Single Chip Microcontrollers: Beyond Arduino



LET'S ROLL

- Microcontrollers are a HUGE field
- Only have <u>50 minutes</u>
- Checkout video online later
- Talk is an Intro

Hope over ½ of you <u>actually try</u> micro development on your own!

How This Thing Works...

- Highly interactive <u>Talk is for YOU</u>
- Stop for Q&A from time to time
- Videoing talk
 - Speak loud when you respond
 - Repeat your response
- Save 5-10 minutes for final Q&A
- The rumors are TRUE!
 Have hardware to give away :)
 - Reward for good answers :)



Look For Golden Border :)

Who IS This Guy?

- "Microcontroller Evangelist"
- Since late 1980s
 - Purdue BS EET Grad, 1992
 - BOY! Have things changed!



MICROS

- Many different micros, including DSP
- Different employers in different fields
 Big fan of ARM Cortex-M micros

NOT A FAN...

8051 based micros

Microchip PICs

Good prototyping options
 Consolation prizes

- 40 pin PIC18F4520s 32K Flash 40 MHz

* Your mileage may vary





What Say Ye?
Why am I here at DC4?
I can name two great reasons :)



• What Say Ye? • What is a Single Chip Microcontroller?







"A single chip microcontroller is an electronic device that contains all the essential silicon necessary to implement embedded control in a single integrated circuit." - Tharon Hall

NOTE: I consider Digital Signal Controllers (DSC) microcontrollers

- Essential Core Elements
 - CPU, Program Memory, RAM, possibly EEPROM
 - Interrupt controller, clock, power, reset and debug module

Peripherals

♦ ETC!

- General Purpose Input / Output (GPIO)
- Timers, WatchDog Timer, Real Time Clock (RTC)
- UART, USART, SPI, I²C (TWI), CAN, USB, Ethernet, etc.
- Analog-to-Digital (A/D,ADC), Digital-to-Analog (DAC), comparators
- Pulse Width Modulation (PWM)
- Timer Capture, Timer Compare
- Brown Out Detection (BOD)
- LCD segment, LCD TFT drivers
- Memory Protection Unit (MPU) <u>NOT MMU!</u>







What Say Ye?





Arduino

What is it used for?
What have you done with it?
Development environment?





- Reduced complexity for hobbyists
- Inexpensive hardware
- Large selection and availability
- Driver in the Maker Community
- Influenced mainstream vendors
- AWESOME community support

Anatomy of Arduino Uno

- 5 Volts
- USB-Serial IC
- *14 DIO (6 PWM)
- 6 Analog Inputs
- 16 MHz main crystal



- Atmel ATMEGA328 microcontroller
 - 32K Flash
 - 2K RAM
 - 1K EEPROM
 - I²C, SPI, UART/USART
- ISP / <u>debugWIRE</u> port

Arduino Uno

- "Professional Grade"
 Embedded Control Board
- Just Add Debugger...
 - Atmel AVR Dragon (\$49)
 Atmel JTAGICE3 (\$99)
 - Atmel-ICE (\$32-\$85)

...and Atmel Studio

| Cyborg_Amulet_ATtiny84 - AtmelStudio (Administrator) | | | × |
|---|--|--|------|
| File Edit View VAssistX ASF Project Build Debug Tools Window Help | | | |
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| iotn84a.h portpins.h iotn84.h io.h interrupt.h asf.h Cyborg_Amulet_ATtiny84 <mark>Cyborg_A</mark> | imulet_ATtiny64.c × Solution | Explorer 👻 | ₽× |
| • A | - 👩 🖾 🖇 | | |
| ⊡/* | + | 🚱 inttypes.h | - |
| Cyborg_Amulet_ATtiny84.c | <u>^</u> | @ io.h | |
| * Created: 5/24/2014 11:35:47 PM | | Ge introd h | |
| * Author: tharon | - | Contraction and the second sec | |
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| alaaluda daurdin ba | | (stdint.h | |
| elicible (avi/10.ii/ | | 10 stdint.h | |
| 1/ | | 🚱 version.h | |
| // Local defines | | Output Files | |
| // | | Cyborg_Amulet_ATtiny84.eep | |
| (IT /O Masks | | Cyborg_Amulet_ATtiny84.elf | |
| #define LED0 8x81 | | Cyborg_Amulet_ATtiny84.hex | |
| #define LED1 0x02 | | Cyborg_Amulet_ATtiny84.lss | 1 |
| #define LED2 0x04 | | Cyborg_Amulet_ATtiny64.map | |
| #define LED3 0x88 | | Cyborg_Amulet_ATtiny64.srec | |
| #define LED4 0x80 | | Libraries | |
| //"1" is off | | - libm | |
| #define ALL OFF (LED0 LED1 LED2 LED3 LED4) | · · · · · · · · · · · · · · · · · · · | src . | |
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| //"0" is on | | a lay common | |
| #define ALL_ON 0x00 | | a (a) boards | |
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| #define LEDB ON (ALL OFF & ~LEDB) | | h internunt | |
| #define LED1_ON (ALL_OFF & ~LED1) | * | b) interrupt.h | |
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| Error List | | * | 4 × |
| O Errors 1 0 Warnings 1 0 Messages | | | |
| Description | File | Line Column Project | |
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| | | | |
| 📸 Error List 🔳 Output 🖷 Find Results 1 | | | |
| Ready | | | |
| | | | |



