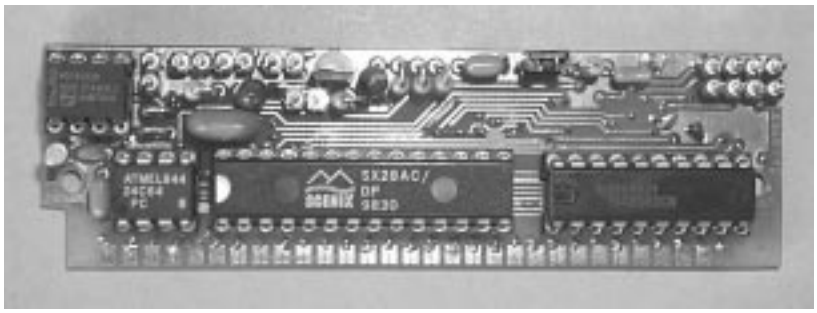
Stick'SX

A high-performance SimmStick compatible processor board



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Project #SSAU0002

Abstract

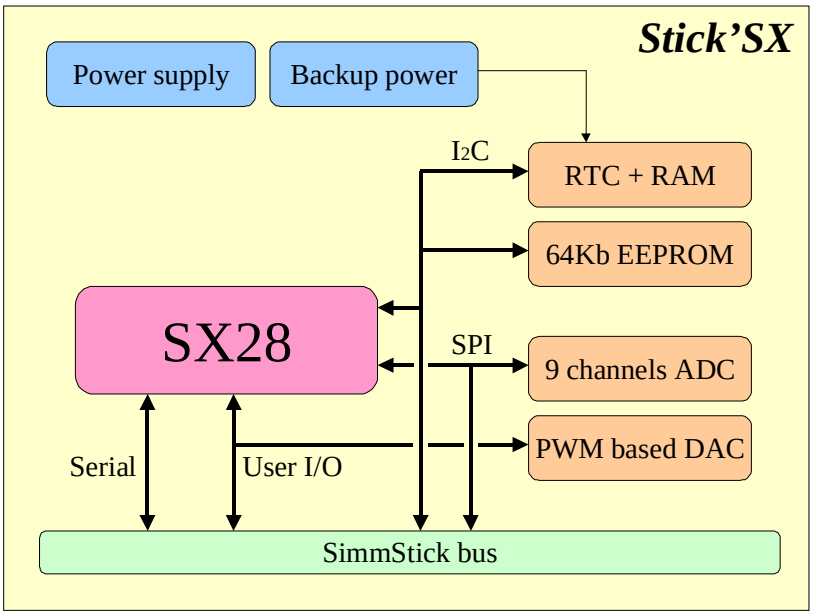
SimmStick™ is a very compact, 30 pin SIMM based, Single Board Computer platform. Currently, SimmStick compatible processor board exist for MicroChip™ PIC series and for ATMEL™ AVR series. There is also a large panel of SimmStick compatible I/O peripheral and main boards.

This project, Stick'SX, is a new SimmStick compatible processor board built around the very powerful Scenix SX28 processor : Up to 100 Mips on a 1" x 3.5" PCB !

Stick'SX drives all SimmStick I/O lines, offering asynchronous, I2C and SPI compatible ports as well as up to 16 general purpose I/O lines.

Moreover, Stick'SX have an impressive list of on-board I/O devices :

- A fast 12 bits, 9 channels, A/D converter,
- A 64Kb user EEPROM,
- A real-time clock/calendar with 240 bytes of battery backed-up RAM,
- A PWM based D/A converter,
- An integrated 5V power supply.



With Stick'SX, the SimmStick architecture is now able to deal with DSP class applications, offering a very low cost canned solution for today power-hungry applications.

