

## Features

- Comprehensive Library of Standard Logic and I/O Cells
- ATC20 Core and I/O Cells Designed to Operate with  $V_{DD} = 1.8V \pm 0.15V$  as Main Target Operating Conditions
- IO25 and IO33 Pad Libraries Provide Interfaces to 2.5V and 3V Environments
- Oscillators Provide Stable Clock Sources
- Basic Analog Input/Output, Power, Ground and Multiplexer Cells Available, High-performance Analog Cells Can Be Developed on Request
- Memory Cells Compiled to the Precise Requirements of the Design
- Compatible with Atmel's Extensive Range of Microcontroller, DSP, Standard-interface and Application-specific Cells

## Description

The Atmel ATC20 CBIC family is fabricated on a proprietary 0.21 micron five-layer-metal CMOS process intended for use with a supply voltage of  $1.8V \pm 0.15V$ . The following table shows the range for which Atmel library cells have been characterized.

**Table 1.** Recommended Operating Conditions

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{DD}$	DC Supply Voltage	Core and Standard I/Os	1.65	1.8	1.95	V
$V_{DD2.5}$	DC Supply Voltage	2.5V Interface I/Os	2.25	2.5	2.75	V
$V_{DD3.3}$	DC Supply Voltage	3V Interface I/Os	3	3.3	3.6	V
$V_I$	DC Input Voltage		0		$V_{DD}$	V
$V_O$	DC Output Voltage		0		$V_{DD}$	V
TEMP	Operating Free Air Temperature Range	Industrial	-40		+85	°C

The Atmel cell libraries and megacell compilers have been designed in order to be compatible with each other. Simulation representations exist for three types of operating conditions. They correspond to three characterization conditions defined as follows:

- MIN conditions:
  - $T_J = -40^\circ\text{C}$
  - $V_{DD}(\text{cell}) = 1.95\text{V}$
  - Process = fast (industrial best case)
- TYP conditions:
  - $T_J = +25^\circ\text{C}$
  - $V_{DD}(\text{cell}) = 1.8\text{V}$
  - Process = typ (industrial typical case)
- MAX conditions:
  - $T_J = +100^\circ\text{C}$
  - $V_{DD}(\text{cell}) = 1.65\text{V}$
  - Process = slow (industrial worst case)

Delays to tri-state are defined as delay to turn off ( $V_{GS} < V_T$ ) of the driving devices. Output pad drain current corresponds to the output current of the pad when the output voltage is  $V_{OL}$  or  $V_{OH}$ . The output resistor of the pad and the voltage drop due to access resistors (in and out of the die) are taken into account. In order to have accurate timing estimates, all characterization has been run on electrical netlists extracted from the layout database.



## Cell-based ASIC

## ATC20

## Summary





## Standard Cell Library SClib

The Atmel Standard Cell Library, SClib, contains a comprehensive set of combinational logic and storage cells. The SClib library includes cells which belong to the following categories:

- Buffers and Gates
- Multiplexers
- Flip-flops
- Scan Flip-flops
- Latches
- Adders and Subtractors

## Decoding the Cell Name

The table below shows the naming conventions for the cells in the SClib library. Each cell name begins with either a two-, three-, or four-letter code that defines the type of cell. This indicates the range of standard cells available.

**Table 2.** Cell Codes

Code	Description	Code	Description
AD	Adder	INVT	Inverting 3-State Buffer
AH	Half Adder	JK	JK Flip-Flop
AS	Adder/Subtractor	LA	D Latch
AN	AND Gate	MI	Inverting Multiplexer
AOI	AND-OR-Invert Gate	MX	Multiplexer
AON	AND-OR-AND-Invert Gates	ND	NAND Gate
AOR	AND-OR Gate	NR	NOR Gate
BH	Bus Holder	OAI	OR-AND-Invert Gate
BUFB	Balanced Buffer	OAN	OR-AND-OR-Invert Gates
BUFF	Non-Inverting Buffer	OR	OR Gate
BUFT	Non-Inverting 3-State Buffer	ORA	OR-AND Gate
CG	Carry Generator	SD	Multiplexed Scan D Flip-Flop
CLK2	Clock Buffer	SE	Multiplexed Scan Enable D Flip-Flop
DE	D-Enabled Flip-Flop	SRLA	Set/Reset Latches with NAND input
DF	D Flip-Flop	SU	Subtractor
INV0	Inverter	XN	Exclusive NOR Gate
INVB	Balanced Inverter	XR	Exclusive OR Gate

## Cell Matrices

The following three tables provide a quick reference to the storage elements in the SCLib library. Note that all storage elements feature buffered clock inputs and buffered output.

