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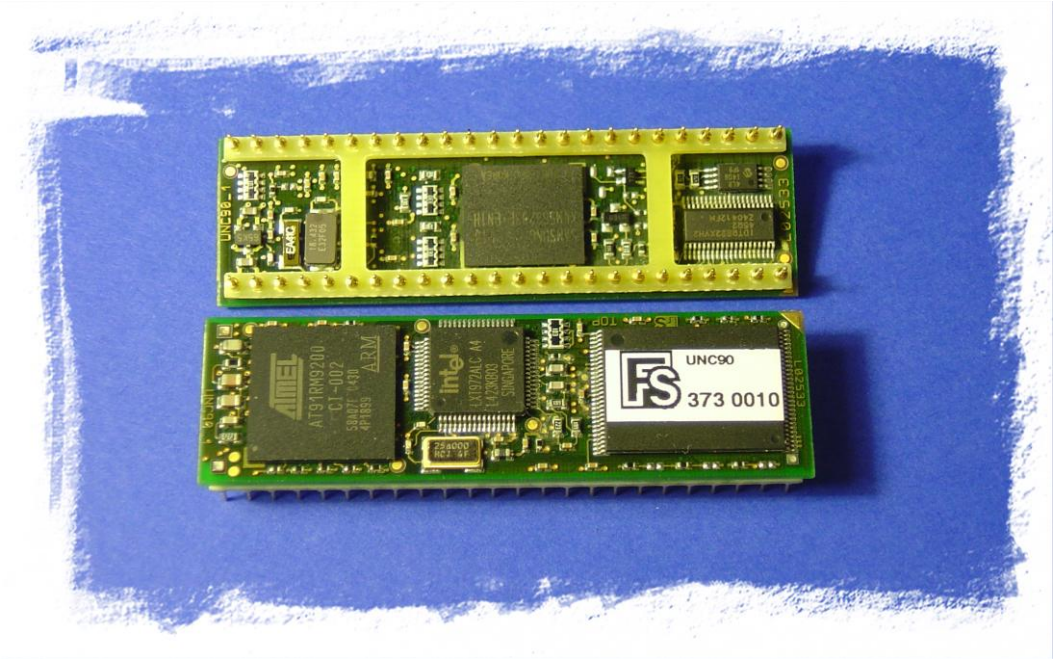
CONNECTCORE 9U - Datasheet

with ATMEL AT91RM9200 Processor



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1. CONNECTCORE 9U Overview

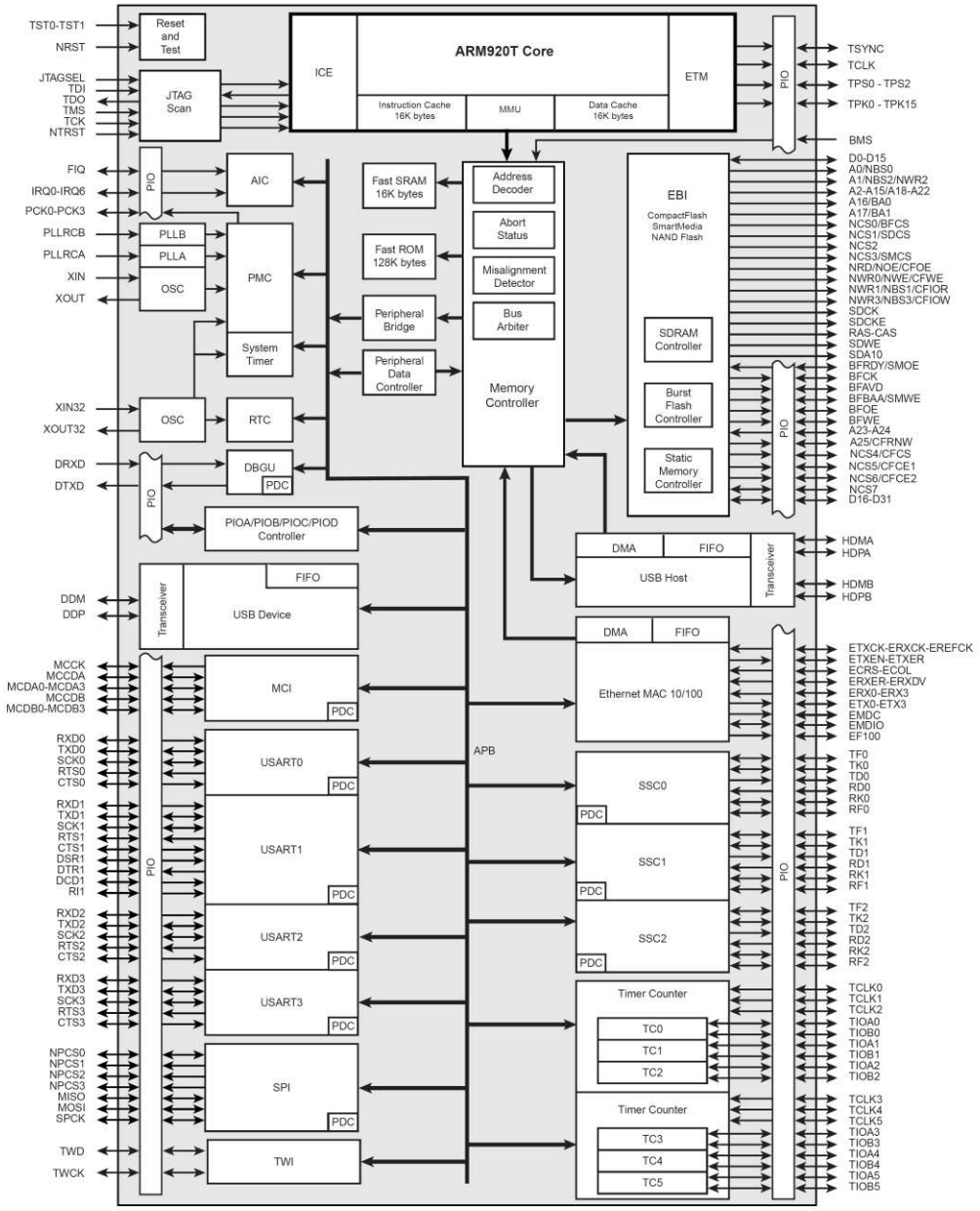
The CONNECTCORE 9U microcontroller module is a member of the UNC (Universal Network Controller) family. The CONNECTCORE 9U module is based on Atmel's AT91RM9200 ARM9 microcontroller running at 180 MHz. It's housed in an industry-standard DIL 48 package, making it extremely easy and cost-effective to integrate into designs which require Ethernet and USB connectivity.