| | Atmel -ICE PCBA SKU: ATATIMEL-ICE-PCBA Low-cost version of AtmeHCE. Populated PCB only. | | More Info 👂 |
|--|--|------------------|----------------|
| | \$32 | Qty 1 | Add to Cart |
| | Atmel AVR Dragon | | |
| ALC: NO | Low-cost debugger with prototyping area | | |
| and the second s | In stock | | More Info 🕥 |
| 4 | \$49 | Qty 1 | Add to Cart |
| , | Atmel -ICE Basic SKU: ATATMEL-ICE-BASIC | | |
| 20 | Basic version of Atmel-ICE containing the most commonly used cables only. | | |
| | In stock | | More Info 🕥 |
| | \$49 | Qty 1 | Add to Cart |
| | Atmel -ICE | | |
| * | SKU: ATATMEL-ICE Atmel-ICE is a powerful development tool for debugging and programming Atmel and AVR® microcontrollers with on-chip debug capability. | ARM® Cortex®-M b | ased Atmel SAM |
| | In stock | | More Info 🕥 |
| | \$85 | Qty 1 | Add to Cart |
| | Atmel JTAGICE3 | | |
| 100 | SKU: ATJTAGICE3 | | |
| 1 | Mid-range debugger | | More Info |
| | | | More mild 🕑 |
| | | | |

News Flash – Arduino Zero

- Due out any day now
- * ARM Cortex-M0+ (SAM)
 - 3.3 Volt
 - 256K Flash, 32K RAM
 - 48 MHz, USB (Host)
- Built In Debugger (EDBG)
- Just add Atmel Studio

"Very affordable"





S4A - Programming the Easy Way

- http://s4a.cat/
- Beginner friendly
- Spanish Material
- H4C Hackerspace?





About S4A

S4A is a <u>Scratch</u> modification that allows for simple programming of the <u>Arduino</u> open source hardware platform. It provides new blocks for managing sensors and actuators connected to <u>Arduino</u>. There is also a sensors report board similar to the PicoBoard one.

The main aim of the project is attracting people to the programming world. The goal is also to provide a high level interface to <u>Arduino</u> programmers with functionalities such as interacting with a set of boards through user events.

The interface



An S4A program to control a light-sensor Theremin, with record and playback capabilities

Donate to S4A

If you wish to help us continue developing and maintaining this project, you can always make a donation!

donate (any amount) of € - to S4A

Hardware? Child's Play!

Scratch for Arduino (S4A) is a modified version of <u>Scratch</u>, ready to interact with <u>Arduino</u> boards. It was developed in 2010 by the <u>Citilab Smalltalk</u> Team and it has been used since by many people in a lot of differents projects around the world.

Our main purpose was to provide an easy way to interact with the real world by taking advantage of the ease of use of <u>Scratch</u>.

"Quick" Q&A Break



Going "Pro"

Atmel Studio IDE Cyborg Amulet ATtiny84.4 Created: 5/24/2014 11:35:47 PM Completely FREE #include <avr/io.h> // Local defines //I/O Masks **Built on Visual Studio** #define LED0 0x01 #define LED1 0x02 #define LED2 0x04 define LED3 0x0 #define LED4 0x8 //~1~ is off //"0" is on #define ALL_ON 0x00 "Professional Grade" dividual LEDs ON #define LEDO ON (ALL OFF & ~LEDO) #define LED1 ON (ALL OFF & ~LED1) 🕽 0 Errors 📗 🔥 0 Warnings 📗 🕕 0 Messages Description I use it almost daily ist 🗖 Output 🗖 Find Result Arduino Plug-In Available

Edit View VAssistX ASF Project Build Debug Tools Window Help 🖬 🖼 👗 🖄 🚵 👘 - (** - 💭 - 🖏 🔚 🔍 🕪 🚧 Debu 수 🛛 🕨 🗛 💷 👰 🐨 🐨 Hex 📓 • 🗐 🖉 🗃 🗐 🖉 📇 👌 ATtiny84 T debugWIRE on AVR io.h iotn84.h iotnx4.h R lock.h portpins. A sfr defs.h i stdint.h Ø version.h
Ø Output Files Cyborg Amulet ATtiny84.ee Cyborg_Amulet_ATtiny84.elf Cyborg Amulet ATtiny84.hes Cyborg_Amulet_ATtiny84.lss Cyborg_Amulet_ATtiny84.map vborg Amulet ATtiny84.sre #define ALL OFF (LED0 | LED1 | LED2 | LED3 | LED4) Column Line

ve to the Arduino IDE.

to be used as an editor.

Successor to "AVR Studio" but AVR & SAM Lots of great example code for Atmel Kits

XFeatures - Beta

Nice to have features in atmel studio.

Feature Rich

| Vm | Arduino IDE for Atmel Studio 6.1 & 6.2 Arduino for Atmel Studio is a simple and fully compatible altern Source remains fully compatible allowing Arduino or Atmel Stu | | | | |
|----|---|--|--|--|--|
| - | LUFA Library | | | | |
| | LUFA, the Lightweight USB Framework for AVKS. | | | | |



Free



Created by: Arduino Team @ Visual Mici Version: 1407.10 Downloads: 78519 Rating:

Going "Pro"

Arduino Libs in Atmel Studio

http://www.engblaze.com/ tutorial-using-atmel-stu dio-6-with-arduino-proje cts/

C/C++ GCC Support

Bit "hackish"

EngBlaze

Arduino, AVR, and hardware hacks, oh my.

