SoM-9X25M

User Manual

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1. Introduction

This document describes EMAC's SoM-9X25M (SBC) module. The SoM-9X25M is a System on Module, designed to be compatible with EMAC's 144-pin SODIMM form factor. This module is built around the ATMEL AT91SAM9X25 microcontroller, which provides several of its key features.

The SoM-9X25M has an onboard Ethernet PHY, 6 serial ports, a RTC, a programmable clock synthesizer, onboard eMMC flash, Serial EEPROM, and DDR2 RAM.

In addition to these standard SoM features, the SoM-9X25M also features a fast 32-bit core, open source software support, and a wide range of controller IO pins.

1.1. Features

- **Small, 144 pin SODIMM form factor (2.66" x 1.5")**
- **Atmel ARM926 Thumb AT91SAM9X25 400Mhz Processor**
- **10/100BaseT Ethernet with on-board PHY**
- **6 Serial ports, one with full handshake and two with CTS/RTS handshake**
- **1 USB 2.0 (Full Speed) Host port**
- **1 USB 2.0 (High Speed) Host port**
- **1 USB 2.0 (High Speed) Device/Host port**
- **Up to 128 MB of DDR2 RAM**
- **Up to 4 GB of Resident eMMC Flash**
- **Up to 16 MB of Serial Flash**
- **Battery backed Real Time Clock**
- **SD/MMC Flash Card Interface**
- **2 SPI ports**
- **1 I2S Audio port**

- **Timer/Counters and Pulse Width Modulation (PWM) ports**
- **4 Channel 10-bit Analog-to-Digital converter**
- **Typical power requirement less than 1 Watt**
- **JTAG for debug, including real-time trace**
- **FREE Eclipse IDE with GCC and GDB development tools**

2. Hardware

2.1. Specifications

- **CPU:** Embedded Atmel AT91SAM9X25 processor running at 400 MHz.
- **Flash:** 4GB eMMC Flash and 8MB (16MB optional) of Serial Data Flash.
- **RAM:** 128 MB 133 MHz DDR2 RAM.
- **Flash Disk:** 4-bit Parallel or SPI serial SDHC/MMC interface.
- **System Reset:** Supervisor with external Reset Button provision.
- **RTC:** Real Time Clock/Calendar with battery backed provision using 32-bit free running counter.
- **Timer/Counters:** 2, 3 channel, 32-bit timers/counters with capture, compare, and PWM. 20-bit interval timer plus 12-bit interval counter.
- **Watchdog Timer:** External Watchdog Timer (6746MAX6747).
- **Digital I/O:** 32 General Purpose I/Os with 16 mA drive when used as an output
- **Analog I/O:** 4 channel, 10-bit Analog-to-Digital converter (ADC)
- **Power:** Power Management Controller allows selectively shutting down on processor I/O functionality and running from a slow clock.
- **JTAG**: JTAG for debug, including real-time trace
- **CLOCKS**: PLL synthesized 8M, 200K, 14.3M clock outputs

Serial Interfaces

- **UARTS:** 6 serial TTL level serial ports with Auto RS485 and some with handshaking (each UART requires external RS level shifting).
- **SPI:** 2 High-Speed SPI ports with Chip Selects.
- **Audio:** I2S Synchronous Serial Controller with analog interface support
- **USB:** 1x USB 2.0 High Speed Host Port, 1x USB 2.0 Full Speed Host Port, 1x USB 2.0 High Speed Device Port.

Ethernet Interface

- **MAC:** AT91SAM9X25 on chip Dual MACs
- **PHY:** Single Micrel KSZ8041 PHY with software PHY shutdown control
- **Interface:** IEEE 802.3u 10/100 BaseT Fast Ethernet (requires external magnetics and Jack)

Bus Interface

- Local ARM AT91SAM9x25 Bus accessible through SODIMM provides 22 address lines, 16 data bus lines, and control lines.

