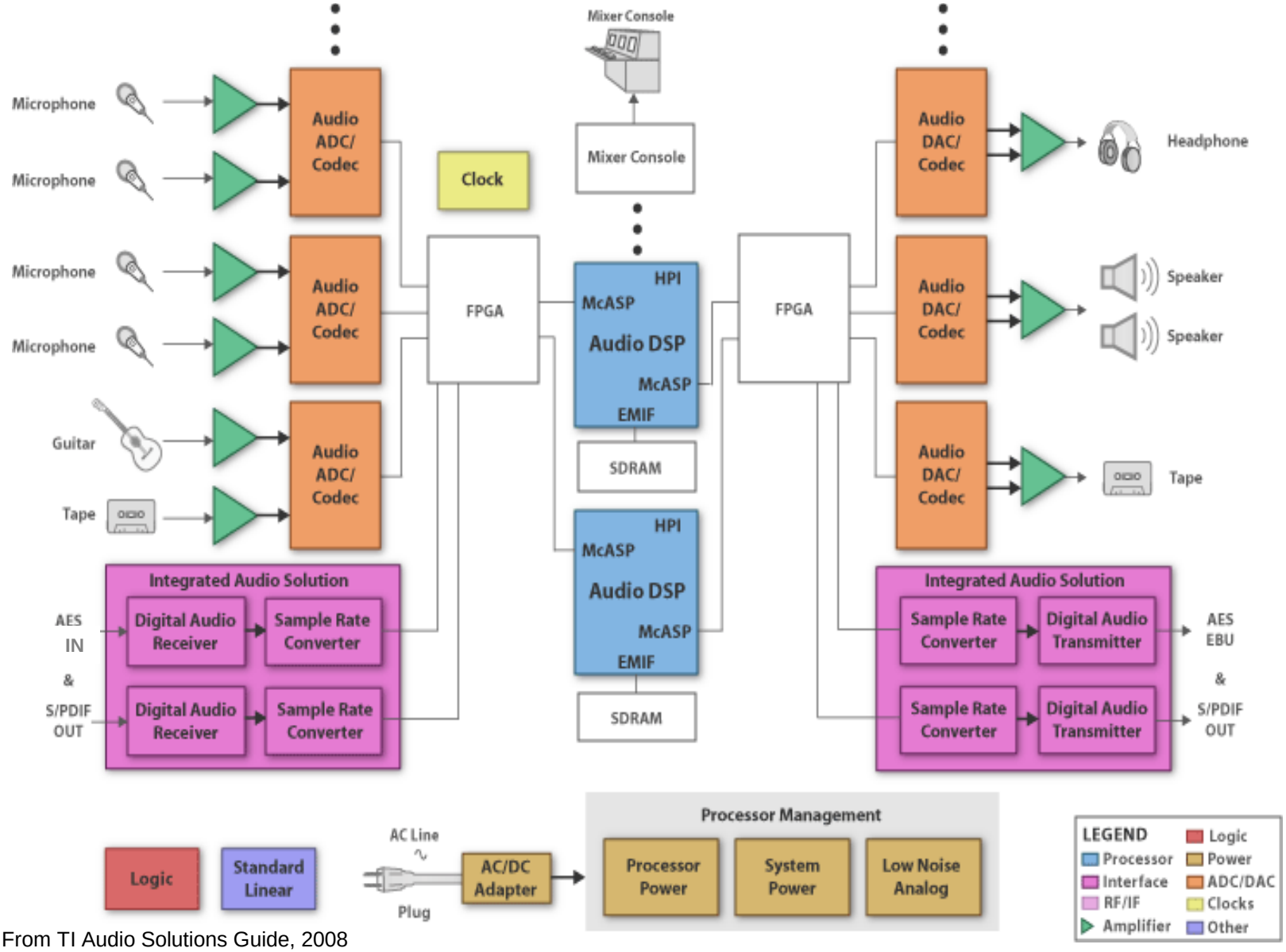
From TI Audio Solutions Guide
1Q2011

System block diagram (DVD receiver)



From TI Audio Solutions Guide, 2007

System block diagram (Pro audio mixer)