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1. Stick'SX specifications

Format :

1-inch SimmStick compatible board

Processor :

- Scenix SX28AC processor
- Raw CPU performance : 50 MIPS (SX28AC), up to 100MIPS (SX28AC100)
- External interrupt latency : 100ns maximum at 50MHz
- 136 bytes on-chip SRAM
- 2048 x 12 bits on-chip program memory (FLASH), rated for 10 000 rewrite cycles
- 8-level hardware stack
- In-circuit programmable
- Integrated watch-dog & brown-out detector
- Power-save modes with multi-source wakeup capability

I/Os :

Drives all SimmStick bus signals :

- D0 to D15 user I/O (*)
- SCL/SDA I_2C interface
- SI/SO asynchronous serial interface (up to 230Kbps)
- IO line (used for RTCC control)

(*) D0 to D4 are used as an SPI interface if the ADC is used, D5 is shared with the DAC output if used.

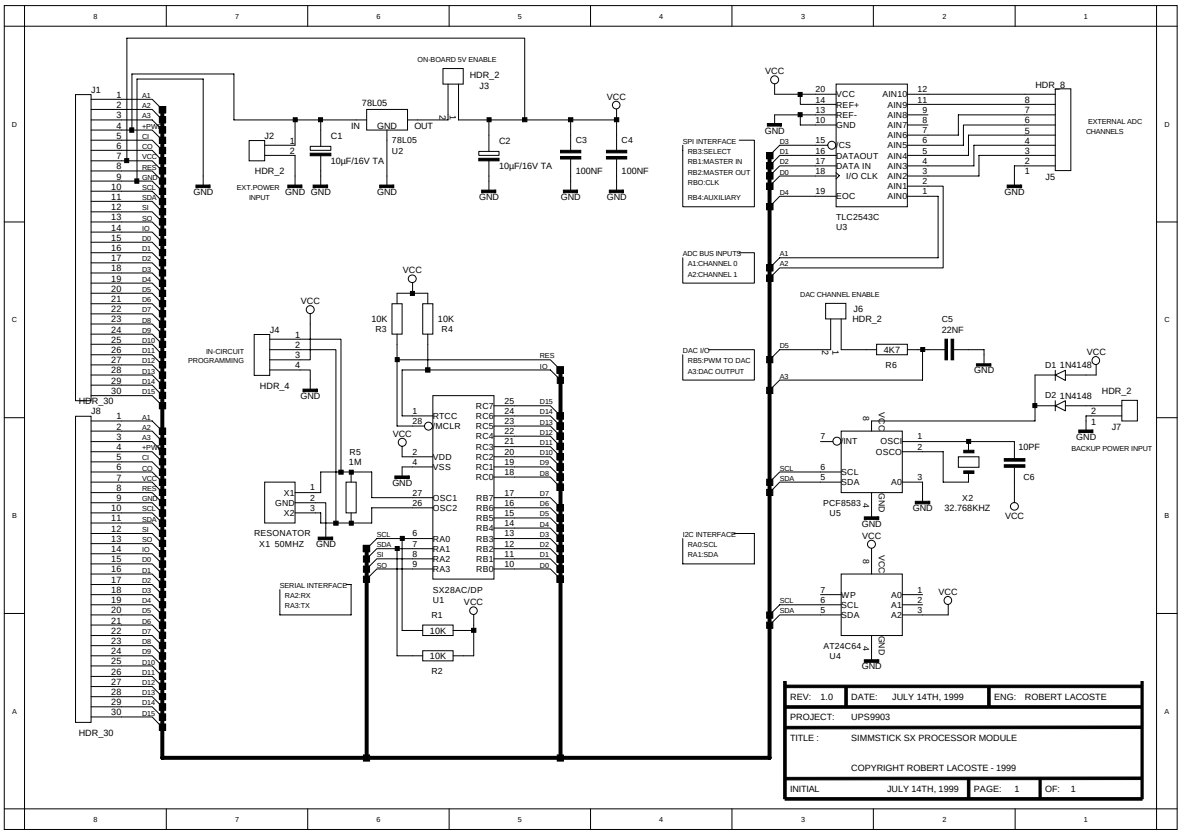
On-board peripherals :