Arduino AVR Tutorials Books Programming Projects Prototyping

Tutorial: Using Atmel Studio 6 with Arduino projects



In our previous Atmel tutorial, we talked about how to set up the powerful AVR Studio 5 IDE to incorporate Arduino libraries and projects. As flexible as AVR Studio 5 is, it had a few issues, and Atmel has been hard at work hustling the next major version out the door. Now, rebranded as Atmel Studio 6 (no longer just for AVRs!), the new version promises to be better, faster, and easier to use. Here, we'll show you the quickest way to get up and running if you want to use Arduino code with all of the new features.

Linked From: http://playground.arduino.cc/Main/DevelopmentTools

Going REALLY Pro – Atmel Studio

• What Say Ye?

Who has used breakpoints, single stepping and watch variables?

Atmel Studio Development

- **C**/C++
- Visual Studio-like environment
- Atmel Studio Debugging
 - Watch/Change variables, I/O registers
 - Halt processor
 - Breakpoints, single stepping
 - "Trace"
 - AVR Simulator

BEWARE!

EYE SORE SLIDE ALERT!



!!RUN!!

Going REALLY Pro – Atmel Studio

| Cyborg_Amulet_ATtiny84 (Debugging) - AtmelStudio (Administrator) | | | |
|---|-------------------------------|------------------|---|
| File Edit View VAssistX ASF Project Build Debug Tools Window Help | | | |
| ! ₩ • • • 1 · · · · · · · · · · · · · · · · | Breakpoints | Alt+F9 | 월 24 回 • 41 結結 글 등 □ 월 34 월 34 8 월 34 * |
| 🗄 🗒 📴 🐺 🍋 🔓 😭 💁 🔬 🖆 📲 🔛 🍙 🕅 Start Debugging and Break | Alt+F5 Data Breakpoints | | 4 👔 Simulator 💂 |
| Disassembly iotn84a.h portpins.h iotr | Ctrl+Shift+F5 Processor View | | ✓ IO View |
| ⇒ main while → while(1) | Ctrl+Alt+F5 I/O View | | |
| PORTA = LED2_ON; Disable debugWIRE and Close | Live Watch | | Name Value |
| else 🕨 Continue | F5 Output | | ayı |
| PORTA = LEDO_ON; | 🐣 🛛 Parallel Tasks | Ctrl+Shift+D, K | ory: prog FLASH |
| Set Stimulifile | Real Parallel Stacks | Ctrl+Shift+D, S | |
| □ int main(void) | Watch | • | 9x0016 0d c0 0c c0 0b c0 0a c0 09 c0 08 , À,À,À,À,À. |
| i uint8 t loop = 0; II Break All | Ctrl+F5 🗮 Autos | Ctrl+Alt+V, A | 0x0021 c0 11 24 1t be ct e5 d2 e0 de bt A.\$Ia0ab¿ 0x0022 cd bt 65 d0 d6 ce 6c fc fc 93 df i.enpôàrïr® |
| 6J QuickWatch | Shift+F9 题 Locals | Alt+4 | 0x0037 93 00 00 cd b7 de 57 00 97 99 f0 ".DI.P=05 |
| //Set initial direction Si Step Into | F11 🗾 Immediate | Ctrl+Alt+I | 0x0042 1a 82 19 82 29 81 3a 81 29 33 31,)::)31 |
| GI Step Over | F10 Call Stack | Alt+7 | 0x004D 05 58 14 29 81 3a 81 21 51 31 41 .x0,.:./-10 0x005S 3a 83 29 83 29 81 3a 81 23 31 |
| //DDR - 0=input, 1=output | Shift+F11 Threads | Ctrl+Alt+H | 0x0063 05 a8 f3 01 97 00 97 59 f7 0f 90, C,, Y.L. |
| DDRA = 0x8F; //LED 0 - 4 Output | Ctrl+F10 Modules | Ctrl+Alt+U | 0x006E 0f 90 df 91 cf 91 08 95 8b b3 8f6'⋢' |
| T Reset | Shift+F5 Processes | Ctrl+Shift+Alt+P | 0x0079 30 19 14 8e e8 8b bb 08 95 8b b3 0.62e |
| //Run forever Percepio Trace | Memory | • | 0x008F b3 8d 38 19 f4 8b e8 8b bb 08 958.6.è.» |
| Toggle Breakpoint | F9 🐙 Disassembly | Alt+8 | 0x0049A 80 03 80 38 19 14 87 68 80 00 088.0.e.». |
| //Rapid flashes New Breakpoint | Registers | Alt+5 | 0x0080 08 95 8e e8 8b bb 08 95 8b b3 8fŽè.» |
| for (loop = 0; loop < 20; loop++ Delete All Breakpoints | Ctrl+Shift+F9 | pro | |
| //All LEDs on O Disable All Breakpoints | | pro | g 0x000c 82 38 19 74 87 60 80 00 08 95 80 28.0.a.* ■ 0x0001 b3 8d 38 19 f4 8e 88 bb b0 89 5.a. 6.ôže |
| PORTA = ALL_ON; Clear All DataTips | | pro | ng 0x00DC 8b b3 8b 38 19 f4 8d e8 8b bb 088.ô.è.». ₩0 DDRA 0x3A 0x8F |
| delay ms(25): Export DataTips | | pro | Ig 0x000E7 95 8b b3 87 38 19 f4 8b e8 8b bb8.6.è.» |
| //All LEDs off Import DataTips | | pro | $g_0 \circ x 0 \circ F = b \circ F = b \circ F \circ$ |
| PORTA = ALL_OFF; Ontions and Settings | | pro | g 0x0108 0f 2e f5 e0 df 2e f0 2d 0f 2e f6õàß.δö ▼ |
| delay ms(60); | | | |
| } | | | |
| | | | |
| for (loop = 0; loop < 30 ; loop++) | | | |
| | | | |
| cw(); | | | |
| detay_ms(150); | | | |
| | | | |
| //Slow counter-clockwise rotation | | | • • • • • • • • • • • • • • • • • • • |
| 100 % • 4 | | | IO Vi |
| Watch 1 | | ₹ ₽ × Break | points v 4 × |
| Name Value | | Type 🔺 New | • X 😣 🍯 🔍 🧕 🖏 🖏 Columns • Search: • In Column: All visible • X |
| | | uint8_t{r Nam | |
| | | | Cyborg Amulet ATtiny84 c line110 character 1 (no condition) break always (currently 1) |
| | | | Cyborg Amulet ATtiny84.c, line 147 character 1 (no condition) break always (currently 1) |
| | | V | Cyborg_Amulet_ATtiny84.c, line 174 character 1 (no condition) break always (currently 0) |
| | | | |
| | | - | |
| 🖼 Autos 👼 Locals 🖉 Watch 1 👰 Watch 2 🖳 Find Results 1 | | 📑 В | reakpoints 🧮 Memory 1 💑 Call Stack 📁 Command Window 🚈 Immediate Window 📕 Output |

