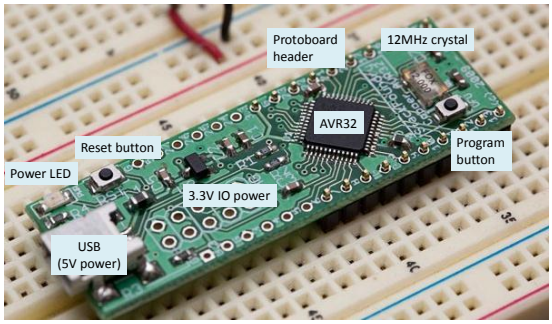
ETH Course 402-0248-00L: Electronics for Physicists II (Digital)

- **1: Setup uC tools, introduction**
- **2: Solder SMD AVR32 board**
- **3: Build application around AVR32**
- **4: Design your own PCB schematic**
- **5: Place and route your PCB**
- **6: Start logic design with FPGAs**

The AVR32 AT32UC3B1256

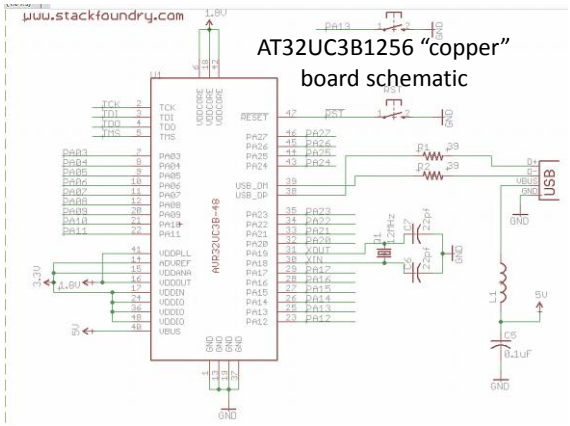
- AT = Atmel: Big microcontroller company
- 32 = 32 bit architecture
- UC3 = Atmel microcontroller family
- B = more powerful and expensive variant ($7 each @25 units)
- 1 = revision
- 256 = 256kB internal high speed flash memory (32kB single cycle SRAM)

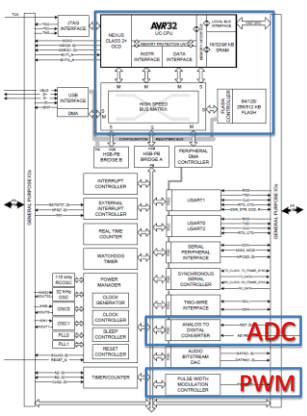
The "bronze" board



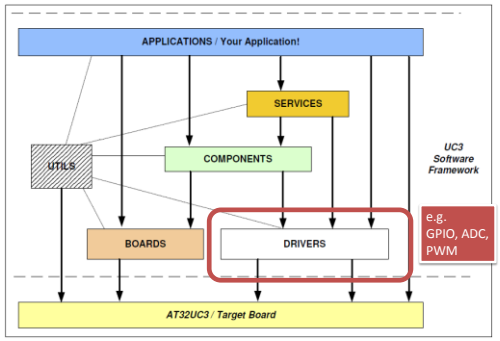
AVR32 capabilities (Ex. 3)

- **System Functions**
  - **Power and Clock Manager**
  - **Two Multipurpose Oscillators**
  - **Watchdog Timer, Real-Time Clock Timer**
- **Interrupt Controller**
  - **Auto-vectored Low Latency Interrupt Service with Programmable Priority**
- **Universal Serial Bus (USB)**
  - **Device 2.0 Full Speed (12Mbps~1MBps)**
- **One Three-Channel 16-bit Timer/Counter (TC)**
- **One 7-Channel 20-bit Pulse Width Modulation Controller (PWM)**
- **Three Universal Synchronous/Asynchronous Receiver/Transmitters (USART)**
- **One Master/Slave Serial Peripheral Interfaces (SPI) with Chip Select Signals**
- **One 8-channel 10-bit Analog-To-Digital Converter, 384ks/s**