**Table 3.** JK Flip-flops

Macro Name	Set	Clear	1x Drive	2x Drive
JKBRBx	•	•	•	•

**Table 4.** D Flip-flops

Macro Name	Set	Clear	Enabled D Input	1x Drive	2x Drive	Single Output
DFBRBx	•	•		•	•	
DFCRBx		•		•	•	
DFCRQx		•		•	•	•
DFCRNx		•		•	•	
DFNRBx				•	•	
DFNRQx				•	•	•
DFPRBx	•			•	•	
DEPRQx	•		•	•	•	•
DENRQx			•	•	•	•
DENRBx			•	•	•	
DECRQx		•	•	•	•	•

**Table 5.** Scan Flip-flops

Macro Name	Set	Clear	1x Drive	2x Drive	Single Output
SDBRBx	•	•	•	•	
SDCRBx		•	•	•	
SDCRNx		•	•	•	•
SDCRQx		•	•	•	•
SDNRBx			•	•	
SDNRNx			•	•	•
SDNRQx			•	•	•
SDPRBx	•		•	•	
SECRQx		•	•	•	•
SENRQx			•	•	•
SEPRQx	•		•	•	•



## Input/Output Pad Cell Libraries IO18lib, IO25lib and IO33lib

The Atmel Input/Output Cell Library, IO18lib, contains a comprehensive list of input, output, bidirectional and tristate cells. The ATC20 (1.8V) cell library includes two special sets of I/O cells, IO25lib and IO33lib, for interfacing with external 2.5V and 3.3V devices.

### Voltage Levels

The IO18lib library is made up exclusively of low-voltage chip interface circuits powered by a voltage in the range of 1.65V to 1.95V. The library is compatible with the SCLib 1.8-volt standard cells library.

### Power and Ground Pads

Designers are strongly encouraged to provide three kinds of power pairs for the IO18lib library. These are “AC”, “DC” and core power pairs. AC power is used by the I/O to switch its output from one state to the other. This switching generates noise in the AC power buses on the chip. DC power is used by the I/O to maintain its output in a steady state. The best noise performance is achieved when the DC power buses on the chip are free of noise; designers are encouraged to use separate power pairs for AC and DC power to prevent most of the noise in the AC power buses from reaching the DC power buses. The same power pairs can be used to supply both DC power to the I/Os and power to the core without affecting noise performance.

**Table 6.** VSS Power Pad Combinations

Core	Switching I/O	Quiet I/O	Library Cell Name	Signal Name
Vssi	VssAC	VssDC		
•			pv18i00	VSS
	•		pv18a00	VSS
		•	pv18d00	VSS
	•	•	pv18e00	VSS
•		•	pv18b00	VSS
•	•	•	pv18f00	VSS

**Table 7.** VDD Power Pad Combinations

Core	Switching I/O	Quiet I/O	Library Cell Name	Signal Name
Vddi	VddAC	VddDC		
•			pv18i18	VDD
	•		pv18a18	VDD
		•	pv18d18	VDD
	•	•	pv18e18	VDD
•		•	pv18b18	VDD
•	•	•	pv18f18	VDD

## Cell Matrices

**Table 8.** CMOS Pads

CMOS Cell Name	3-State I/O	Output Only	3-State Output Only	Drive Strength	Pad Sites Used
PC18B01	•			1x	1
PC18B02	•			2x	1
PC18B03	•			3x	1
PC18B04	•			4x	1
PC18B05	•			5x	1
PC18O01		•		1x	1
PC18O02		•		2x	1
PC18O03		•		3x	1
PC18O04		•		4x	1
PC18O05		•		5x	1
PC18T01			•	1x	1
PC18T02			•	2x	1
PC18T03			•	3x	1
PC18T04			•	4x	1
PC18T05			•	5x	1

**Table 9.** TTL Pads

TTL Cell Name	3-State I/O	Output Only	3-State Output Only	Drive Strength	Pad Sites Used
PT18B01	•			2 mA	1
PT18B02	•			4 mA	1
PT18B03	•			8 mA	1
PT18O01		•		2 mA	1
PT18O02		•		4 mA	1
PT18O03		•		8 mA	1
PT18T01			•	2 mA	1
PT18T02			•	4 mA	1
PT18T03			•	8 mA	1

**Table 10.** CMOS/TTL Input Only Pad

CMOS Cell Name	Input Levels	Schmitt Input Level Shifter	Non-Inverting	Inverting	Pad Sites Used
PC18D01	CMOS		•		1
PC18D11	CMOS			•	1
PC18D21	CMOS	•	•		1
PC18D31	CMOS	•		•	1

Note: All 3-state I/Os, 3-state output only and input pads are also available with pull-up and pull-down device.