Stopped

Atmel Studio – The Result



Johnny Long moment...

Atmel Studio – ASF

| New Example Proj | ect from ASF or Extensions | × |
|--|--|--|
| Device Family: | Category: All Search for Example Projects | FreeRTOS Peripheral Control Example - Arduino Due/X |
| All Projects Kit Category Technology Addon | SAM D20 Xplained Pro (100) Image: SAM D21 Xplained Pro (113) Image: SAM3N-EK (57) Image: SAM3N-EK (57) Image: SAM3N-EK (73) Image: SAM3N-EK (73) Image: SAM3N-EK (73) Image: SAM4CMP-DB (54) Image: SAM4CP16BMB (54) Image: SAM4EX (110) Image: SAM4EX (110) Image: SAM4EX (110) Image: SAM4CP16BMB (54) Image: SAM4CMP-DB (54) Image: SAM4CP16BMB (54) Image: SAM4EX (112) Image: SAM4EX (112) Image: SAM4EX (112) Image: SAM4EX (112) | Default FreeRTOS.org demo application creating several tasks to showcase the use of the FreeRTOS API. [FreeRTOS Peripheral Control Example - Ar- duino Due/X - ATSAM3X8E] |
| Project Name: | FREERTOS_PERIPHERAL_CONTROL1 | |
| Location: | C:\Users\tharon.KATECH\Documents\Atmel Studio\6.2\Cyborg_Amulet_ATtiny84 | Browse |
| Solution: | Add to Solution | • |
| Solution name: | Cyborg_Amulet_ATtiny84 | |
| Device: | ATSAM3X8E | |
| | | <u>Q</u> K <u>C</u> ancel |

Atmel Studio – Atmel Gallery

| Extension Manager | - | THE R. P. LEWIS CO., LANSING MICH. | _ | | ? × |
|---|------------------|---|------------------|---|---|
| Installed Extensions | Sort by: | Highest Ranked | | | Search Available Downloads |
| Available Downloads All Updates (2) | Vm | Arduino IDE for Atmel Studio 6.1 & 6.2 Arduino for Atmel Studio is a simple and fully compatible alternative to the Arduino IDE. Source remains fully compatible allowing Arduino or Atmel Studio to be used as an editor. | Free Download | * | |
| | ~ # | LUFA Library LUFA, the Lightweight USB Framework for AVRs. | Free | | Created by: Arduino Team @ Visual Micro Version: 1407.10 |
| | 12 | XFeatures - Beta Nice to have features in atmel studio. Project Enhancements: | Free | | Downloads: 79738 Rating: More Information Getting Started |
| | a | QTouch Library 5.3 Provides libraries for QTouch. The minimum supported ASF version is 3.15.0. | Free | Ξ | Reviews ****** muchirijohn |
| | CV AVR | CodeVisionAVR C Compiler Evaluation Code size limited Evaluation version of the CodeVisionAVR C Compiler and CodeWizard for the Atmel Tiny, Mega and Xmega AVR 8-bit Microcontrollers. Includes also a new easy to use USB library and the LCD Vision font and image editor/converter for graphic displays. Requi | Free | | 9/10/2014 Version: 1407.10 mohamed keshk 9/9/2014 Version: 1407.10 |
| | 57 (M) | Atmel ARM GNU Toolchain The ARM GNU Toolchain supports all Atmel ARM Cortex-M devices. | Free | | Anderson Pedrosa 9/8/2014 Version: 1407.10 |
| | ~~ | Naggy Compiler diagnostics and preprocessor lowlighting in Atmel Studio for C and C++ projects. | Free | | Pitt 9/6/2014 Version: 1407.10 |
| | Ð | FreeRTOS + Trace Gain an unprecedented insight into the runtime world of your FreeRTOS system using this powerful toolbox with 20+ views of kernel and application events. Facilitates debugging and optimization. (30-day trial + Free Edition) | Free | | 9/2/2014 Version: 1407.10 daniel mogetta 8/28/2014 Version: 1407.10 |
| | \$ ~8 | Atmel AVR (32 bit) GNU Toolchain The AVR 32-bit GNU Toolchain supports all AVR 32-bit devices. | Free | | FU YEN-SIANG 8/27/2014 Version: 1407.10 GOOD!! |
| | | ToDoManager An extension to track Tasks, Bugs, Features or anything that needs tracking. Version 2.1 includes support for the new Atmel Studio 6.1. | Free | | Johnny Cash 8/26/2014 Version: 1407.10 |
| | 80 | Atmel Software Framework Contains the latest ASF 3.19.0 version, including FreeRTOS integration. 1 2 3 | Free | Ŧ | Brian Link 8/22/2014 Version: 1407.10 Great! |