The CONNECTCORE 9U has the same form factor (63 x 19 mm) as the CONNECTCORE 7U. The pin compatibility allows CONNECTCORE 7U users to easily migrate to the ARM9 technology, offering higher performance.

2. ATMEL AT91RM9200

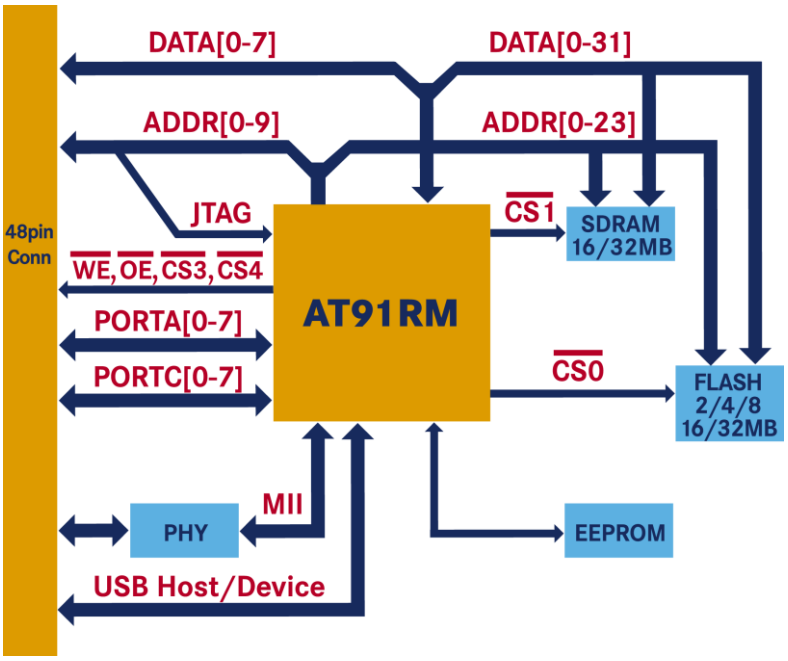
The AT91RM9200 is a complete system-on-chip built around the ARM920T ARM Thumb processor. It incorporates a rich set of system and application peripherals and standard interfaces in order to provide a single-chip solution for a wide range of compute-intensive applications that require maximum functionality at minimum power consumption at lowest cost.