- High performance 12 bits analog to digital converter (10 channels, 10µs conversion time, built-in sample & hold and self-test modes)
- One PWM based analog output
- 64 Kb on-board user EEPROM (8K x 8)
- Low power clock/calendar I_2C chip
- 240 extra bytes of battery backed RAM available for the user
- On-board 5V regulator

2. Hardware design

2.1. Schematics

Here under the complete schematic of the Stick'SX board :



2.2. The SX28 micro-controller

Stick'SX main processor (U1) is a **Scenix SX28AC/DP**. Currently this chip is available in 50MHz grade, but will be very soon be available in 75MHz and 100MHz versions with the same pin-out. For detailed specifications of the SX28 micro-controller, see [R1].

An on-board 50 MHz (or 75/100MHz) resonator (X1) provide the main clock to the chip. The 4-pins header J4 provides a Parallax™ compatible port for in-circuit programming and debugging.

The /MCLR and RTCC pins are pulled-up and routed to the /RES and IO SimmStick bus signals. The IO pin can then be used as an external interrupt request line or as a generic counter input.

The RA0/RA1 lines are dedicated to the I^2C interface, the RA2/RA3 lines to the asynchronous serial interface. This setup is compatible with the Scenix virtual peripheral library default assignments.

The other I/O lines (RB0-RB7 and RC0-RC7) drive the SimmStick D0 to D16 user I/O signals.

2.3. EEPROM memory

An **AT24C64** EEPROM chip (ATMEL, see [R4]) can be plugged into socket U4. This chip is a high capacity serial EEPROM (8Kx8) with a guaranteed 1 million write cycles reliability. It is acceded though a 2 wires I^2C bus and is ideally suited as a large memory buffer for data logging applications.

Lower capacity chips (AT24C32 or AT24C16) can also be used.

2.4. A/D converter

The on-board A/D converter (U3) is a Texas Instruments **TLC2543C** (see [R3]). This chip is built using TI's own LinEPIC™ technology, and provides 12 bits resolution with a quick 10µs conversion time over temperature.

A built-in sample & hold and analog multiplexer gives 11 external analog inputs and 3 self-test calibration voltages. Two of the analog inputs are routed to SimmStick bus A1/A2 user lines, while 7 of the remaining lines are available on the dedicated header J8 (2 inputs are left unused : AIN7 and AIN8).

This A/D converter is linked to the processor through a high speed SPI compatible interface, using D0 to D3 user I/Os. D4 is used to monitor the end-of-conversion signal. So the D0-D4 signals can only be used as general purpose I/O if no chip is plugged in socket U3. Otherwise, D0 to D2 can still be shared with other SPI peripherals, while D3 and D4 are reserved for the A/D converter.

2.5. D/A converter

A simple digital to analog converter is implemented through J6, R6 and C5, acting as a low pass filter between the user I/O line D5 and the bus signal A3 : Using a PWM virtual peripheral driver allows to use A3 as an analog output with minimal processor overhead.

The values of R6 and C5 should be modified depending on the PWM frequency, the standard values giving a 20KHz cutoff frequency. The jumper J6 must be left open in order to use D5 as a general purpose I/O.

2.6. Real-time clock & battery backed-up RAM

Stick'SX on-board real-time clock/calendar is a Philips PCF8583 (U5). This I^2C compatible chip provides a time reference with a resolution of 1/100th of a second (see [R5]).

The PCF8583 also integrate 240 bytes of general-purpose battery backed-up RAM, as well as programmable alarm and timer operations.

This low power chip has its own 32.768KHz crystal (X2) and can use as a backup source any small battery or supercap through the header J7 (1V to 5V).