Atmel Web Help – Atmel Spaces

| | 🗿 Atmel - GF | orge AS > Proj∈ 🗶 | | | x |
|------|--|----------------------------|---|---------------------|----|
| 4 | ⇒ C fi [| spaces.atmel.com/gf/projec | t/ | + 0 0 | ≡ |
| | Silver Pro Colloidal Silver Generator | spcsgenerrator | Silver Pro Colloidal Silver Generator Simply the best. | (Project not rated) | |
| | SD card bootloader | sdbootloader | This is a bootloader for small AVRs that will fit into a 2K BLS and without requiring SPI (just four IO lines) it can read an SD card, search the root directory for a file called AVRAPnnn.BIN (where nnn is a version number) and if nnn on the card is a higher number than held in flash (version number held in EEPROM) it replaces the application section of the flash with the file contents. | (Project not rated) | |
| | Script for building AVR-GCC on Linux | make-avr-gcc | This the project make-avr-gcc from Carsten 'Bing600' Foss. It was originally introduced as post "Script for building AVR-GCC 4.5.1 on Linux" in the AVR Freaks Forum. | (Project not rated) | |
| | SAMsPlayground++ | samsplayground | SAMsPlayground is an initiative to write a GUI framework for the SAM XPlained Pro starter Kits / Evaluation Boards | (Project not rated) | |
| | SAM9263 | sam9263 | learn ARM with AT91SAM9263-EK | (Project not rated) | |
| | SAM4L-EK WORKSHOP | sam4l_workshop | collect files & docts for SAM4L-EK Workshop, June 2013 | (Project not rated) | |
| | mfile | mfile | What? You don't know what's mfile? You must be kidding :-) | (Project not rated) | |
| | Mathematical Equation Calculator | mec | Under Modification | (Project not rated) | ĺ |
| | mashAVR | mashavr | A simple program to control a mash-tun. Basically a PID-unit designed for brewing. | (Project not rated) | 11 |
| | Mara programming language | mara | Mara is a programming language dedicated to 8bit ATMEL AVR microcontrollers with a focus on simplicity and productivity. | (Project not rated) | |
| | Joerg's test project | joergtest | Test project | (Project not rated) | |
| | Introduce ATMEL PRODUCTs | scspace0001apl | 2013. 04. 24 : Introduce ATMEL STUDIO6 and play Low Power Demo with ATSAM4L-EK 2013. 06. 05 : Introduce ATMEL Crypto Authentication and ATECC108 | (Project not rated) | |
| | <u>iDiqi Connector for</u> <u>Arduino</u> | idigi-arduino | The iDigi Connector for Arduino is a software library that allows you to connect your Arduino to the [iDigi Device Cloud][iDigi]. Why would you want to connect your Arduino to iDigi? With iDigi you can: * Control your Arduino sketch remotely from a web app or smartphone, even if your Arduino is behind a firewall * Upload data from your Arduino to iDigi using a simple, easy to use interface Requires an Arduino Mega or Arduino Due and Ethernet shield. Consumes about 40k of flash and 2k of SRAM on the Mega platform. | (Project not rated) | |
| | eCos SAM4S Xplained porting | sam4s_ecos | porting eCos on SAM4S Xplained board (HAL and Serial Driver) | (Project not rated) | |
| | Dual Wood Stove Controller | stovecontrol | WOOD STOVE CONTROLER complete Hardware Drawings and code AVRGCC in Atmel Studio 6 FreeRTOS port for ATmega32 Stepper control with STEPPER POS Adc with 64 sample moving avg buffer DS1620 bitbang driver LCD HD44780 driver SPI Master and slave driver Keypad driver | (Project not rated) | |
| | ct-ng: an AVR32 GNU Toolchain Builder | ct-ng | ct-ng: An AVR32 GNU cross-toolchain builder | (Project not rated) | |
| | Classe USB Battery Charging | usb_bc | This project is an evolution of XmegaA3BU-Xplained to implement USB Battery Charging. With this evolution, XmegaA3BU can be recognize by host like a USB battery charging device. With USB Battery Charging, USB device receive more current from usb host. First version of project consists in detecting usb host port type. | (Project not rated) | |
| | Christmas Lights | christmaslights | HW and SW hobby project for Christmas tree lights based on AVR. What is planned is small PCB boards with RGB leds and a AVR of some sort, two connectors where we can connect an unlimited amount of boards in a string. We should be able to control the color and intensity of every board. And of course we need a control unit so that we can control it all from a webpage or something. | (Project not rated) | |
| | ButtLoad - Butterfly AVRISP | buttload | Based on the Atmel Butterfly development board, ButtLoad is specially written firmware which converts a low-cost official Atmel Butterfly evaluation board into a smart ISP programmer for other members of the Atmel AVR family. | (Project not rated) | |
| | Bluetooth Transceiver for Model Locos | bluetrain | The BlueTrain project is developing a Bluetooth transceiver for model locomotives that is controlled by a Bluetooth enabled computer or iDevice. This project is open-source in the hope that it will result in the improvement of model locomotive control. The first target of this project is the Development version that will reside in the tender of an HO steam locomotive and be controlled by a Laptop. The major development hardware consist of a Nano board (Atmega328p), a Bluetooth serial board, and a "de-brained" DCC decoder board. The development software consists of an embedded Atmel328p program, "BlueTrain", and a laptop (Win32) based control program, "BlueCommand". Independent related commercial developments based on this project are encouraged. | (Project not rated) | |
| spac | es.atmel.com/gf/pro | ject/idigi-arduino/ | e AVR XPlained Mini evaluation board from Atmel Corp. | (Project not rated) | П |