Mechanical and Environmental

- **Dimensions:** SODIMM form factor with the length dimension extended (2.66" x 1.5")
- **Power Supply Voltage:** +3.3 Volts DC +/- 5%
- **Power Requirements:**
  - Typical 3.3 Volts @ 210 mA (less than 1 watt)
  - Max current draw during boot process: 255 mA
  - Constant busy loop: 245 mA
  - Idle system: 210 mA
  - Idle system with Ethernet PHY disabled: 145 mA
  - APM sleep (slow clock) mode with Ethernet PHY disabled: 20 mA
- **Operating Temperature:** -40 ~ 85° C (-40 ~ 185° F), fan-less operation
- **Operating Humidity:** 0%~90% relative humidity, non-condensing

2.2. Real Time Clock

The SoM-9X25 has an embedded Real-time Clock. Battery backup is provided from the carrier board using the VSTBY pin. The SoM-9X25 will retain the RTT value register during reset and hence use it as a RTC. The RTC has the provision to set Alarms that can interrupt the processor. For example the processor can be placed in sleep mode and then later awakened via the Alarm function.

2.3. Watchdog Timer

The SoM-9X25 provides an external Watchdog Timer/ Supervisor (6746MAX6747) with an extended watchdog timeout period of 1.42 seconds (±10%). Upon power-up the Watchdog is disabled and does not require pulsing. To start the Watchdog it must first be enabled. This is done by configuring port line PC6 as an output and setting it low in software. Once enabled, the Watchdog should be pulsed, using port line PC7, continually every 1.28 seconds or faster to prevent the Watchdog from timing out and resetting the module. If you are using the watchdog to force a system reset, you may need up to 1.56 seconds of inactivity before the Watchdog reset will occur. The watchdog is automatically disabled upon reset but it can also be disabled by setting PC6 high.

2.4. External Connections

The SoM-9X25M connects to a carrier board containing its connectors, power supply and any expansion IO, through a standard gold-plated SODIMM 144 pin edge connector (top-side shown below).

The SoM model will fit in any standard 144-pin SODIMM socket. These connections are designed to be compatible with all EMAC 144-pin SoM products. See EMAC SoM 144-pin SODIMM Pinout Specification to see how other 144-pin SoMs pin-outs line up with the SoM-9X25's pin-out.

The use of the SODIMM form-factor for EMAC's SoMs is a sound choice that has been proven rugged and reliable in the laptop market.

The remainder of this section describes the pin-out as it applies specifically to the SoM-9X25 processor.

2.4.1. External Bus

The SoM-9X25 provides a flexible external bus for connecting external bus peripherals such as the CPLD of the SoM-150ES which connects through a subset of these connections. The Flash WP for the Data Flash is active low and pulled up on-module.

SODIMM Pin#	SoM Pin Name	Processor Pin Name(s)	Description
100	GP_CS1	NCS2/D29/PD19	General Purpose Processor Chip Select CS2
98	GP_CS2	NCS4/D30/PD20	General Purpose Processor Chip Select CS4
108	GP_CS3	NCS5/D31/PD21	General Purpose Processor Chip Select CS5
16	~OE	NRD	Read Signal
83	~WR	NWRE/NWR0	Write Signal
6	~RST_IN	NRST	Processor Reset In
43	~RST_OUT	SOM_RST_OUT	Processor Reset Out
44	~EA	SHDN	Shutdown Control
85	Flash WP	Dataflash WP	Data Flash Write Protect
72	ALE/~TS	WKUP	Wake-Up Input
26,35,33,31, 28,109,111, 113,10,12,18, 14,37,5,11,9, 7,13,97,17, 15,104	A0-A21	A0-A19, A23-A24	Address Bus
29,27,25,22, 23,21,19,20, 8,24,34,70, 77,81,84,86	D0-D15	D0-D15	Data Bus

2.4.2. Module specific interface

The SoM-9X25 module specific interface brings out several module specific connections from the processor. The interface includes the debug serial port, USB host/device and MMC/SD interfaces. Remember the USB Data lines are differential pairs and need to be routed as such.

SODIMM Pin#	SoM Pin Name	Processor Pin Name(s)	Description
45	MS0	A25	PD18
46	MS1	DRXD/CANRX0/PA9	Debug RX/GPIO
47	MS2	DTXD/CANTX0/PA10	Debug TX/GPIO
48	MS3	TXD2/SPI0_NPCS1/PA7	ESER5 TX/GPIO
49	MS4	RXD2/SPI1_NPCS0/PA8	ESER5 RX/GPIO
50	MS5	MCI0_DA0	MCI A Data0
51	MS6	MCI0_CDA	MCI A Command
54	MS7	MCI0_CK	MCI Clock
55	MS8	MCI0_DA1	MCI A Data1
56	MS9	MCI0_DA2	MCI A Data2
57	MS10	MCI0_DA3	MCI A Data3
60	MS11	DHSDM/HHSDMA	Device/Host USB
61	MS12	DHSDP/HHSDPA	Device/Host USB
64	MS13	HHSDPB	High Speed HostA USB
65	MS14	HFSDPC	Full Speed HostB USB
66	MS15	HHSDMB	High Speed HostA USB
67	MS16	HFSDMC	Full Speed HostB USB

2.4.3. JTAG

The SoM specifications allows for access to the JTAG lines for the AT91SAM9X25 processor. These connections will allow the Flash to be programmed in circuit via a program running from the processor and also the capability to debug software.