From TI Audio Solutions Guide, 2008

MicBric: Functional specification

- **direct digital recording with pro audio quality of 1-4 condenser microphones onto a portable computer**
- Gain control on all inputs, with absolute calibration
- Selection of which microphones are active
- Choice of matrixing such as direct, M/S, -format etc.
- Select phantom power on/off
- Simple usage with little possibility of error
- Robust and compact design
- If possible, powered by the computer

Technology choices

- Standard connection to the computer:
  S/P-DIF, USB, Ethernet, FireWire,
  infrared, W-LAN, Bluetooth?
- Signal processing:
  in the computer, or in the MicBric?
- Programmability:
  Microcontroller, DSP, FPGA?
- Host computers:
  Win PC, Macintosh, Linux?
- Connector types? (determines the minimum dimensions)
  XLR, jack ¼", minijack 3.5 mm, RCA, other?

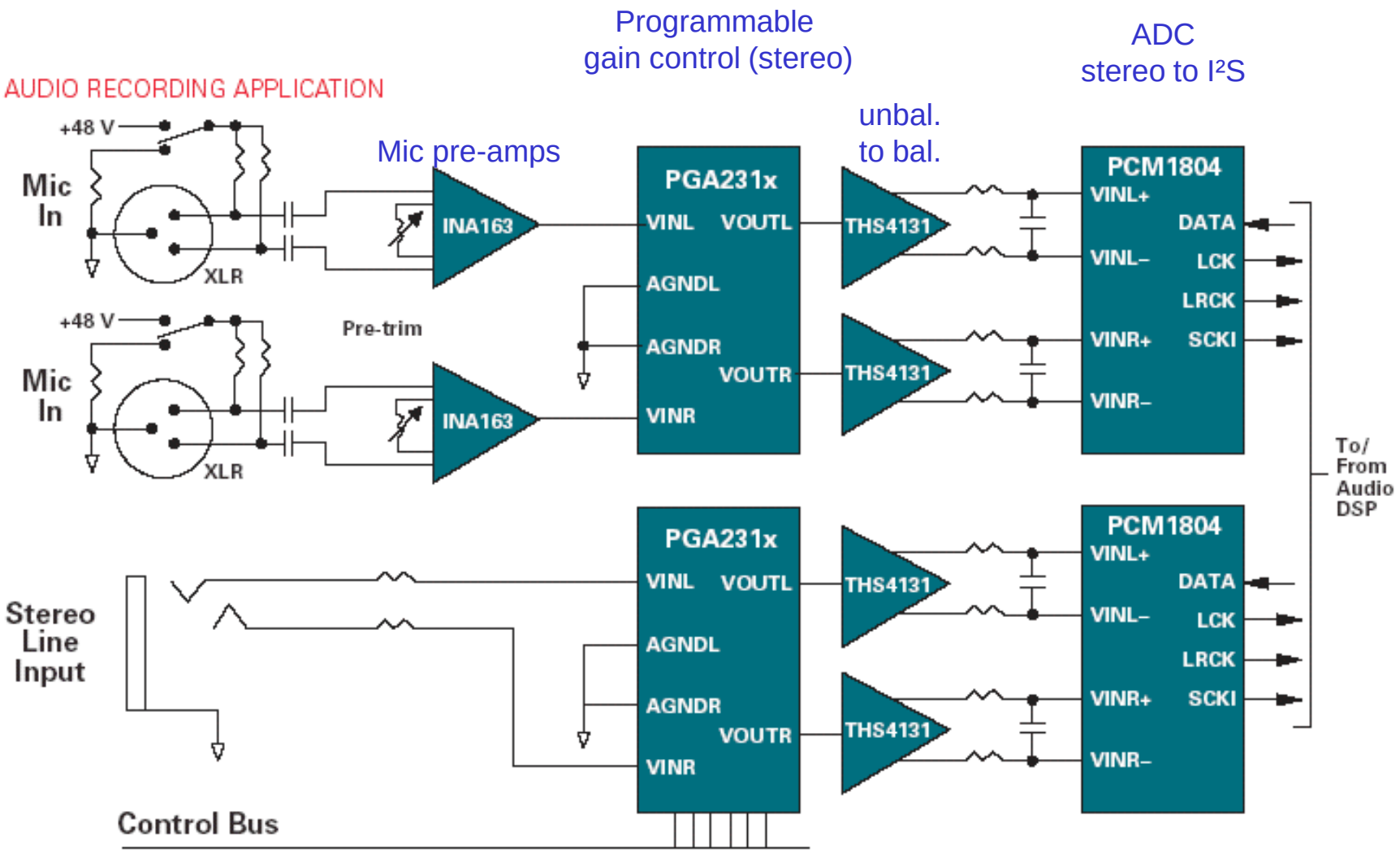
Audio specifications

- Dynamics?
- Noise level?
- Distortion?