2.1. Processor Block Diagram



3. CONNECTCORE 9U

3.1. Module Block Diagram



3.2. Features

- ATMEL AT91RM9200 Processor
- Processor clock of 180 MHz
- Up to 32Mbytes Flash memory (16-bit)
- Up to 32Mbytes SDRAM memory (32-bit@80MHz)
- 8Kbytes EEPROM for storage of configuration data
- Reset Logic (through +3.3V Power Monitor)
- 1 Full Function UART + 1 standard UART (TXD, RXD, RTS and CTS)
- GPIOs and Interrupt signals
- 10/100 Base-T Ethernet communication (ATMEL MAC + external PHY)
- USB Host and Device 2.0 Full Speed (12 Mbit/s)
- 2 Synchronous Serial Controller
- Two wire interface (TWD)
- JTAG Interface and Integrated Embedded In-Circuit-Emulator
- Single +3.3V Power Supply
- Same size and pinning as CONNECTCORE 7U (compatibility with CONNECTCORE 7U)
- Extended temperature grade (-25°C to +70°C)

3.3. GPIO usage on CONNECTCORE 9U

3.3.1. PIO Controller A usage

I/O Line	Peripheral A	Peripheral B	Reset State	Comments
PA0	MISO	PCK3	I/O	
PA1	MOSI	PCK0	I/O	
PA2	SPCK	**IRQ4**	I/O	
PA3	PCS0#	IRQ5	I/O	
PA4	PCS1#	PCK1	I/O	
PA5	PCS2#	TXD3	I/O	
PA6	PCS3#	RXD3	I/O	
PA7	**ETXCK** / **EREFCK**	PCK2	I/O	
PA8	**ETXEN**	MCCDB	I/O	
PA9	**ETX0**	MCDB0	I/O	
PA10	**ETX1**	MCDB1	I/O	
PA11	**ECRS** / **ECRSDV**	MCDB2	I/O	
PA12	**ERX0**	MCDB3	I/O	
PA13	**ERX1**	TCLK0	I/O	
PA14	**ERXER**	TCLK1	I/O	
PA15	**EMDC**	TCLK2	I/O	
PA16	**EMDIO**	IRQ6	I/O	
PA17	TXD0	TIOA0	I/O	
PA18	RXD0	TIOB0	I/O	
PA19	SCK0	TIOA1	I/O	
PA20	CTS0	TIOB1	I/O	
PA21	RTS0	TIOA2	I/O	
PA22	**RXD2**	TIOB2	I/O	
PA23	**TXD2**	IRQ3	I/O	
PA24	SCK2	PCK1	I/O	
PA25	**TWD**	**IRQ2**	I/O	
PA26	**TWCK**	**IRQ1**	I/O	
PA27	MCCK	TCLK3	I/O	
PA28	MCCDA	TCLK4	I/O	
PA29	MCDA0	TCLK5	I/O	
PA30	**DRXD**	**CTS2**	I/O	
PA31	**DTXD**	**RTS2**	I/O	

⇒ The grayed line indicate the GPIOs is used on the CONNECTCORE 9U.

⇒ The bolded name indicate the main functions why this GPIO has been chosen.

3.3.2. PIO Controller B usage

I/O Line	Peripheral A	Peripheral B	Reset State	Comments
PB0	**TF0**	RTS3	I/O	
PB1	**TK0**	CTS3	I/O	
PB2	**TD0**	SCK3	I/O	
PB3	**RD0**	MCDA1	I/O	
PB4	RK0	MCDA2	I/O	
PB5	RF0	MCDA3	I/O	
PB6	**TF1**	TIOA3	I/O	
PB7	**TK1**	TIOB3	I/O	
PB8	**TD1**	TIOA4	I/O	
PB9	**RD1**	TIOB4	I/O	
PB10	RK1	TIOA5	I/O	
PB11	RF1	TIOB5	I/O	
PB12	TF2	**ETX2**	I/O	
PB13	TK2	**ETX3**	I/O	
PB14	TD2	**ETXER**	I/O	
PB15	RD2	**ERX2**	I/O	
PB16	RK2	**ERX3**	I/O	
PB17	RF2	**ERXDV**	I/O	
PB18	RI1	**ECOL**	I/O	
PB19	DTR1	**ERXCK**	I/O	
PB20	**TXD1**		I/O	
PB21	**RXD1**		I/O	
PB22	SCK1		I/O	
PB23	**DCD1**		I/O	
PB24	**CTS1**		I/O	
PB25	**DSR1**	EF100	I/O	
PB26	**RTS1**		I/O	
PB27	PCK0		I/O	
PB28	**FIQ**		I/O	
PB29	**IRQ0**		I/O	

⇒ The grayed line indicate the GPIOs is used on the CONNECTCORE 9U.

⇒ The bolded name indicate the main functions why this GPIO has been chosen.