SODIMM Pin#	SoM Pin Name	Processor Pin Name(s)	Description
139	JTAG_TCK	TCK	JTAG clock
137	JTAG_TDI	TDI	JTAG serial in
138	JTAG_TDO	TDO	JTAG serial out
140	JTAG_TMS	TMS	JTAG operation mode
112	JTAG_TRST	NTRST	Test Reset Signal

2.4.4. One-Wire/ I²C/I2C

The SoM specification calls for a one-wire port. Since the SoM-9X25 does not have a one-wire port, this line is not connected for One-Wire Operation. The 9X25 processor does provide an I2C bus and so these pins are dedicated to that function although they can also be used as GPIOs.

SODIMM Pin#	SoM Pin Name	Processor Pin Name(s)	Description
116	LOCAL1W /SCL /SCL	TWCK1/PC1	One Wire or I²C Clock
88	SDA	PA23/TWD	I2C Data
88	SDA	TWD1/PC0	I²C Data

2.4.5. Ethernet

The SoM-9X25 provides a Micrel KSZ8041 Ethernet RMII PHY IC on board. Carrier designers need only run these lines through the appropriate magnetics layer to have a functional Ethernet connection. Remember the RX and TX lines are differential pairs and need to be routed as such.

The LED/configuration pins' state at reset determines the Ethernet's configuration (10-baseT, 100-base-T, autoconfig) and the function of the LED's. The SoM-100ES and the SoM-150ES pull them all high, which configures the chip for network autoconfig, with LED1 functioning as active low link, and LED2 functioning as active low Rx Activity (Refer to Carrier schematics).

The Ethernet PHY can be put into a low power mode by writing directly to the MAC via software.
Additional power can be saved by turning off the PHY Oscillator. This is done by setting GPIO PA25 low. Make sure to send software commands to the PHY to put it into power-down mode before shutting off the Oscillator. When restoring the PHY first turn the Oscillator on before accessing the PHY.

SODIMM Pin#	SoM Pin Name	LXT972 Pin Name	Description
89	LED_LINK/ CFG_1	LED_A	Ethernet LED/Configuration pin
90	LED_RX/ CFG_2	LED_B	Ethernet LED/Configuration pin
94	Ethernet_Rx-	Ethernet_Rx-	Low differential Ethernet receive line
92	Ethernet_Rx+	Ethernet_Rx+	High differential Ethernet receive line
93	Ethernet_Tx-	Ethernet_Tx-	Low differential Ethernet transmit line
91	Ethernet_Tx+	Ethernet_Tx+	High differential Ethernet transmit line

The AT91SAM9X25 has two Ethernet MAC controllers. While Ethernet 1 is connected to the on board PHY, the Ethernet 0 signals are brought out of the SoM-9X25 allowing for an additional Ethernet on a custom carrier board. Note that to utilize the second Ethernet will require an external PHY on the Carrier board. Also several signals will have to be sacrificed to get this functionality.

SODIMM Pin#	SoM Pin Name	LXT972 Pin Name	Description
82	COMB_RTS /GPIO	RTS0/MCI1_DA1/E0 _TX0/PA2	
78	COMB_CTS /GPIO	CTS0/MCI1_DA2/E0 _TX1 /PA3	
75	IRQA/GPIO	PB0/RTS2/E0_RX0	
32	IRQB/GPIO	PB1/CTS2/E0_RX1	
123	SPI_CS0	SPI0_NPCS3/E0_RX DV/PB3	
124	SPI_CS1	PB4/E0_TXCK/TWD2	
110	SPI_CS2	PB5/E0_MDIO/TWC K2	
106	COMC_DTR /GPIO	PB2/E0_RXER/SCK2	
76	COMC_RI /GPIO	PB15/AD4/E0_RXCK	
136	GPIO15	SPI1- NPCS2/TWCK0/E0_ TXEN/PA31	
105	GPIO16	SPI1_NPCS3/TWD0/ E0_MDC/PA30	