Atmel AVR & SAM Web Help

AVRFREAKS.NET



AT91.COM



Atmel Kits

| | Name | Processor | Features | Debugging | Atmel Store | DigiKey |
|---|--------------------------------------|--|---|---------------------------|-------------|---------|
| - AL | Atmel Atmega328P Xplained Mini | Atmega328 16Mhz, 32K Flash, 2K RAM, 1K EEPROM | Arduino Compatible Headers | Built-In | \$8.88 | \$13.42 |
| AVR Butterfly | Atmel AVR Butterfly | Atmega169 16MHz, 16K Flash, 1K RAM, 512 EEPROM | Display, Audio, Light Sensor, Joystick, Voltage Input | External JTAG Required | \$20 | \$27.04 |
| | Atmel MEGA- 1284P Xplained | Atmega1284P 128K Flash, 16K RAM, 4K EEPROM | LEDs, switches, Q- Touch button, light and temp sensors. USB to serial | External JTAG Required | \$29 | \$36.36 |
| | Olimex AVR- IO-M16 | Atmega16 16Mhz, 16K Flash, 2K RAM, 1K EEPROM | RS-232, 4 Relays, 4 Iso-Inputs | External JTAG Required | N/A | \$35.28 |
| | Atmel SAM4S XPLD | SAM4 S Cortex-M4 120MHz 1M FLASH, 128K RAM, NO EEPROM | Touch slider, USB to serial | Built-In | \$29 | \$36.90 |
| | Atmel SAM G53 Xplained Pro | SAMG53 Cortex-M4F 48Mhz, 512K Flash, 96K RAM, NO EEPROM | User button, LED, RTC crystal | Built-In | \$29 | \$36.90 |
| and | Atmel SAM D21 Xplained Pro | SAMD21 Cortex-M0+ 48Mhz, 256K Flash, 32K RAM, NO EEPROM | User button, LED, RTC crystal, Host/Device USB | Built-In | \$39 | \$49.45 |

"Quick" Q&A Break



The Incredible World of Micros

Digi-Key Search Results: 44K+ matches

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| Atmel | * | Kinetis K10 | ARM® Cortex®-M0 | 8-Bit 48 MIPS |
| Atmel Cypress Semiconductor Corp | * | Kinetis K10 Kinetis K20 | ARM® Cortex®-M0 ARM® Cortex®-M0+ | 8-Bit 8/16-Bit 48 MIPS 48MHz |
| Atmel Cypress Semiconductor Corp Epson Electronics America Inc-Semiconducto | - Box | Kinetis K10 Kinetis K20 Kinetis K30 | ARM® Cortex®-M0 ARM® Cortex®-M0+ ARM® Cortex®-M3 | 8-Bit 8/16-Bit 16-Bit 16-Bit |
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Resources on the Web

| Atmel | Get Started - AVR Microcontrollers | http://www.atmel.com/products/microcontrollers/avr/start_now.aspx |
|--------------------------------------|--|---|
| Atmel | Atmel University Courseware | http://www.atmel.com/about/corporate/university/new-course-syllabus.aspx |
| Perceptual Systems Research Group | Getting Started with ARM Microcontrollers — An Overview of the ARM Ecosystem by Jay Carlson, UNL | http://psrg.unl.edu/2013/10/03/getting-started-with-arm-microcontrollers/ |
| | Getting Started with NXP's LPC11XX Cortex-M0 ARM Microcontrollers | http://eewiki.net/display/microcontroller/Getting+Started+with+NXP%27s +LPC11XX+Cortex-M0+ARM+Microcontrollers |
| 🐺 Texas Instrument | S TI's MCU Getting Started Guide | http://www.ti.com/lsds/ti/microcontrollers_16-bit_32-bit/msp/getting-started.page |
| | HACK A DAY | http://hackaday.com/ |
| | Mariano Filippa's Blogs | http://www.mfilippa.com/articles http://www.mfilippa.com/articles/micro_board_design |

Resources on the Web

Where to Buy...

| CORPORATION CONTRACT | Digi-Key | http://www.digikey.com/ |
|----------------------|-------------|---------------------------|
| sparkfun | Spark Fun | https://www.sparkfun.com/ |
| Radafruit | adafruit | http://www.adafruit.com/ |
| Atmel | Atmel Store | http://store.atmel.com/ |
| | | |

Resources on the Web

ARM Cortex-M Forums From: http://community.arm.com/docs/DOC-7261

3 – Other information and materials

3.1 - Books

A list of ARM related books can be found in: http://www.arm.com/support/resources/arm-books/index.php

3.2 – On the web

Beyond the ARM web site, there are also numerous sources of further information:

On the ARM Connected Community web page, 🗉 Alban Rampon has created a page of 🗎 MCU resources.