3.3.3. PIO Controller C usage

I/O Line	Peripheral A	Peripheral B	Reset State	Comments
PC0	BFCK		I/O	
PC1	BFRDY / SMOE#		I/O	
PC2	BFAVD#		I/O	
PC3	BFBAA# / SMWE#		I/O	
PC4	BFOE#		I/O	
PC5	BFWE#		I/O	
PC6	WAIT#		I/O	
PC7	**A23**		A23	
PC8	**A24**		A24	
PC9	A25 / CFRNW		A25 / CFRNW	
PC10	**CS4#** / CFCS#		CS4# / CFCS#	
PC11	CS5# / CFCE1#		CS5# / CFCE1#	
PC12	CS6# / CFCE2#		CS6# / CFCE2#	
PC13	CS7#		CS7#	
PC14			I/O	
PC15			I/O	
PC16	**D16**		I/O	
PC17	**D17**		I/O	
PC18	**D18**		I/O	
PC19	**D19**		I/O	
PC20	**D20**		I/O	
PC21	**D21**		I/O	
PC22	**D22**		I/O	
PC23	**D23**		I/O	
PC24	**D24**		I/O	
PC25	**D25**		I/O	
PC26	**D26**		I/O	
PC27	**D27**		I/O	
PC28	**D28**		I/O	
PC29	**D29**		I/O	
PC30	**D30**		I/O	
PC31	**D31**		I/O	

⇒ The grayed line indicate the GPIOs is used on the CONNECTCORE 9U.

⇒ The bolded name indicate the main functions why this GPIO has been chosen.

3.3.4. PIO Controller D usage

I/O Line	Peripheral A	Peripheral B	Reset State	Comments
PD0	ETX0		I/O	
PD1	ETX1		I/O	
PD2	ETX2		I/O	
PD3	ETX3		I/O	
PD4	ETXEN		I/O	
PD5	ETXER		I/O	
PD6	DTXD		I/O	
PD7	PCK0	TSYNC	I/O	
PD8	PCK1	TCLK	I/O	
PD9	PCK2	TPS0	I/O	
PD10	PCK3	TPS1	I/O	
PD11		TPS2	I/O	
PD12		TPK0	I/O	
PD13		TPK1	I/O	
PD14		TPK2	I/O	
PD15	TD0	TPK3	I/O	
PD16	TD1	TPK4	I/O	
PD17	TD2	TPK5	I/O	
PD18	PCS1#	TPK6	I/O	
PD19	PCS2#	TPK7	I/O	
PD20	PCS3#	TPK8	I/O	
PD21	RTS0	TPK9	I/O	
PD22	RTS1	TPK10	I/O	
PD23	RTS2	TPK11	I/O	
PD24	RTS3	TPK12	I/O	
PD25	**DTR1**	TPK13	I/O	
PD26		TPK14	I/O	
PD27		TPK15	I/O	

⇒ The grayed line indicate the GPIOs is used on the CONNECTCORE 9U.

⇒ The bolded name indicate the main functions why this GPIO has been chosen.

3.4. Port pin mapping

The mapping of the PORT pins available externally on the CONNECTCORE 9U module are shown in the table below :

Signal CONNECTCORE 7U	Signal CONNECTCORE 9U	Serial	SPI, NMSI	Special Functions	Hardwired
PORTA0	PB23 **DCD1#** / none PB0 **TF0** / RTS3	DCD1#	TF0		
PORTA1	PB24 **CTS1#** / none	CTS1#			
PORTA2	PB25 **DSR1#** / EF100	DSR1#			
PORTA3	PB21 **RXD1** / none PB3 **RD0** / MCDA1	RXD1	RD0		
PORTA4	PB1 **TK0** / CTS3#	RI1# (1)	TK0		
PORTA5	PB26 **RTS1#** / none	RTS1#			
PORTA6	PD25 **DTR1#** / TPK13 **PB27** PCK0	DTR1#			
PORTA7	PB20 **TXD1** / none PB2 **TD0** / SCK3	TXD1	TD0		
PORTC0	PB6 **TF1** / TIOA3 PB29 **IRQ0** / none **PA27** MCCK / TCLK3		TF1	IRQ0	
PORTC1	PA30 DRXD / **CTS2#** PB28 **FIQ**	CTS2#		FIQ	
PORTC2	PA25 **TWD** / **IRQ2**			IRQ2	TWD (2)
PORTC3	PA22 **RXD2** / TIOB2 PB9 **RD1** / TIOB4 **PA2** SPCK / **IRQ4**	RXD2	RD1	IRQ4	
PORTC4	**PA24** SCK2 / PCK1, PB7 **TK1** / TIOB3		RESET_OUT# / TK1		

Signal CONNECTCORE 7U	Signal CONNECTCORE 9U	Serial	SPI, NMSI	Special Functions	Hardwired
PORTC5	PA31 DTXD / **RTS2#**	RTS2#			
PORTC6	PA26 **TWCK** / **IRQ1**			IRQ1	TWCK (2)
PORTC7	PA23 **TXD2** / IRQ3 PB8 **TD1** / TIOA4	TXD2	TD1		

Notes :

- (1) - The signal RI1 (from USART1) is shared with the ECOL (collision detect) MII signal and it's not accessible on another pin. The ring indicator function must be made through an IRQ sensitive port pin. The port pin used is PA2, this pin has an IRQ feature.