2.4.6. SPI

The AT91SAM9X25 processor provides a dual (0 and 1) SPI module for communicating with peripheral devices. The SPI0 bus is connected internally to the serial flash, which uses SPI0_NPCS0 (SPI0_NPCS0 is not brought out to the card fingers). The first Table below lists the lines for the #0 SPI module. While the SoM pin specification allows for three SPI chip selects, there are not three available, so GPIO lines are utilized for SPI slave select line SPI_CS1 and SPI_CS2. The second Table below lists the lines for the #1 SPI module.

SPI 0 Pinout

SODIMM Pin#	SoM Pin Name	Processor Pin Name(s)	Description
122	SPI_MI	SPI0_MISO /MCI1_DA0/PA11	SPI0 serial data in
121	SPI_MO	SPI0_MOSI /MCI1_CDA/PA12	SPI0 serial data out
120	SPI_SCK	SPI0_SPCK /MCI1_CK /PA13	SPI0 serial clock out
123	SPI_CS0	SPI0_NPCS3 /E0_RXDV/PB3	SPI0 slave select line 0
124	SPI_CS1	PB4 /E0_TXCK/TWD2	SPI0 slave select line 1

SODIMM Pin#	SoM Pin Name	Processor Pin Name(s)	Description
110	SPI_CS2	PB5 /E0_MDIO/TWCK2	SPI0 slave select line 2

SPI 1 Pinout

SODIMM Pin#	SoM Pin Name	Processor Pin Name(s)	Description
133	GPIO12	SPI1_MISO /TIOA0/PA21	SPI1 serial data in
134	GPIO13	SPI1_MOSI /TIOA1/PA22	SPI1 serial data out
135	GPIO14	SPI1_SPCK /TIOA2/PA23	SPI1 serial clock out
136	GPIO15	SPI1-NPCS2 /TWCK0/E0_TXEN/PA31	SPI1 slave select line 0
105	GPIO16	A24/SPI1_CS1/PC5	SPI1 slave select line 1

2.4.7. MCI Multimedia Card

The AT91SAM9X25 processor provides a dual 4-bit MMC/SD card interface using the MC lines. MMC/SD MCI0 lines are allocated for SDIO functionality although they can be configured as GPIOs. The MMC/SD MCI1 lines are shared with SPI0 and Serial Port lines. MMC/SD MCI1 may be used with a custom carrier only.

The SoM-100ES Carrier board uses a serial SPI based MMC/SD interface. The SoM-9X25 could be programmed to use this serial interface, however the drivers provided are written to utilize the 4-bit interface and as such required the SoM-150ES Carrier board to use these drivers.

MMC/SD MCI0

SODIMM Pin#	SoM Pin Name	Processor Pin Name(s)	Description
54	MS7	MCI0_CK	MCI Clock
51	MS6	MCI0_CDA	MCIA Command
50	MS5	MCI0_DA0	MCIA D0
55	MS8	MCI0_DA1	MCIA D1
56	MS9	MCI0_DA2	MCIA D2
57	MS10	MCI0_DA3	MCIA D3

MMC/SD MCI1

SODIMM Pin#	SoM Pin Name	Processor Pin Name(s)	Description
120	SPI__SCK	SPI0_SPCK/MCI1_CK/ PA13	MCI Clock

SODIMM Pin#	SoM Pin Name	Processor Pin Name(s)	Description
121	SPI_MO	SPI0_MOSI/MCI1_CDA /PA12	MCIB Command
122	SPI_MI	SPI0_MISO/MCI1_DA0 /PA11	MCIB D0
82110	COMB_RTS /GPIOSPI_CS2	RTS0/MCI1_DA1/E0_TX0/PA2	MCIB D1
78	COMB_CTS /GPIO	CTS0/MCI1_DA2 /E0_TX1/PA3	MCIB D2
30	COMC_DCD /GPIO	PA4/SCK0/MCI1_DA3 /E0_TXER	MCIB D3

2.4.8. Serial Ports

The SoM-144 pin specification has the provision for 3 serial ports. However, the AT91SAM9X25 provides 7 serial ports. The SoM-9X25 provides 6 serial ports. The 3 additional serial ports are accommodated through the use of alternate SoM pins. The SoM specification calls for Com0 to be the terminal port, which is the default for both Dallas/Maxim's Tini OS, and μClinux. USART03 on the 9X25 processor provides handshaking pins.