2.7. Power supply

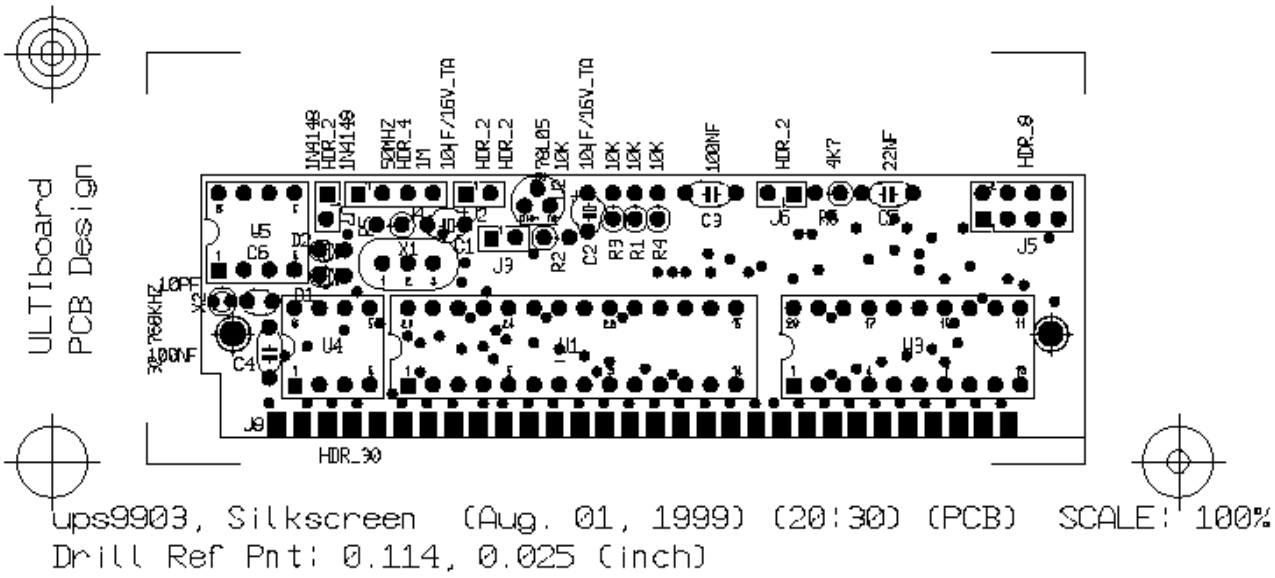
The Stick'SX can be powered either from a SimmStick bus VCC 5V line (with J3 open) or, thanks to the on-board regulator 78L05 (U2), from an unregulated 7-10V source (J3 closed). This unregulated source can come from the PWR bus line or directly from the header J2.