- (2) - TWD and TWCK signals come from the Two Wire Unit (TWI Unit) and are used for I2C interface.

- Only USART1 has DSR, DTR, DCD and RI signals – the other one is a standard USART (only TXD, RXD, CTS and RTS signals).

- Signals DTXD and DRXD are accessible on the CONNECTCORE 9U socket - this allow us to have access to the Debug Unit (DBGU). DTXD is accessible on PORTC5 and DRXD is accessible on PORTC1.

- The port pins can be used as interrupt pins, but there is a double condition. Firstly, the PIO interrupts are not level sensitive, but change sensitive. Secondly, these IRQ can not be used in power save modus (an input change detection is possible only by comparing two successive samplings of the input of the I/O line, that's why the PIO controller clock must be enabled or this clock signal can be stopped during power save modus). The input change interrupt is available, regardless of the configuration of the I/O line, i.e. configured as an input only, controlled by the PIO controller or assigned to a peripheral function.

3.5. Chip Selects

Chip Select	Usage	Memory-Map

Chip Select	Usage	Memory-Map
CS0#	Flash Memory	0x1000 0000 – 0x1FFF FFFF
CS1#	SDRAM Memory	0x2000 0000 – 0x2FFF FFFF
CS2#	Not used	
CS3#	Available outside CONNECTCORE 9U	0x4000 0000 – 0x4FFF FFFF
CS4#	Available outside CONNECTCORE 9U	0x5000 0000 – 0x5FFF FFFF
CS5#	Not used	
CS6#	Not used	
CS7#	Not used	

3.6. Reset Pin

On the CONNECTCORE 7U, the reset pin was a bi-directional signal allowing to directly connect a reset button outside the module. Since the power on reset needs to way until the 32 kHz Oscillator is stabilized (start-up time of 900ms), the power on reset signal on the CONNECTCORE 9U must be quite long and that's why a open-drain reset controller has been used (this type of controller have longer reset time). This choice implies that when a reset signal comes from outside, it needs to be debounced externally and an additional reset controller should be added on the baseboard.

3.7. USB

If the USB signals aren't used externally on the base board, it's recommended to put pull-down resistors on the signals. A typical value for this pull-down resistors is 15k.

3.8. EEPROM mapping

The system needs a storage for configuration data, such as the MAC address for the Ethernet Controller. On the module is a 8Kbytes EEPROM with an I²C interface for this purposes.

Address	Description
0x0000 – 0x007F	Production Area
0x0080 – 0x00FF	Reserved Area
0x0100 – 0x08FF	U-Boot environment
0x0900 – 0x0CFF	Linux environment
0x0D00 – 0x1FFF	User space

3.9. Software

3.9.5. Bootloader

The CONNECTCORE 9U boots with the universal bootloader U-Boot.

U-Boot is an open-source cross-platform boot loader that provides out-of-the-box support for hundreds of embedded boards and a wide variety of CPUs including PowerPC, ARM, XScale, MIPS, Coldfire, NIOS, Microblaze and x86.

U-Boot is capable of downloading the kernel and the rootfs by Ethernet. Therefore no flash programming is needed to test a new kernel.

After power-up or reset the processor loads the U-Boot boot loader. This is performed in different steps.

- The AT91RM9200 microcontroller executes a primary bootstrap that configures the interrupt and exception vectors, the clocks and the SDRAM, then decompresses the U-Boot code from Flash to RAM, and finally passes the execution control to the U-Boot.

- The U-Boot configures the Ethernet PHY, the Flash memory, the serial console and loads the settings stored as environment variables in the EEPROM.

- Then after a timeout (programmable) U-Boot executes the script (list of commands separated by semi-colons) contained in environment variable *bootcmd*. The user can stop the autoboot by sending a character to the serial port (pressing a key from the serial console connected to the target). If stopped, U-Boot displays a command line console.

U-Boot uses the first 128k address range of the flash memory to store the bootloader.

Address	Area
0x1002 0000 – 0x10FF FFFF	15.875Mbytes Flash available
0x1001 0000 – 0x1001 FFFF	64 Kbytes U-Boot image
0x1000 0000 – 0x1000 FFFF	64 Kbytes boot.bin image

The preliminary bootloader (boot.bin) is in charge of making the very early initialization of the CPU. It also loads the u-boot image from flash to RAM and once it is in RAM runs from there.