SoM Defined Serial Lines

SODIMM Pin#	SoM Pin Name	Processor Pin Name(s)	Description
71	COMA_RXD	URXD0/PC9	COMA Receive/GPIO
73	COMA_TXD	UTXD0/PC8	COMA Transmit/GPIO
38	COMB_RXD	RXD0/SPI0_NPCS2/PA1	COMB Receive/GPIO
36	COMB_TXD	TXD0/SPI1_NPCS1/PA0	COMB Transmit/GPIO
82	COMB_RTS/GPIO	RTS0/MCI1_DA1 /E0_TX0/PA2	COMB RTS/GPIO
78	COMB_CTS/GPIO	CTS0/MCI1_DA2 /E0_TX1/PA3	COMB CTS/GPIO
103	COMC_RXD	RXD3/PC23	COMC Receive/GPIO
102	COMC_TXD	TXD3/PC22	COMC Transmit/GPIO
107	COMC_DSR/GPIO	PC26/SCK3	COMC DSR /GPIO
106	COMC_DTR/GPIO	PB2/E0_RXER/SCK2	COMC DTR/GPIO
76	COMC_RI/GPIO	PB15/AD4/E0_RXCK	COMC RING/GPIO
30	COMC_DCD/GPIO	PA4/SCK0/MCI1_DA3 /E0_TXER	COMC DCD/GPIO
39	COMC_RTS/GPIO	RTS3/PC24	COMC RTS/GPIO
79	COMC_CTS/GPIO	CTS3/PC25	COMC CTS/GPIO

Alternate Serial Lines

SODIMM Pin#	SoM Pin Name	Processor Pin Name(s)	Description
46	MS1	DRXD/CANRX0/PA9	Debug Receive/GPIO
47	MS2	DTXD/CANTX0/PA10	Debug Transmit/GPIO
95	CANRX	CANRX1/RXD1	COMD Receive/GPIO
96	CANTX	CANTX1/TXD1	COMD Transmit/GPIO
49	MS4	RXD2/SPI1_NPCS0/PA8	COME Receive/GPIO
48	MS3	TXD2/SPI0_NPCS1/PA7	COME Transmit/GPIO
75	IRQA/GPIO	PB0/RTS2/E0_RX0	COME RTS/GPIO
32	IRQB/GPIO	PB1/CTS2/E0_RX1	COME CTS/GPIO

2.4.9. GPIO

This section provides for the SoM general purpose IO section. All of these pins can be configured to be general-purpose digital ports. They can also be configured to take advantage of several of the functions of the 9X25's internal silicon. All of the internal A/D ports are brought out here, as well as all of the available IRQs, the second SPI and the pins for general-purpose timer/counters.

Interrupts:
The AT91SAM9X25 is capable of using any GPIO pin as an interrupt as well as the pins that are labeled IRQ.

A/D:
The AT91SAM9X25 Analog to Digital pins provides 4 channels of 10-bit resolution with a 2.27us conversion time. With the enhanced DSP extensions, this can make quite a capable signal processor. The Analog to Digital Reference is controlled by PB16 and can be enabled or disabled to reduce power consumption.

Timer/Counters:
The general-purpose Timer/Counter (TC) module on the AT91SAM9X25 is comprised of six 32-bit timer/counter channels with independently programmable input-capture or output compare lines. These can be used for a wide variety of timed applications, including counters and PWM.

For more information on the A/D and Timer functions of the AT91SAM9X25 processor, users are referred to the TC section of the AT91SAM9X25 *User's Manual*.

Module Status LED:
A Green general purpose Status LED is connected to PC10 of the processor.