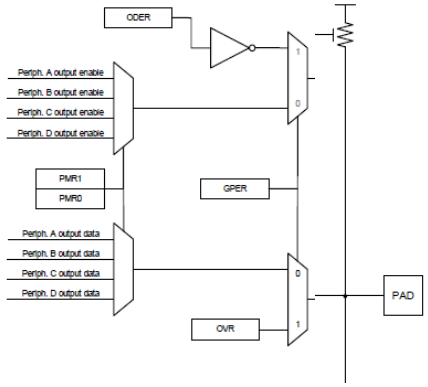
AVR32 Software Framework

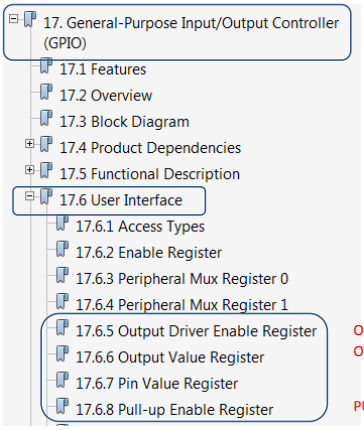


"Registers" are memory locations that control or report hardware state

- Example: the PWM registers control everything about PWM, such as period, duty cycle, etc.
- Example: The GPIO (General Purpose Input Output) registers control the pins, such as whether the pin is an *output* (digital 0 or 1) or *input* (high impedance). If the pin is an input, another register controls if a pull-up resistor is enabled.

Figure 17-2. Overview of the GPIO Pac





From the AVR32 datasheet – GPIO registers

ODER register example

17.6.5 Output Driver Enable Register

Name: ODER

Access Type: Read, Write, Set, Clear, Toggle

Offset: 0x40, 0x44, 0x48, 0x4C

Reset Value: -

31	30	29	28	27	26	25	24
P31	P30	P29	P28	P27	P26	P25	P24
23	22	21	20	19	18	17	16
P23	P22	P21	P20	P19	P18	P17	P16
15	14	13	12	11	10	9	8
P15	P14	P13	P12	P11	P10	P9	P8
7	6	5	4	3	2	1	0
P7	P6	P5	P4	P3	P2	P1	P0

- **P0-31: Output Driver Enable**
  0: The output driver is disabled for the corresponding pin.
  1: The output driver is enabled for the corresponding pin.

All register have a default reset value

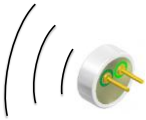
Table 17-4. Register Reset Values

Port	Register	Reset Value
0	GPER	0xFFFFFFFF
0	PMR0	0x00000000
0	PMR1	0x00000000
0	ODER	0x00000000
0	OVR	0x00000000
0	PUER	0x00000000

On reset, all output drivers are disabled

Exercise 3: "Sound volume robot"

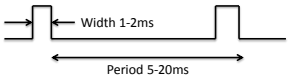
- measures sound volume and moves arm to indicate loudness
- microphone -> preamp -> ADC -> uC -> PWM output

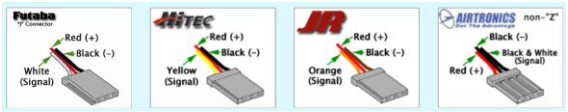



(debugging, programming)

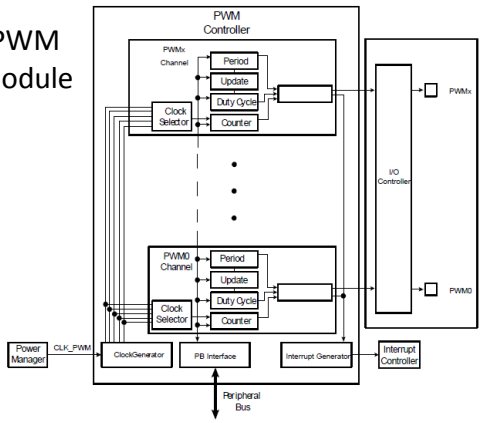
"RC" servos (Radio-Control Servo-Motors)