3.9.6. Operating System

The CONNECTCORE 9U is delivered with LxNETES as a complete Linux development environment. The following features are integrated in the distribution :

- Linux kernel v2.6 for ARM9
- GNU toolchain : GCC v3.3.2, GDB and uClibc v0.9.24
- Dynamic loading of modules
- Shared libraries
- Supported filesystems : CRAMFS, JFFS2, NFS and others
- Support for on chip 10/100 Ethernet
- PPP support
- Debugging via gdbserver over serial or Ethernet

- Flash programming utilities (update-flash)
- EEPROM support

4. Connector pinout

Pin	Type	Signal	Description	Comment
1	Out	A4	Memory Address	
2	O/O	A5/TCK	ADDR5..9 are multiplexed with JTAG signals controlled by LEDLNK/SEL#	JTAG-Booster / Multi-ICE must be removed if JTAG signal are not selected (LEDLNK/SEL# jumper not plugged)
3	O/I	A6/TMS		
4	O/I	A7/TDI		
5	O/O	A8/TDO		
6	O/I	A9/TRST#		
7	I/O	PORTA0	PORTA0..7 have different functions depending on setup and usage – See general purpose I/O descriptions for details	
8	I/O	PORTA1		
9	I/O	PORTA2		
10	I/O	PORTA3		
11	I/O	PORTA4		
12	I/O	PORTA5		
13	I/O	PORTA6		
14	I/O	PORTA7		

Pin	Type	Signal	Description	Comment
15	I/O	PORTC0	PORTC0..7 have different functions depending on setup and usage – See general purpose I/O descriptions for details	
16	I/O	PORTC1		
17	I/O	PORTC2		4k7 pull-up resistor / SDAT_I2C
18	I/O	PORTC3		
19	I/O	PORTC4		
20	I/O	PORTC5		
21	I/O	PORTC6		4k7 pull-up resistor / SCLK_I2C
22	I/O	PORTC7		
23	PWR	+3.3V	Power Supply	
24	PWR	GND	Ground connection	
25	Od	PWRGOOD	Power Good	10k pull-up resistor
26	In	TPIP	Ethernet Input +	
27	In	TPIN	Ethernet Input -	
28	Out	TPOP	Ethernet Output +	
29	Out	TPON	Ethernet Output -	
30	O/I	LEDLNK/SEL#	Ethernet Activity LED – ADDR/JTAG Mode Selection : JTAG mode active when grounded	It's very important to implement a jumper outside the module to change between addresses or JTAG signals. For the CONNECTCORE 9U to boot-up, the jumper must not be set.
31	Bidir	USB-	USB differential Data negative	
32	Bidir	USB+	USB differential Data positive	
33	I/O	D7	Memory Data	
34	I/O	D6	Memory Data	
35	I/O	D5	Memory Data	
36	I/O	D4	Memory Data	
37	I/O	D3	Memory Data	
38	I/O	D2	Memory Data	
39	I/O	D1	Memory Data	
40	I/O	D0	Memory Data	
41	Out	A0	Memory Address	
42	Out	A1	Memory Address	
43	Out	A2	Memory Address	

Pin	Type	Signal	Description	Comment
44	Out	A3	Memory Address	
45	Out	WE#	Memory Write Enable	
46	Out	RD#	Memory Read Enable	
47	Out	CS3#	Chip Select 4	
48	Out	CS4#	Chip Select 3	

In : Input signal
Out : Output signal
Bidir : Bi-directional
Pwr : Power Line
I/O : Input or output signal
Od : Open-drain