SODIMM Pin#	SoM Pin Name	Processor Pin Name(s)	Description
75	IRQA/GPIO	PB0/RTS2/E0_RX0	GPIO
32	IRQB/GPIO	PB1/CTS2/E0_RX1	GPIO
40	GPIO0	TIOB3/PC3	GPIO
42	GPIO1	TCLK3/PC4	GP IRQ /Serial CLK/GPIO
87	GPIO2	TK/TCLK0/PA24	SSC TX CLK/TC Ext CLK/GPIO
80	GPIO3	TF/TCLK1/PA25	SSC TX Sync/TC Ext CLK/GPIO
125	GPIO4	TD/TCLK2/PA26	SSC TX Data/TC Ext CLK/GPIO
126	GPIO5	RD/TIOB0/PA27	SSC RX Data/TC Chan I/O/GPIO
127	GPIO6	TIOB1/RK/PA28	SSC RX CLK/TC Chan I/O/GPIO
128	GPIO7	RF/TIOB2/PA29	SSC RX Sync/TC Chan I/O/GPIO
129	GPIO8	AD0/PWM0/SCK1/PB11	Analog Input/Pulse Width Modulated Output /GPIO
130	GPIO9	AD1/PWM1/PB12	Analog Input/Pulse Width Modulated Output /GPIO
131	GPIO10	AD2/PWM2/PCK1/PB13	Analog Input/Pulse Width Modulated Output /GPIO
132	GPIO11	AD3/PWM3/PB14	Analog Input/Pulse Width Modulated Output /GPIO
133	GPIO12	SPI1_MISO/TIOA0/PA21	SPI Data In/ TC Chan I/O/GPIO
134	GPIO13	SPI1_MOSI/TIOA1/PA22	SPI Data Out/ TC Chan I/O/GPIO
135	GPIO14	SPI1_SPCK/TIOA2/PA23	SPI CLK/ TC Chan I/O/GPIO
136	GPIO15	SPI1-NPCS2 /TWCK0/E0_TXEN/PA31	SPI CS/I^2C/GPIO
105	~LDAC/~GPIO	SPI1_NPCS3 /TWD0/E0_MDC/PA30	SPI CS/I^2C/GPIO
114	8MHz	TIOA3/PC2	TC Chan I/O/GPIO
115	200KHz	TIOA4/PC5	TC Chan I/O/GPIO
117	14.3MHz	TIOA5/PC12	TC Chan I/O/GPIO

2.5. Power Connections

The SoM-9X25 requires a 3.3V supply for the Bus and I/O voltages. The 1.0V core voltage is regulated on module from the 3.3V. Unlike some other modules no other supply voltage other than 3.3V is required.

SODIMM Pin#	SoM Pin Name	Processor Pin Name(s)	Description
3,4,141,142	3.3VCC	3.3VCC	3.3 Volt I/O voltage to the processor
1,2,52,53, 58,59,62,63, 68,69,143, 1144	GND	GND	Ground
119	VSTBY	VDDBU	Voltage standby, this is the backup voltage provided to the internal RTC of the processor. If RTC readings are not important for the application, this can be attached to the 3.3V rail.
118	ALT_VCC	Not Used	Not Required
101	AV_VCC	Not Used	Analog power is not required for the SoM-9X25

SODIMM Pin#	SoM Pin Name	Processor Pin Name(s)	Description
99	V_REF	Not Used	No external Analog Reference voltage is required for the SoM-9X25.

2.6. Boot Options

The SoM specification provides two pins for boot time configuration. On the SoM-9X25, these are BMS and Flash Disable. The Boot Mode Select (BMS) pin allows the SoM-9X25 to low-level booted from either its internal ROM or external (carrier resident) NOR flash.

The Flash Disable pin should be tied to GND to enable the Serial Data Flash .

The Module can high-level boot from either the Serial Data Flash or the eMMC Flash (selected through the low-level bootloader). It is recommended to high-level boot from the Serial Data Flash, as this Flash is more reliable than the eMMC Flash.

SODIMM Pin#	SoM Pin Name	Processor Pin Name(s)	Description
41	BOOT_OPTION1	BMS	Boot Mode Select
74	BOOT_OPTION2	Flash Disable	Serial Data Flash Disable

2.7. Serial Data Flash

The Serial Data Flash is connected to SPI0 and uses SPI0_NPCS0 to enable it. The Serial Data Flash also has a Write Protect Provision. To Write Protect the Serial Data Flash pull SoM pin# 85 low. SoM pin# 85 is pulled up by a 10K ohm resistor on the module.

If this feature is required it would be implemented on the carrier as a jumper or an I/O line.

3. Design Considerations

One of the goals of the SoM-9X25 is to provide a modular, flexible and inexpensive solution capable of delivering high-end microcontroller performance.