Stephan Cadene has kindly compiled a list of useful documents and posted it on the LinkedIn ARM based group:

Some links and books to begin in ARM Architectures

(http://www.linkedin.com/groups/Some-links-books-begin-in-85447.S.204601318)

Microcontroller vendors also have a lot of documentation, tutorials, application notes, etc. Some of them also have their own user forums:

ARM[®]Connected Community

| Vendors | Forum pages |
|----------------------|---|
| Atmel | http://forum.atmel.com/ |
| Cypress | http://www.cypress.com/?app=forum |
| Freescale | https://community.freescale.com/community/kinetis |
| Infineon | http://www.infineonforums.com/forums/3-Microcontroller-Forum |
| NXP | http://forums.nxp.com/ |
| Silicon Laboratories | http://www.silabs.com/support/forums/pages/default.aspx |
| ST Microelectronics | https://my.st.com/public/STe2ecommunities/mcu/Lists/STM32Discovery/AllItems.aspx |
| Texas Instruments | Cortex-M - http://e2e.ti.com/support/microcontrollers/stellaris_arm/f/default.aspx Cortex-R - http://e2e.ti.com/support/microcontrollers/hercules/f/default.aspx |
| Toshiba | https://forum.toshiba-components.com/forumdisplay.php?1-Microcontroller |



Web based IDE

FRDM-K64F | mbed

Explore

Platforms

mbed

mbed.org

Made Easy – much like Arduino

mbed Compiler /frdm_rtos_ ×

Handbook

Cookbook

Getting Started

life.augmented

- More commercial intent
- **Broad vendor support**

Components

Development Platform for Devices

The mbed development platform is the fastest way to create products based on ARM microcontrollers.

The project is being developed by ARM, its Partners and the contributions of the global mbed Developer Community.

Find out why you should base your next ARM microcontroller powered product on the mbed platform »







mbed Enabled





ST Nucleo F401RE

- · Cortex-M4, 84MHz
- 512-KB Flash, 96-KB SRAM





57



ST Nucleo F334R8

Cortex-M4, 72MHz

· 64-KB Flash, 16-KB SRAM

| | Manufacturer | Name | Processor | Features | Debugger | S/W Development | DigiKey Price |
|-----------------|------------------------------|-----------------------------|---|--|--|---|--------------------------|
| | Freescale | FRDM-KL25Z Freedom Board | Kinetis MKL25Z128VLK4 Cortex-M0+ 48MHz, 16K RAM, 128K Flash | mbed Enabled, USB Host/Device, accelerometer, cap touch, tri-color LED, Arduino headers | Built In. Can debug external targets | Kinetis Design Studio, No Code Limit | \$12.95 |
| | Freescale | FRDM-KL46Z Freedom Board | Kinetis MKL46Z256VLL4 Cortex-M0+, 48MHz, 32KB RAM, 256KB FLASH | mbed Enabled, USB Host/Device, accelerometer, cap touch, tri-color LED, Arduino headers, Magnetometer, light sensor, LCD display | Built In. Can debug external targets | Kinetis Design Studio, No Code Limit | \$15.00 |
| mbed Enabled | Freescale | FRDM-K64F Freedom Board | Kinetis MK64FN1M0VLL12 Cortex-M4F, 120MHz, 256KB RAM, 1MB FLASH | mbed Enabled, USB Host/Device, accelerometer, tri-color LED, Arduino headers, Magnetometer, Ethernet, push buttons, <u>RF24L01+</u> and Bluetooth expansion pins | Built In. Can debug external targets | Kinetis Design Studio, No Code Limit | \$29.00 |
| | Switch Science, NXP Micro | mbed LPC1114FN28 | Kinetis NXP LPC1114FN28 Cortex- M0, 48 Mhz, 32K FLASH, 4K RAM | mbed Enabled, minimum H/W | External debugger, supports programming via UART | LPCxpresso, 256K free limit | \$20 @ Switch Science |
| | ST Micro | ST Nucleo F401RE | STM32F401RET6 Cortex-M4F, 84 Mhz, 512K Flash, 96K RAM | mbed Enabled, Arduino headers, STMicroelectronics Morpho headers, LED and button | On-board ST- LINK/V2.1 | Proprietary IDEs, up to 32K Free | \$10.33 |
| | ST Micro | ST Nucleo F411RE | STM32F411RET6 Cortex-M4F, 100 Mhz, 512K Flash, 128K RAM | mbed Enabled, Arduino headers, STMicroelectronics Morpho headers, LED and button | On-board ST- LINK/V2.1 | Proprietary IDEs, up to 32K Free | \$15.69 |