5. Ordering Number

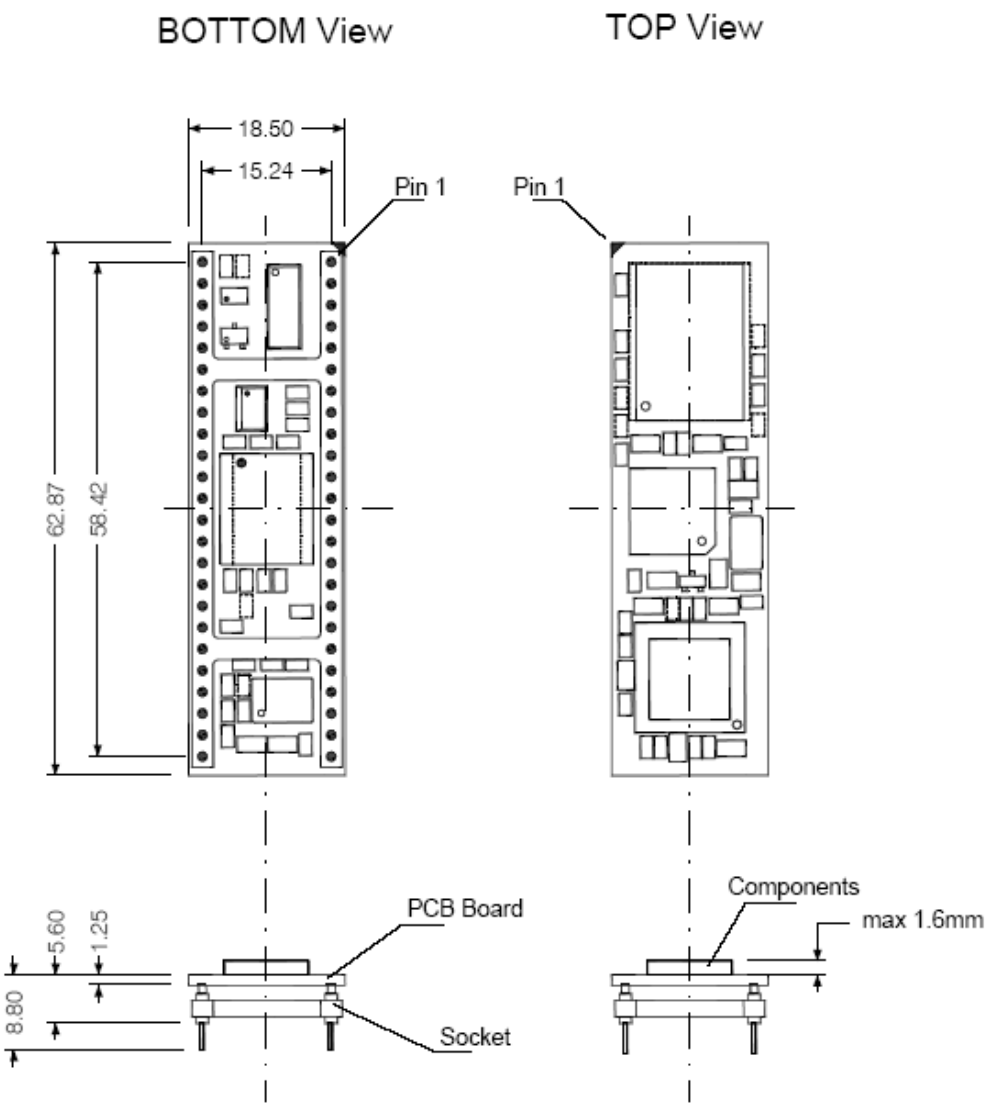
Order Number	AT91RM9200	SDRAM	Flash	Temperature Grade
373	180MHz	16MB	16MB	-25°C to 70°C
	180MHz	32MB	16MB	-25°C to 70°C

6. DC Characteristics

The following table provide DC characteristics for the CONNECTCORE 9U module :

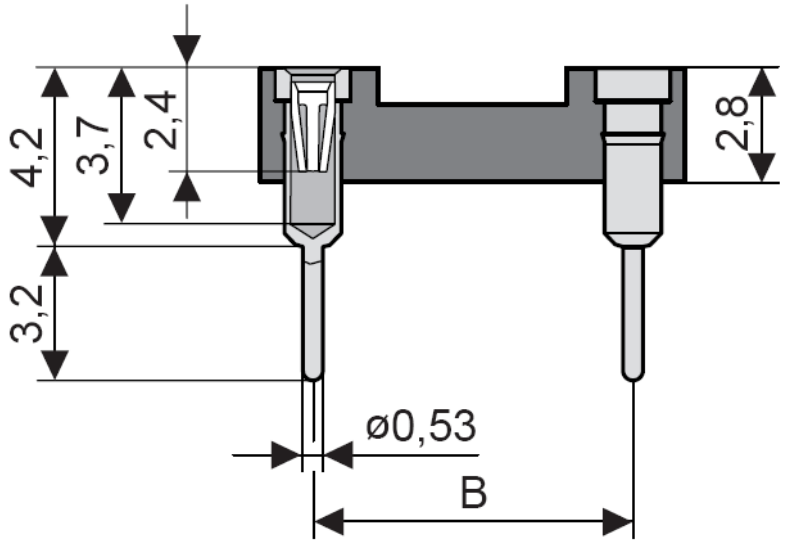
OPERATING CONDITIONS					
Symbol	**Description**	**Min**	**Typ.**	**Max**	**Unit**
Vcc	Supply Voltage	3.14	3.3	3.45	V
Icc	Supply Current @ 110 MHz		152		mA
	Supply Current @ 180 MHz		TBD		mA