3.1. The EMAC SoM Carrier-SoM-150ES

EMAC provides an off the shelf carrier for the SoM-9X25 module, the SoM-150ES, which provides power to SoM modules and provides them with an extended range of I/O. This board comes with full schematics and BOM, and can be used as is, or as a reference for a customer's own design.

http://www.emacinc.com/som/som150es.htm

EMAC also offers a semi-custom engineering service. By modifying an existing design, EMAC can offer quick-turn, low-cost engineering, for your specific application.

3.2. The EMAC SoM Carrier-SoM-100ES

EMAC provides an off the shelf carrier for it's SoM modules, the SoM-100ES, which provides power to SoM modules and provides them with an extended range of I/O. This board can be used in conjunction with the SoM-9GX25, however the Carrier does not provide USB. Additionally, the MMC/SD Flash interface will not work with the provided 4-bit drivers.

http://www.emacinc.com/som/som100es.htm

3.3. Power

The SoM-9X25 requires a voltage of 3.3V at ~300mA. For a bare-bones population, users can get away with using only 3.3V, and simply provide this to all the voltage inputs listed in Power Connections section. This however, will not provide battery backup for the RTC or 5V for the USB Host ports

3.3.1. Legacy

ALT_VCC is a legacy connection, required to support the SoM-400EM and may be used in future SoM modules. If general SoM compatibility is not an issue then this can be tied to 3.3V. The SoM-9X25 does not use this connection.

3.3.2. Analog Reference

No external Analog Reference voltage (VREF) is required for the SoM-9X25. An on-module 2.5V reference is provided. Analog input range is therefore 0 to 2.5V. This pin is normally a No Connect on the Module. This Reference uses power and therefore can be turned off by setting GPIO Port Line PA22 to a high, thus conserving about 3 ma.

3.3.3. Shutdown Logic Pins

The SHDN signal is a digital output only (0 or 3.3V), which is driven by the Shutdown Controller on the processor.

The WKUP signal is a digital input with an input voltage 0 or 3.3V, pulled up on-module to 3.3V.

Both of these pins are connected directly to the processor.

3.3.4. Battery Backup

The SoM-9X25 contains 3 potentially non-volatile memory areas, the eMMC flash, the real time clock, and the serial flash of the processor. The flash is always non-volatile, the real time clock requires a backup voltage to maintain its data. This backup voltage comes from the VSTBY pin, and should be connected to 3.3 volts.

The RTC will draw approximately 10 uA when the processor is not powered by the 3.3V supply. The Static current can rise to 18uA if the temperature increases to 85° C. When the module is powered no current is drawn from the backup battery supply. If the RTC is not needed, this can be tied to 3.3V.

The SoM-100ES and SoM-150ES provide battery backup voltage through a socketable BR2032, which is a standard 3V 190mA/H 20MM coin battery that can be picked up from most electronics stores.

3.3.5. Analog Voltage

When designing power for the Analog subsystem there are 2 major considerations, range and accuracy.

- **Range**
  The AV_VCC pin normally provides the range. However on the SoM-9X25 the Analog VCC (VDDANA) is directly connected to filtered 3.3V. The power supplied to the analog subsystem limits the range of voltages that can be accurately measured. The internal analog converters cannot measure a voltage higher than their power rail. The Analog input range is 0 to 2.5V.

- **Accuracy**
  The accuracy of the A/D converters is determined by the V_REF pin, which provides the reference voltage to the analog subsystem. The stability of the voltage between this pin and ground will affect the accuracy of the subsystem's measurements. No external Analog Reference voltage is required for the SoM-9X25. An on-module 2.5V reference is provided. Analog input range is therefore 0 to 2.5V.

4. Software

The SoM-9X25 offers a wide variety of software support from both open source and proprietary sources. The hardware core was designed to be software compatible with the Atmel AT91SAM9X25-EK reference design, which is supported by Linux and WinCE 6.0.