## IO25lib and IO33lib Low Slew Rate Cells

The IO25lib (IO33lib) cells comprise a series of 1.8V/2.5V (1.8V/3.3V) input/output pads developed for low supply voltage processes in order to interface 1.8V ASICs to 2.5V (3.3V) environments.

All IO25lib (IO33lib) cells are slew rate controlled. Advantage has been taken of the 1.8V to 2.5V (3.3V) level shifter (slow by construction) to reduce the slew rate without reducing speed.

**Table 11.** IO25lib/IO33lib Pads

3V Interface Pad Name	3-State I/O	Output Only	3-State Output Only	Input Only	Drive Strength	Pad Sites Used
pc25b0x/pc33b0x	•				2 mA, 4 mA, 8 mA, 16 mA	1
pc25d00/pc33d00				•		1
pc25o0x/pc33o0x		•			2 mA, 4 mA, 8 mA, 16 mA	1
pc25t0x/pc33t0x			•		2 mA, 4 mA, 8 mA, 16 mA	1

Note: All 3-state I/Os, 3-state output only and input pads are also available with pull-up and pull-down device.

**Table 12.** IO25lib/IO33lib Power Pads

Cell Name	Power Bus Connections				Pad Sites Used
	vssi	mixvss	vddi	mixvdd	
pv25e00/pv33e00		•			1
pv25i00/pv33i00	•				1
pv25i25/pv33i25			•		1
pv25e33/pv33e33				•	1
pv25ecrn/pv33ecrn		•		•	2

## Oscillator Cell Library Osc18lib

The Atmel Oscillator Library provides stable clock sources. It comprises five oscillators and one power-on-reset.

The Atmel two-pad oscillators are designed with the Pierce three-point oscillator structure. For the 32.768 kHz oscillator, the load capacitance must be between 6 pF and 12.5 pF. For high-frequency oscillators, the load capacitance must be between 15 pF and 20 pF. External capacitors must be added in order to obtain the correct load capacitance.

Clock output is high at off state (onosc = 0).

The oscillators provide a bypass mode (onosc = 0), clock = not (xin).

Table 13 gives the available Osc18lib cells and their major characteristics.

**Table 13.** Oscillator and POR Cells

Cell Name	Description
OSC18f33K	Low frequency, optimized for 32.786 kHz crystal
OSC18f9M	4 - 9 MHz crystal oscillator
OSC18f16M	8 - 16 MHz crystal oscillator
OSC18f27M	10 - 27 MHz crystal oscillator
OSC33KLP	32.786 Hz uPower crystal oscillator. Low frequency, optimized for 32.786 kHz crystal
POR18	Static and dynamic reset with internal hysteresis

## Basic Analog Cell Library ANA18lib, ANA25lib, ANA33lib

The Atmel CBIC analog library makes the following parts available:

- Multiplexer modules
  - Multiplexers to minimize cross-talk (for use with high-impedance nodes).
  - Multiplexers to minimize ON resistance.
- Analog input and output cells
- Analog power and ground cells

A special set of basic analog I/O cells, ANA25lib (ANA33lib), is available for interfacing with external 2.5V (3.3V) devices.

## General-purpose Analog Cell Library GPIlib

The General-purpose Analog Cell Library (GPIlib) is composed of cells performing various analog functions.

Currently available are regulators, power management cells, op amps, comparators, ADCs and DACs. All these cells are on request only. Additional high-performance, complex analog cells can be developed according to specific customer requirements.



## Atmel Compiled Megacell Library

The Atmel Compiled Megacell Library enables compilation of megacells for the functions Synchronous RAM, Asynchronous RAM, Asynchronous Dual-port RAM and Synchronous ROM, according to the user's precise requirements.

The Atmel megacells can be instanced as often as required in designs and can be used in parallel with cells from all other Atmel CBIC libraries. All the megacell representations required for schematic entry, simulation, place and route, layout generation, and verification are created automatically.

### Compiled Synchronous RAM Megacells

The Atmel Synchronous RAM compiler has bidirectional or separate I/O ports, and can be configured in multi-bank form, with a maximum of four banks.

The range of permitted Synchronous RAM megacell configurations is as follows:

Number of bits 128, .. 144K bits  
Number of words 32, .. 8K  
Word Size 4, .. 36 bits

The following table shows the range of performances for particular Synchronous RAM configurations under typical conditions.

Configuration	1K x 8 (8K bits)	2K x 16 (32K bits)	4K x 32 (128K bits)
Density (Kbits/mm <sup>2</sup> )	51	58	62
Frequency (MHz)	237	157	112
Dynamic Power (mW/MHz)	0.17	0.36	0.73

### Compiled Asynchronous RAM Megacells

The Atmel Asynchronous RAM compiler has bidirectional or separate I/O ports, and can be configured in multi-bank form, with a maximum of four banks.