7. Mechanical drawings



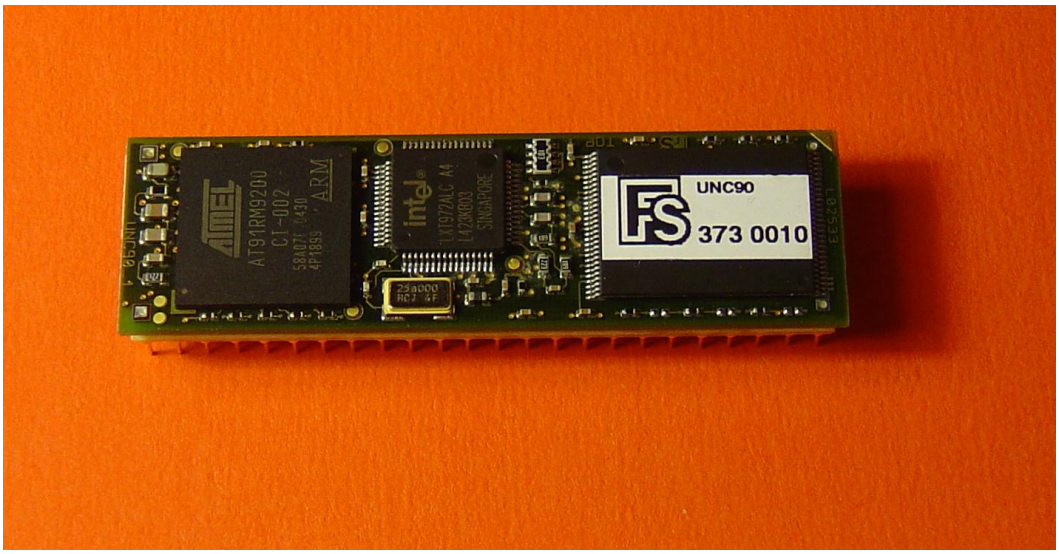
Dimensions are given in mm

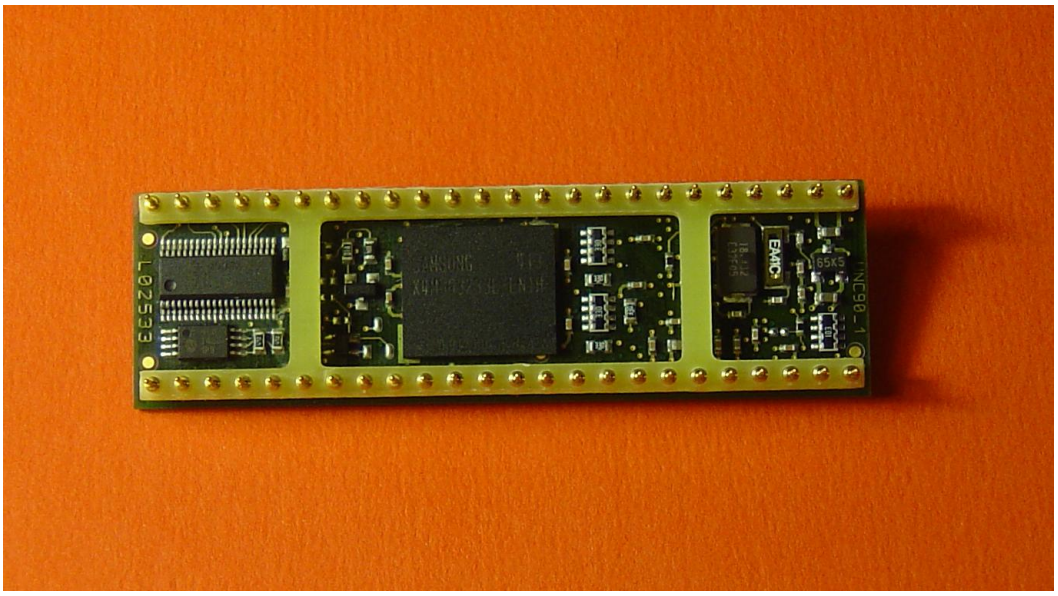
The CONNECTCORE 9U has a total height of 8.8 + 1.6 = 10.4mm.



When the CONNECTCORE 9U is directly soldered on the PCB, the height of the module is : 5.6 + 1.6 = 7.2mm

When the CONNECTCORE 9U is plugged in a socket, the total height of the module increase by at least 4.2 mm. So the total height would be of : 7.2 + 4.2 = 11.4 mm




L02533
SAMSUNG
BMC
65K9
UNC90_1