4.1. Eclipse

EMAC provides sample code for the SoM-9X25 as CDT projects within the free Eclipse IDE. Eclipse is a powerful open-source Java based IDE. It has plug-ins for development and debugging in Java and C, as well as several other languages.

http://www.eclipse.org/

EMAC offers a free download of Eclipse pre-integrated with the CDT plug-in and plug-ins for remote debugging and SVN. Eclipse requires the Java Runtime Environment to be installed on the development system. Currently EMAC only supports the use of Eclipse under the Linux environment for the SoM-9X25. The Eclipse environment and JRE for Linux are available online along with user manuals.

ftp://ftp.emacinc.com/PCSBC/Development_Kits/EMAC_Open_Tools/

4.1.1. Eclipse CDT plug-in

The Eclipse CDT plug-in provides a powerful graphical IDE for C development. This plug-in relies on GNU Make to build its files, so its projects are highly portable to other IDE's (or lack of them completely). It also offers a MI based debugger, for plugging into newer gdbs.

http://www.eclipse.org/cdt/

4.2. Das U-Boot

The SoM-9X25 is distributed with Das U-Boot installed. U-Boot is an open source/cross-architecture platform independent bootloader. It supports reading and writing to the flash, auto-booting, environmental variables, and tftp. Das U-boot can be used to upload and run and/or reflash the OS on the SoM-9X25 without the use of a JTAG cable, or to run stand-alone programs without an OS. SoM-9X25 modules are shipped with a valid MAC address installed in flash in the protected ethaddr environmental variable of U-Boot. At boot time U-Boot automatically stores this address in a register within the MAC, which effectively provides it to any OS loaded after that point. Future releases of the SoM-9X25M will store the MAC address in the onboard serial flash.

4.3. Embedded Linux

EMAC Open Embedded Linux is an open source Linux distribution for use in embedded systems. The current SoM-9X25 build uses a Linux 2.6 kernel that has been has been patched to support the SoM-9X25 and SoM-150ES devices.

The distribution contains everything a user could expect from a standard Linux kernel, powerful networking features, advanced file system support, security, debugging utilities, and countless other features.

The SoM-9X25 will work out of the box with EMAC's Embedded Linux distribution, and EMAC provides the most up to date distribution via ftp. The SoM-9X25 comes preinstalled with a 2.6.20 or later Linux kernel.

4.3.1. Linux with Xenomai Real Time Extensions

Xenomai provides real time extensions to the kernel and can be used to schedule tasks with hard deadlines and μs latencies. The Xenomai build is an additional module that can be added to the standard Linux kernel and is available for a one-time inexpensive support/installation fee.

http://www.xenomai.org/

4.3.2. Linux Modules

EMAC provides support for many Linux modules such as: Cherokee Web Server, PHP, SQLite, Perl, SNMP, DHCP Server, etc. As with the Xenomai module, other modules can be added to the standard Linux file system and are available for a one-time inexpensive support/installation fee.

4.3.3. Linux 2.6 patches

In addition to standard Embedded Linux support, EMAC has released a number of patches and device drivers from the open source community and from internal EMAC engineering into its standard distribution. Currently, the kernel patches and some useful scripts may be downloaded from EMAC's SoM ftp site at:

ftp://ftp.emacinc.com/Controllers/SoM/SoM-9X25/Software/Linux-Kernel/

Along with kernel patches, EMAC provides the binaries for the kernel and root file system.

4.4. Open Embedded

The Linux build for the SoM-9X25 is based on the Open Embedded (www.openembedded.org) Linux build system. The current kernel is Linux 2.6.20 or higher patched to support the SoM-9X25. Open Embedded is a superior Linux distribution for embedded systems. Custom Linux builds are also available on request.

The basic root file system includes:

- Busybox 1.9.2 or higher
- Hotplugging support
- APM utilities for power management
- Dropbear SSH server
- Telnet/FTP support running under inetd
- busybox-httpd HTTP server
- JFFS2 file system with utilities

4.5. ARM EABI Cross Compiler

The popular open source gcc compiler has a stable build for the ARM family. The Embedded Linux kernel and EMAC Eclipse CDT projects use this compiler for building ARM stand alone, and OS specific binaries. The EMAC Eclipse SDK provides source level debugging over either the JTAG port or over Ethernet or serial using gdbserver. The Linux binaries for the ARM EABI cross compiler are available online along with the SDK for the SoM-9X25 at the following location.

ftp://ftp.emacinc.com/Controllers/SoM/SoM-9X25/Tools/

4.6. Java

The AT91SAM9G20 includes the ARM Jazelle hardware which combined with the Jazelle software package provides an advanced multi-tasking Java Virtual Machine (JVM). The use of the Jazelle software requires a license from ARM and is not provided with the EMAC SDK. For more information see the following link.

http://www.arm.com/products/esd/jazelle_home.html

Note: All of the links in this document are subject to change. Please contact EMAC for updated link locations if necessary.