The range of permitted Asynchronous RAM megacell configurations is as follows:

Number of bits 128, .. 128K bits  
Number of words 16, .. 4K  
Word Size 8, .. 36 bits

The following table shows the range of performances for particular Asynchronous RAM configurations under typical conditions.

Configuration	1K x 8 (8K bits)	2K x 16 (32K bits)	4K x 32 (128K bits)
Density (Kbits/mm <sup>2</sup> )	40	40	50
Frequency (MHz)	270	268	185
Dynamic Power (mW/MHz)	0.24	0.38	0.63



## Compiled Asynchronous Dual-port RAM Megacells

The Atmel Asynchronous Dual-port RAM has bidirectional or separate I/O ports, and can be configured in multi-bank form, with a maximum of four banks.

The range of permitted Asynchronous Dual-port RAM Megacell configurations is as follows:

Number of bits	128, .. 16K
Number of words <sup>(1)</sup>	64, .. 2K
Word Size <sup>(1)</sup>	2, .. 36 bits

Note: 1. Must be the same for both ports.

The following table shows the range of performances for particular Asynchronous Dual-port RAM configurations under typical conditions.

Configuration	128 x 8 (1K bits)	256 x 16 (4K bits)	512 x 32 (16K bits)
Density (Kbits/mm <sup>2</sup> )	22	32	36
Frequency (MHz)	305	274	248
Dynamic Power (mW/MHz)	0.09	0.31	0.41

## Compiled Synchronous ROM Megacells

The Atmel Synchronous ROM is diffusion programmable and is applicable in low power solutions. It can be configured in multi-bank form, with a maximum of four banks.

The range of permitted Synchronous ROM Megacell configurations is as follows:

Number of bits	256, .. 512K
Number of words	64, .. 8K
Word Size	4, .. 72 bits

The following table shows the range of performances for particular Synchronous ROM configurations under typical conditions.

Configuration	2K x 8 (16K bits)	4K x 16 (64K bits)	8K x 32 (256K bits)
Density (Kbits/mm <sup>2</sup> )	400	568	669
Frequency (MHz)	190	170	120
Dynamic Power (mW/MHz)	0.13	0.26	0.54



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*Page: 7* Adds description of Oscillator Cell Library, Basic Analog Cell Library, General-purpose Analog Cell Library.



## **Atmel Headquarters**

### *Corporate Headquarters*

2325 Orchard Parkway  
San Jose, CA 95131  
TEL 1(408) 441-0311  
FAX 1(408) 487-2600

### *Europe*

Atmel Sarl  
Route des Arsenaux 41  
Case Postale 80  
CH-1705 Fribourg  
Switzerland  
TEL (41) 26-426-5555  
FAX (41) 26-426-5500

### *Asia*

Room 1219  
Chinachem Golden Plaza  
77 Mody Road Tsimhatsui  
East Kowloon  
Hong Kong  
TEL (852) 2721-9778  
FAX (852) 2722-1369

### *Japan*

9F, Tonetsu Shinkawa Bldg.  
1-24-8 Shinkawa  
Chuo-ku, Tokyo 104-0033  
Japan  
TEL (81) 3-3523-3551  
FAX (81) 3-3523-7581

## **Atmel Operations**

### *Memory*

2325 Orchard Parkway  
San Jose, CA 95131  
TEL 1(408) 441-0311  
FAX 1(408) 436-4314

### *Microcontrollers*

2325 Orchard Parkway  
San Jose, CA 95131  
TEL 1(408) 441-0311  
FAX 1(408) 436-4314

La Chantrerie  
BP 70602  
44306 Nantes Cedex 3, France  
TEL (33) 2-40-18-18-18  
FAX (33) 2-40-18-19-60

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FAX (33) 4-42-53-60-01

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Colorado Springs, CO 80906  
TEL 1(719) 576-3300  
FAX 1(719) 540-1759

Scottish Enterprise Technology Park  
Maxwell Building  
East Kilbride G75 0QR, Scotland  
TEL (44) 1355-803-000  
FAX (44) 1355-242-743

### *RF/Automotive*

Theresienstrasse 2  
Postfach 3535  
74025 Heilbronn, Germany  
TEL (49) 71-31-67-0  
FAX (49) 71-31-67-2340

1150 East Cheyenne Mtn. Blvd.  
Colorado Springs, CO 80906  
TEL 1(719) 576-3300  
FAX 1(719) 540-1759

### *Biometrics/Imaging/Hi-Rel MPU/ High Speed Converters/RF Datacom*

Avenue de Rochepleine  
BP 123  
38521 Saint-Egreve Cedex, France  
TEL (33) 4-76-58-30-00  
FAX (33) 4-76-58-34-80

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### *e-mail*

literature@atmel.com

### *Web Site*

<http://www.atmel.com>

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