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| Program Workspace | <pre>pmmin.cpp X pmmin.cpp X #include "mbed.h" #include "tos.h" digitalOut led1(LED1); S InterruptIn sw2(S%2); duint32_t button_pressed; Thread *thread2; syocid sw2_press(void) l thread2->signal_set(0x1); l thread2->signal_set(0x1); l thread2->signal_set(0x1); l thread2->signal_set(0x1); l thread2:set(0x1); led1 = lled1; ted1 = lled1; ted</pre> | Error Number | Resource | Errors: 0 | Warnings: 0 | Infos: 0 |
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| Halm_goleC_N252 Frdm_rtos_K64F Frdm_serial_K462 Frdm_test_K462 Frdm_timer_K1252 Frdm_binky_LPC1114 V mode_plinky_LPC1114 V Nucleo_pvm2 | 6 mbed | L | ibrary Build | 25 Apr 2014 | | | | IName Created Last Modified Last Built URL Revision Status | rram_mmer_NL252 25 Apr 2014 25 Apr 2014 moments ago n/a no revisions uncommitted chang cumentation is out of | ges f date |
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| Program Workspace | Program: frdm_rtos_K64F | | | | | | | Program Details | | | | | |
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| AnalogOut | | Expor | t Target: | 🗼 FRDM-K64F | - | | | Description | | | | | |
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| BusOut | | | | 🕎 Keil uVision4 | | | | | | | | | |
| CANMessage | Filter: Search criteria | | | DS-5 | | | | | | | | | |
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| DigitalIn | Compile output for program: fro | dm_rtos_K64 | lF | 🌾 GCC (Code Sourcery) | | | | Errors: 0 | Warn | ings: 0 | Infos: | 0 | |
| DigitalOut | Description | | | 😚 GCC (ARM Embedded) | | Error Number | Resource | In Folder | | Locatio | n | | |
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| FileSystemLike | | | | Kinetis Design Studio | | | | | | | | | |
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"Final" Q&A Break



BONUS SLIDES

* Flip through quickly? Video will pick up :)



RTOS – FreeRTOS

http://www.freertos.org/

| C A B www.freertos.org | | * O O P |
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| Quick Start Supported MC | Us Books & Kits Visualisation Ecosystem Training Contact & Support | Email List + 🕒 🔊 |
| Quick Start Guide + Videos Front Page (homepage) | ▼ FreeRTOS [™] | Latest News |
| Download FreeRTOS Books and Manuals FreeRTOS FreeRTOS Interactive! Contact, Support, Advertising | Don't let your RTOS solution lock you in - FreeRTOS is the easy to use, high quality, cross platform standard for microcontrollers. 35 architectures - 18 toolchains, millions of product deployments - just 1 market leading RTOS. | FreeRTOS V8.1.2 available for download - Change History - Upgrading - |
| FreeRTOS+ Latest New: Internet of Things Connect directly to devices. No firewall hassles. Tiny code size. Live demo - Try it now | FreeRTOS TM is a market leading real time operating system (or RTOS) from Real Time Engineers Ltd. that supports 35 architectures and receives 107000 downloads a year. It is professionally developed, strictly quality controlled, robust, supported, and free to use in commercial products without any requirement to expose your proprietary source code. It is used in every imaginable market sector | FreeRTOS Sponsors USB TCP/IP File Systems |
| FreeRTOS+ Ecosystem Showcase Internet of Things: | from toys to aircraft navigation. Why would you choose anything else? The FreeRTOS value proposition Things you might not know about FreeRTOS | Supplied as integrated and functioning FreeRTOS projects from the |
| Innovative complete solution TCP/IP: Low cost pre-ported libraries | Latest News | Official FreeRTOS Partner |
| FreeRTOS BSPs: 3 rd party driver packages | FreeRTOS V8.1.2 released. See the change history and upgrading guide. New Internet of Things solution. Connect peer to peer. No firewall hassles. Tick suppression for low power demoled on SAMU. PX100 and STM321 | Napier |
| DOS compatible FAT FS | - The suppression for low power deniced on Shimite, rector and Shimize. | PR partner for |
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RTOS – NuttX

http://www.nuttx.org/

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| | Article Read Show pagesource Old revisions | د Login م | | | | |
| Navigation | NuttX is a real-time operating system (RTOS) with an emphasis on standards compliance and small footprint. Scalable from 8-bit to 32-bit microcontroller environments, the primary governing standards in NuttX are Posix and ANSI standards. Additional standard APIs from Unix and other common RTOS's (such as VxWorks) are | NuttX Real-Time Operating System Key features Supported platforms File system | | | | |
| Home Downloads Documentation Forum | adopted for functionality not available under these standards, or for functionality that is not appropriate for .Device Drivers deeply-embedded environments (such as fork()). .Networking NuttX was first released in 2007 by Gregory Nutt under the permissive BSD license. .USB Support .USB Device S | | | | | |
| Wiki Links | Key features | Graphics Support Add-Ons NuttShell Pascal Runtime | | | | |
| Print/export | Standards Compliant. Core Task Management. Modular design. | | | | | |
| Download as PDF Printable version | Fully pre-emptible. Naturally scalable. | | | | | |
| Toolbox | Highly configurable. Easily extensible to new processor architectures, SoC architecture, or board architectures. See Porting Guide. | | | | | |
| What links here Recent changes | FIFO and round-robin scheduling. Realtime, deterministic, with support for priority inheritance. Tickless operation. | | | | | |

Freescale Kinetis Cortex-M0+/M4F



Kinetis Breakout Board

Lack of DIPs for prototyping!
Kickstarter project?



Other platform besides Kinetis?

Java on ST Micros

http://www.stm32java.com/
http://www.st.com/web/en/catalog/tools/PF252537
NOT CHEAP

Cost of the STM32Java offer

For evaluation

- STM32Java SDK 3-month limited evaluation version
 - Free download at www.stm32java.com
- Kits with an evaluation board and a DVD-ROM
 - STM3220G-JAVA with an STM32F2 series evaluation board
 - STM3240G-JAVA with an STM32F4 series evaluation board



For development

• **STM32-JAVA**, One year STM32Java SDK license at US\$ 2600, with maintenance and support



Embedded JavaScript

Espruino.com

ESPRUINO WEB IDE





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Don't Get TOO Excited...



My Website

http://unscriptedmadness.com/

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Robot Stuff! :)

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