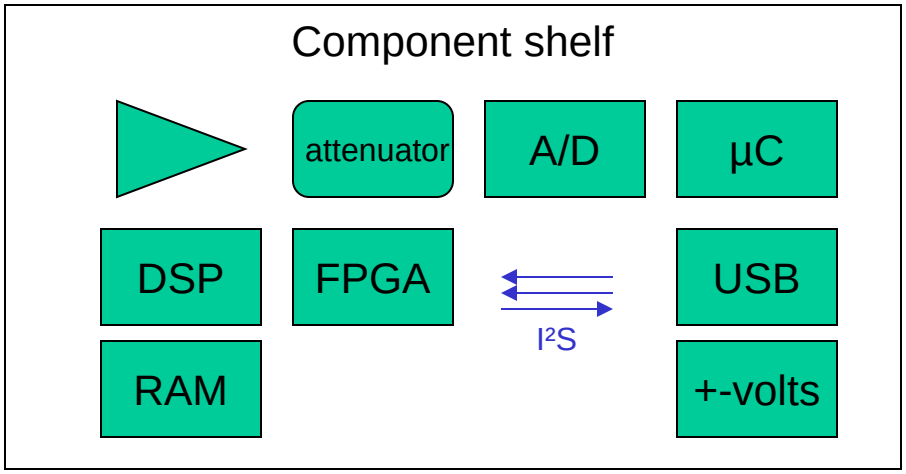
Physical specifications

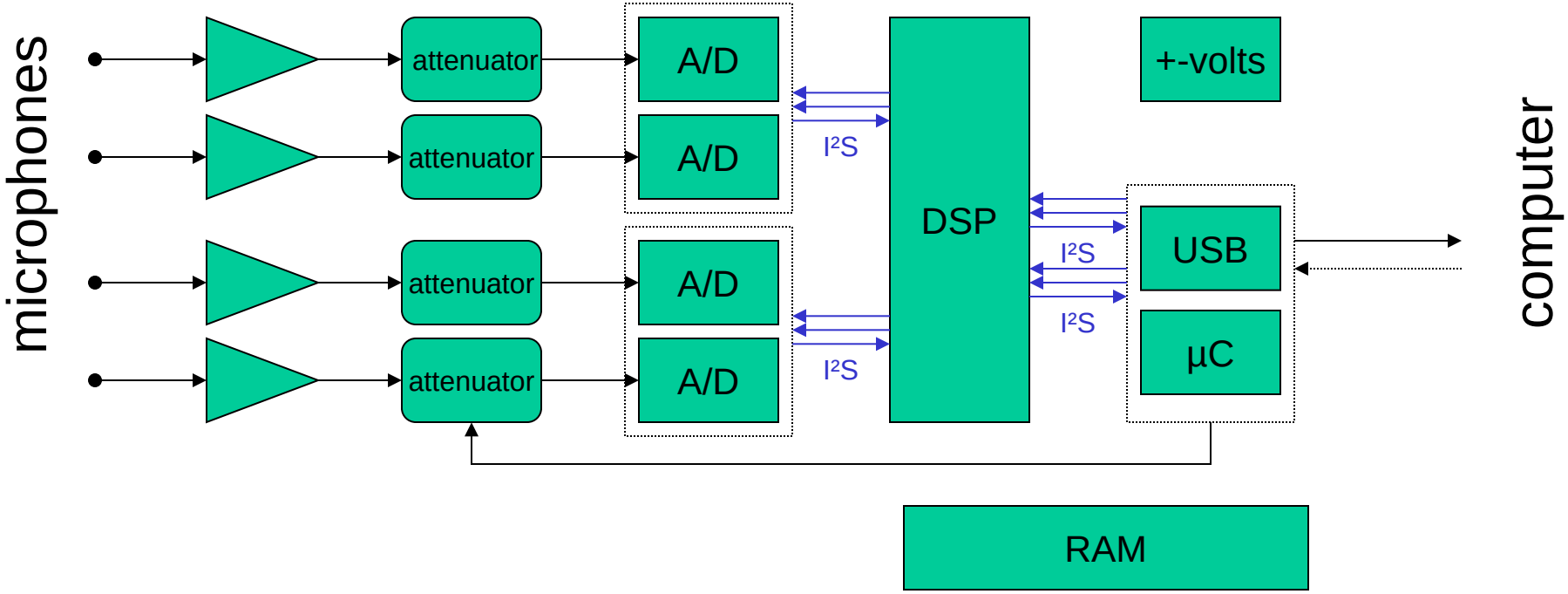
- Dimensions, weight
- Power consumption/Supply voltage
- Exterior design and mechanics