3. Physical design

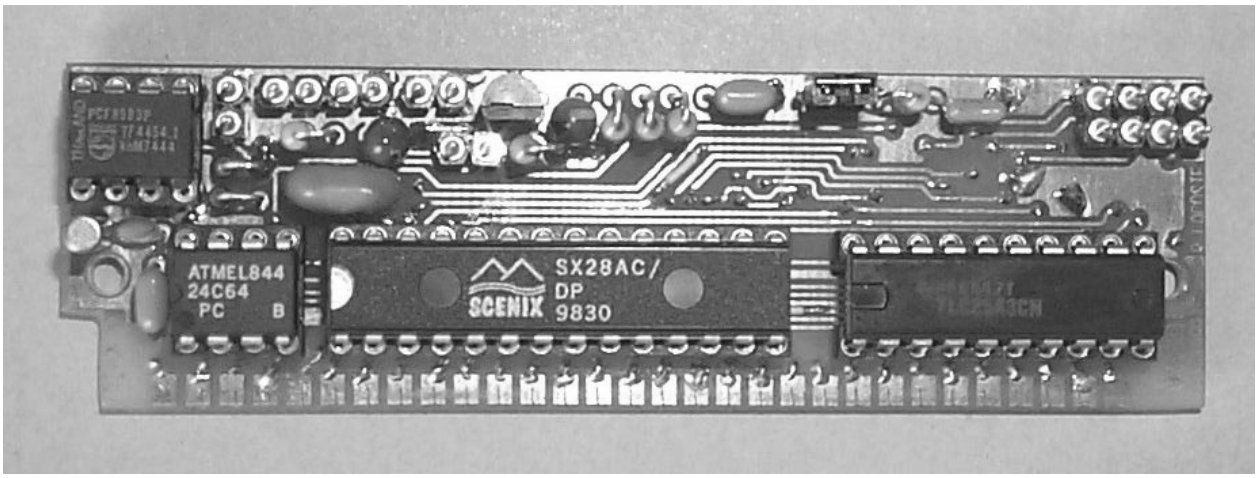
3.1. The Printed Circuit Board

Here under the implementation of the Stick'SX PCB. The artwork is quite dense, but allows shrinking everything on a double-sided 1" standard SimmStick form factor board (see [R7]).

All components are in "classic" packages (i.e. non-SMT), in order to as easy as possible to find (and to solder !) for the hobbyist user. A double-sided ground plane allows limiting as much as possible RF and EMC issues : A must at 50 or 100MHz !



Here under a picture of the assembled prototype :



