AT91 Timing Calculator User Notes

1. Introduction
This application note describes the use of the spreadsheet AT91 Timings Calculator.xls that can be downloaded and unzipped from the Atmel web site:
This spreadsheet automatically calculates all the timing parameters for the following AT91 ARM® Thumb® devices:
   • AT91M40800, AT91R40807, AT91R40008, AT91M42800A, AT91M55800A,
     AT91RM3400, AT91RM9200
For definitions of these timing parameters, refer to the datasheet for the corresponding AT91 product.

1.1 Restrictions
This tool applies to the following (or subsequent) datasheet revisions:
   • AT91M40800: Literature No.1393C
   • AT91R40807: Literature No. 1367C
   • AT91R40008: Literature No. 1795D
   • AT91M42800A: Literature No. 1776B
   • AT91M55800A: Literature No. 1727E
   • AT91RM3400: Literature No. 1790A
   • AT91RM9200: Literature No. 1768B
2. Overview

The Microsoft® Excel® workbook AT91 Timings Calculator.xls provides a quick calculation tool for the AT91 signal timings depending on the application environment in terms of power supply level, ambient temperature and output load capacitance.

The workbook is made up of several worksheets:

- One worksheet of instructions (entitled Readme)
- One user interface worksheet (entitled User Input)
- One worksheet of results (entitled Timing Results)
- One worksheet producing all the derating tables to be applied (entitled Derating Abacus)
- One worksheet per AT91 device producing the basic timing parameter data (entitled AT91M40800_AT91F40816 etc.).

3. Data Source

All basic timing parameter data has been extracted from electrical and mechanical data in the related AT91 product datasheet.

All derating table data has been extracted from the relevant Atmel Process Technology Library Databook.

4. Directions for Use

The user interface is the worksheet entitled User Input.

4.1 Inputs

In the User Input section of this worksheet:

Choose the appropriate item in each of the following pull-down menus:

- The AT91 microcontroller of interest (AT91 Device field)

Fill in the following fields:

- Operating Master Clock Frequency (Master Clock Frequency (MHz) field)
- Master Clock Timings $t_{CL}$ and $t_{CH}$
- Operating Ambient Temperature (Operating Temperature (°C) field)
- $V_{DDIO}$ or $V_{DD}$ (for the single voltage x40 Series Family) Power Supply Levels ($V_{DD}/V_{DDIO}$ Power Supply Level (V) field)
- $V_{DDCORE}$ Power Supply Level ($V_{DDCORE}$ Power Supply Level (V) field)
- The load capacitance on each output signal of interest (Output Signals Capacitance Loads (pF) table)

Note: Be sure to enter values consistent with the associated Electrical Characteristics Datasheet parameters.

- If they are known, the Memory/Peripheral Device Parameters Used for Wait-States, Address to Chip Select Setup Cycles, RW Setup and Hold Cycles, and Data Float Time Cycles Calculation (ns). See “Optional Inputs” on page 3.
- The number of Wait-States programmed to access the memory to interface
4.2 Outputs

The worksheet then automatically computes and displays the timing parameters in the Timing Results worksheet.

Note: The NRD and NWR Capacitance Loads consistency regarding Master Clock Frequency status field informs the user whether or not the Master Clock Frequency is consistent with the NRD and NWR Capacitance Loads. If it is not, the advice given in this status field should be followed.

4.3 Optional Inputs

As an option, fill in the Memory/Peripheral Device Parameters Used for Wait-States and Data Float Time Cycles Calculation fields with the parameters extracted from the datasheet describing the device to be interfaced:

- $t_{CE}$ is the Chip Select assertion to Output Data Valid maximum delay in the read cycle
- $t_{OE}$ is the Output Enable assertion to Output Data Valid maximum delay in the read cycle
- $t_{DH}$ is the Output Data Hold Time (as a Maximum) from Output Enable deassertion in the read cycle
- $t_{WEH}$ is the Minimum Write Pulse Width in the write cycle
- $t_{DS}$ is the Data In Setup Time (as a Minimum) to Write Enable deassertion in the write cycle

For LCD Interface Mode, when the number of Address to Chip Select Setup cycles is not null:

- $t_{AH}$ is the Address Hold Time (as a Maximum) from Chip Select in the read/write cycle
- $t_{AS}$ is the Output Enable / Write Enable Assertion to the Chip Select assertion in the read/write cycle
- $t_{DHR}$ is the Output Data Hold Time (as a Maximum) from Output Enable deassertion in the read cycle

For ISA Interface Mode, when the number of Address to Setup cycles OR Hold cycles is not null:

- $t_{AS}$ is the Maximum Setup Time for the four operating modes I/O Read, I/O Write, MEM Read and MEM Write
- $t_{AH}$ is the Maximum Hold Time for the four operating modes I/O Read, I/O Write, MEM Read and MEM Write
- $t_{WEH}$ is the Maximum of Minimum Enable Pulse Width for the four operating modes I/O Read, I/O Write, MEM Read and MEM Write

4.4 Optional Output

If the above data is entered, the worksheet automatically computes and displays in the Timing Calculation Results area the number of Wait-States to add, related to the read and write cycles, the number of Data Float Time cycles, the number of Address to Chip Select Setup cycles or the RW Setup or Hold cycles to program.
5. Application Example

As an example, the AT91 Timing Calculator will be used to find out the number of standard wait states to program in the EBI Chip-select Register in order to interface the AT91RM9200 microcontroller with an AT49BV1604-90 Flash boot memory.

The AT91RM9200 is clocked at 60 MHz, powered at 1.8V for VDDCORE and 3.0V for VDDIO and the application temperature is up to 85°C. The load capacitance of each AT91RM9200 output pin is 10 pF.

The steps are as follows:

In the User Input sheet of the worksheet, fill in the following values:

- Choose the AT91RM9200 in the AT91 Device pull-down menu.
- Fill in the Master Clock Frequency (MHz) field at 60.
- Select MDIV = 1, PCK changes to 120 MHz.
- Fill in the VDD/VDDIO and VDDCORE Power Supply Level (V) fields with 3.0V and 1.8V, respectively.
- Fill in the Operating Temperature (°C) field at 85
- Fill in all the Output Signal Capacitance Loads (pF) at 10.
- Fill in the Memory/Peripheral Device Parameter fields (ns) as follows:
  - tCE = 90
  - tOE = 40
  - tDH = 25
  - tWEH = 50
  - tDS = 40

The results are then calculated and can be read in the Timing Results worksheet.

Note that in the Number of Wait-States and Data Float Times table:

- The Number of Wait-States to add due to the Read Access (Standard Read Protocol or Early Read Protocol) is 6.
- The number of Wait States due to the Write Access cycle is 3.
- The Number of Data Float Time cycles to program is 2.

All the EBI Parameters are now valid for the connection of an AT49BV1604-90 Flash memory to an AT91RM9200 microcontroller. These may be printed or saved as required.
6. Revision History

Table 6-1.

<table>
<thead>
<tr>
<th>Document</th>
<th>Comments</th>
<th>Change Request Ref.</th>
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<tbody>
<tr>
<td>2620A</td>
<td>First issue.</td>
<td></td>
</tr>
<tr>
<td>2620B</td>
<td>Major document update to account for new products AT91RM3400 and AT91RM9200.</td>
<td>04-341</td>
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