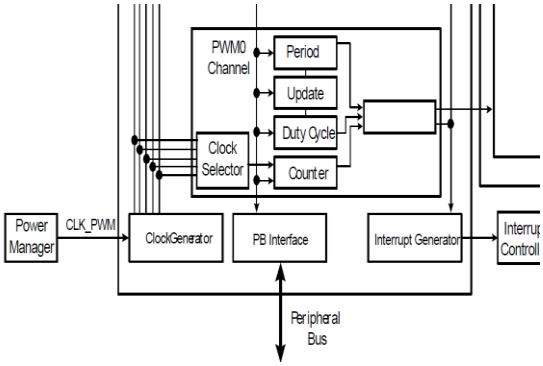
- Position controlled – Servo has internal position measurement and controller
- Rotation angle 120 degrees
- Pulse width from 1-2ms sets desired position
- Pulses must be sent at frequency 50-200Hz
- Pulse height >2V

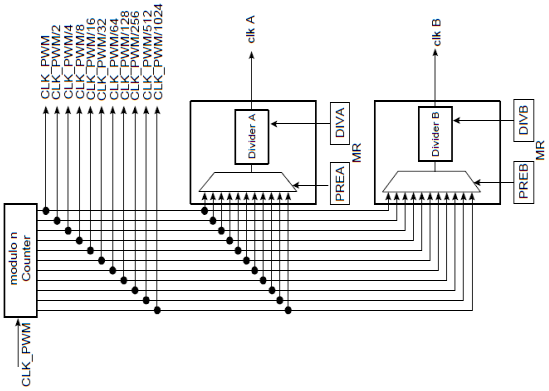


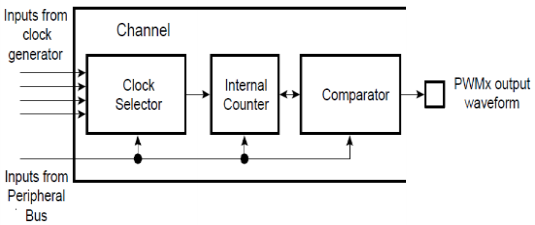


PWM module







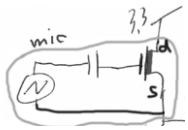


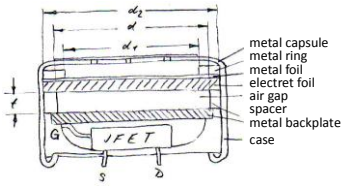
Timing registers

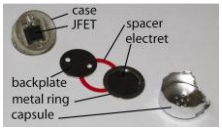
- Period – counter is reset after *cprd*
- Duty Cycle – waveform switches after *cdty*
- Update – *cprd* or *cdty* is updated from *cupd*, depending on *cpd*

Electret Microphone

- Cheap (< 1$)
- Electret material, no polarization voltage is required
- Low-noise JFET buffer
- Metal foil is connected to source of the JFET through metal capsule







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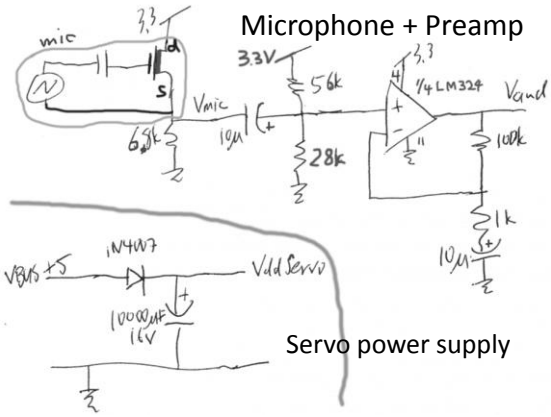
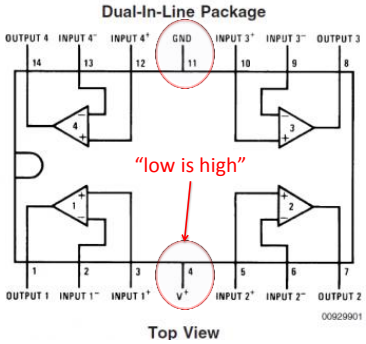
Microphone + Preamp



Servo power supply

LM324 quad JFET opamp



Top View

AVR32 Analog to Digital converter

- 10-bit Successive approximation register (SAR) type
- 6 multiplexed single-ended input channels
- Max combined sample rate 384ks/s
- External trigger
- Hardware sequencer
- Peripheral DMA