Input stage using examples from TI



Block diagram





Price examples, IC's

Motorola		
DSP56362	24-bit integer DSP	$10 ×1000
Analog Devices		
AD21065	32-bit floating point DSP	$12 ×1000
Burr-Brown/Texas Instruments		
PCM1804	Stereo delta-sigma 24-bit A/D converter	$4.95 ×1000
Texas Instruments		
INA163	Low-noise microphone pre-amp	$2.47 ×1000
Texas Instruments		
TUSB3200A	Streaming USB controller & 8502 MCU core	$4.21 ×1000

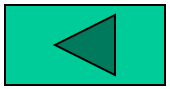
Where is the signal processed?

In the host computer

+ relatively easy to program
+ lower cost for the external hardware
- Reliability issues, OS is not a real-time OS
- Requires different versions for different OS (and ongoing software updates)

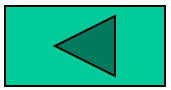
In our device

+ the function is defined in one place
+ higher total performance (the host PC is freed up)
+ less sensitive to changes in the host OS audio subsystem
- Higher outboard cost



Comm.types – pros & cons

Type	Advantages	Disadvantages
S/P-DIF (eller AES/EBU)	Can connect directly to other pro-audio devices	Only two channels in the consumer form ”Dumb” input or needs a control connection as well
USB 2.x	Hot-swap, self configuring standard protocol exists, guaranteed bandwidth, can supply modest power	Limited range, 10 m
Ethernet	Widespread technology, global reach	Uncertain bandwidth, requires exclusive connection for uninterrupted service, may require a TCP/IP-stack in our device
FireWire IEEE-1394	Possibly compatible with mLAN from Yamaha. Popular with Apple & Sony computers	(Unknown to this designer)
Infrared FIR 4 Mbit/s	Wireless, simple	Power needed, line-of-sight required, PC must have fast IR in the same room, bandwidth remains questionable
BlueTooth	Wireless	Power? Bandwidth? Range < 10m
W-LAN	Like Ethernet but wireless	Power needed, uncertain bandwidth

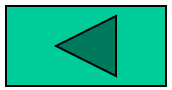


Programmability

Microcontroller, "the janitor"
A small microprocessor, 8-bit or 16-bit
Rather slow, cannot process audio on its own
Has many forms of I/O: serial and parallel ports
Can be mask programmed

DSP - digital signal processor
Can manipulate several audio signals in real time, up to 32-bit floats
Requires a special programming environment (compiler/assembler/linker)
May need an external memory
Can be mask programmed

FPGA – field programmable gate array
Tens of thousands of gates on a chip, the user configures them
Ready-made "programs" are available for many standard functions
Can be customised into a do-it-all chip including memory
Often used as "glue"



DSP – typical characteristics

A DSP is like an ordinary microprocessor, but

- Each instruction runs in one clock cycle
  → predictable execution time
- Can multiply-and-add two or three
  numerical operands in one clock cycle
- Often has several separate memory buses or memory blocks
  (e.g., program, data1, data2) to speed up memory access
- Some can change register sets very quickly (for context switch)
- Often has hardware for high-speed data exchange
- Can perform addition with or without saturation
- Does not support parallel processes in hardware (no MMU)
- Does not have speculative execution
  or other tricks/techniques that make the timing uncertain