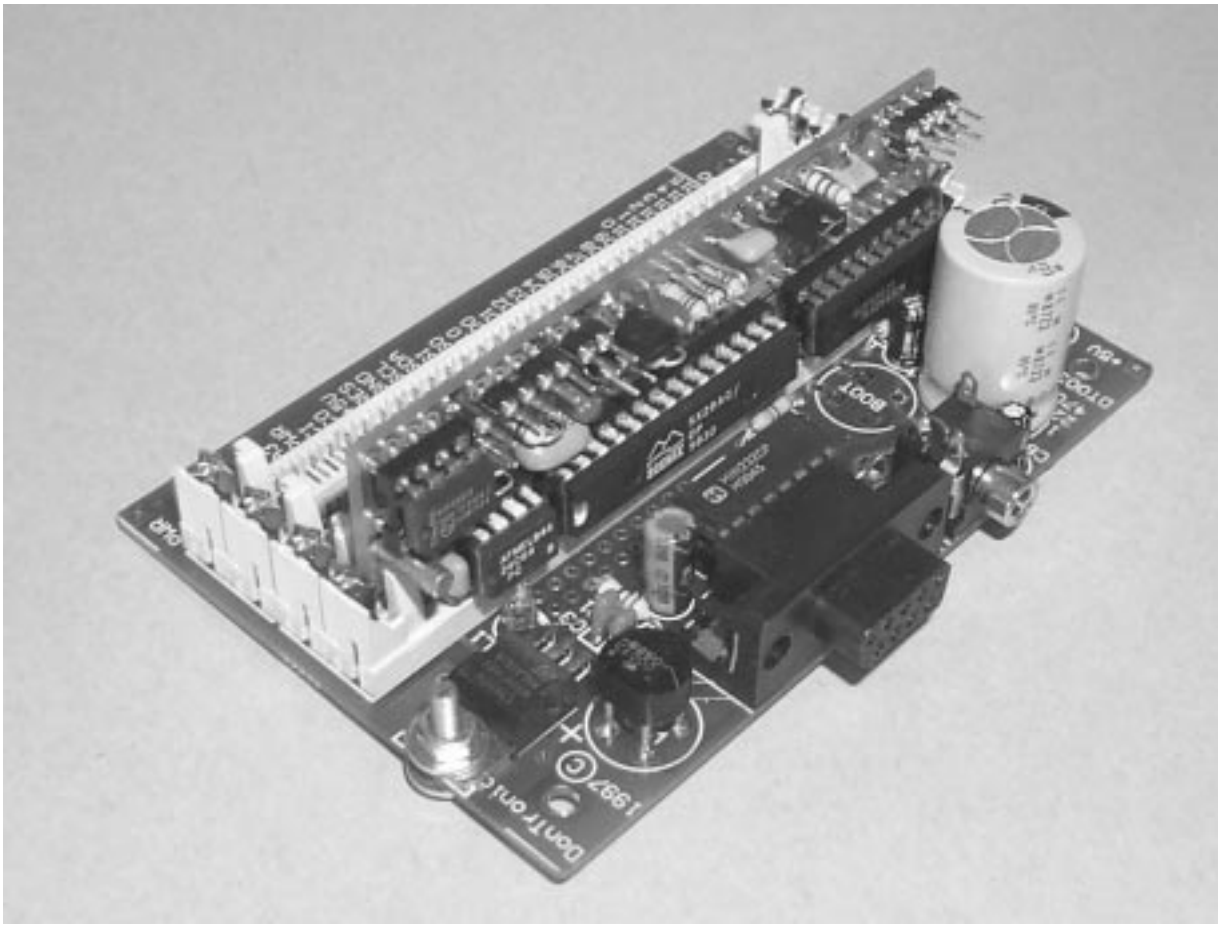
3.2. Configuration jumpers

As a summary, here under the different headers and jumpers present on the Stick'SX board:

J1 : SimmStick bus edge connector
J2 : External unregulated power input
J3 : To be shorted to use the internal 5V regulator
J4 : In-Circuit programming connector
J5 : Extra analog inputs
J6 : To be shorted to use the analog output
J7 : Backup power supply input

3.3. Prototype test configuration

Stick'SX prototype was tested on a Dontronics DT003 main board. A test I/O board was built using a Dontronics DT201 proto board : this helped the testing of the different Stick'SX I/O signals.



4. Software support

4.1. Code compatibility

The Scenix SX micro-controllers are upward compatible to MicroChip's PIC16C5X. This will greatly help porting existing applications to the Stick'SX board, and will help a lot to flatten the learning curve for designers already used to the PIC family !

4.2. Virtual peripherals

Thanks to the horsepower of the SX devices, Scenix has developed and supported the concept of "virtual peripherals" : A VP is in fact the software emulation of I/O peripherals usually found on high-end micro-controllers. Moreover, a large number of VPs are available as freeware on Scenix web site (see [R2]).

Currently, the list of available VP includes :

- Software UART (2400 to 230.4Kbps),
- Octal UART (8 x 19.2Kbps),
- I^2C master & slave interfaces (including multi-master),
- SPI/uWire master & slave interfaces,
- 8 channels 8-bit PWM,
- Stepper motor controller,
- LCD drivers (4-bits & 8-bits),
- 4x4 keyboard scan,
- 16-bit timer,
- Artificial sine wave generator,
- FSK generation,
- DTMF generation & detection,
- Software modems,
- Etc…

And this list is of course extended each week, by Scenix or third parties.

For the Stick'SX module, the UART, I^2C, SPI and PWM virtual peripherals can be used to smoothly drive the different on-board peripherals.

4.3. Development tools

The Stick'SX board provides a Parallax™ compatible in-circuit programming and debugging interface, through the OSC1/OSC2 pins. This interface can be directly used with Parallax™ development tools.

For the very small budgets, alternative freeware development tools are now available on the web, for example Dan Steele's assembler and programmer toolkit (see [R8]).

6. References

[R1] SX18/20/28AC 50 MIPS Datasheet
Dated 5/99, Literature Order #SXL-DS01-03
http://www.scenix.com/products/datasheets/sx_datasheet.PDF

[R2] Scenix Virtual peripheral library
http://www.scenix.com/virtual/vp/index.html

[R3] TLC2543, 12-Bit Serial-Out 11-Input Analog-to-Digital Converter Datasheet
http://www.ti.com/sc/docs/products/analog/tlc2543.html

[R4] AT24C32/64 32/64K, 2-Wire Bus Serial EEPROM w/Cascadable Feature
(16 pages, updated Dec 21 1998)
http://www.atmel.com/atmel/acrobat/doc0336.pdf

[R5] PCF8583; Clock/calendar with 240 x 8-bit RAM Product Information
http://www-us2.semiconductors.philips.com/pip/PCF8583P

[R7] SimmStick Specifications
http://www.simmstick.com/whatissi.htm

[R8] Dan Steele's Scenix freeware development tools
http://members.rotfl.com/dturner/scenix2.zip
http://members.rotfl.com/dturner/sxbufled.zip