Digital Blocks
Semiconductor IP

DB-I2C-S-SCL-CLK-APB
APB Bus - I2C Slave Controller

General Description

The Digital Blocks DB-I2C-S-SCL-CLK-APB Controller IP Core interfaces an ARM, MIPS, PowerPC, ARC or other high-performance microprocessor via the AMBA 2.0 APB System Interconnect Fabric to an I2C Bus. The I2C is a two-wire bidirectional interface standard (SCL is Clock, SDA is Data) for transfer of bytes of information between two or more compliant I2C devices.

The DB-I2C-S-SCL-CLK-APB, in the I2C Slave Controller Core managing the I2C protocol & physical layer, contains no free running clock, while interfacing through dual-clock FIFOs to the AMBA APB Bus, for a low power, low noise Microprocessor interface to the I2C Bus. The I2C Slave Controller Core runs off the external SCL clock while the APB side off the APB Clock.

The DB-I2C-S-SCL-CLK-APB Controller implements the Slave-Transmit and Slave-Receive protocol according to the Philips I2C-Bus Specification, Version 2.1 as well as the updated NXP UM10204 Rev 7 – 1 Oct 2021 Specification.

The DB-I2C-S-SCL-CLK-APB is a member of Digital Blocks DB-I2C Controller IP Core family, which includes I2C Master/Slave, I2C Master-only, and I2C Slave-only configurations.

Figure 1 depicts the system view of the DB-I2C-S-SCL-CLK-APB Controller IP Core embedded within an ASIC, ASSP or FPGA device.

Figure 1: DB-I2C-S-SCL-CLK-APB Controller – System Diagram
Features

- Slave \( I^2C \) Controller Modes:
  - Slave – Transmitter
  - Slave – Receiver

- Supports four \( I^2C \) bus speeds:
  - Hs-Mode (3.4+ Mb/s)
  - Fast Mode Plus (1 Mbit/s)
  - Fast Mode (400 Kb/s)
  - Standard Mode (100 Kb/s)

- Low power, low noise applications requiring non-free running SCL Clock in the \( I^2C \) protocol & physical layer logic processing and APB Clock only to interface to the Microprocessor.

- Parameterized FIFO memory for off-loading the \( I^2C \) transfers from the processor:
  - Targets embedded processors with higher performance algorithm requirements, by the \( I^2C \) Controller independently controlling the Transmit or Receive of bytes of information buffered to and from a FIFO.

- \( I^2C \) compliant features:
  - Repeated Start, 7/10-bit addressing

- Enhanced system-level features & integration capabilities:
  - CPU Interface via parameterized FIFO with support for APB / AHB / AXI / AXI-lite / Avalon interconnect fabrics

- Enhanced system-level features & integration capabilities (OPTIONAL):
  - Direct interface to user Registers within ASIC / ASSP / FPGA device, for Master/Slave transfer across the \( I^2C \) Bus

- 5 sources of internal interrupts with masking control

- Compliance with AMBA 2.0 and \( I^2C \) specifications:
  - AMBA Specification (Rev 2.0), APB Bus

Digital Blocks offers \( I^2C \) Master/Slave, Master-only, and Slave-only Controller IP supporting Hs-Mode / Fast Mode Plus / Fast Mode / Standard Mode.
Pin Description

The DB-I2C-S-SCL-CLK-APB I2C Slave Controller interface signals are listed in Table 1. Note that a bi-directional driver is available for SDAI / SDAO.

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>APB Bus Interface</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PCLK</td>
<td>Input</td>
<td>Bus Clock</td>
</tr>
<tr>
<td>PRESETn</td>
<td>Input</td>
<td>APB Reset (Active Low)</td>
</tr>
<tr>
<td>PAD[11:0]</td>
<td>Input</td>
<td>APB Address Bus</td>
</tr>
<tr>
<td>PSEL_DB_I2C</td>
<td>Input</td>
<td>APB Select for DB-I2C</td>
</tr>
<tr>
<td>PENABLE</td>
<td>Input</td>
<td>APB Strobe</td>
</tr>
<tr>
<td>PWRITE</td>
<td>Input</td>
<td>APB Transfer Direction (Read/Write)</td>
</tr>
<tr>
<td>PRDATA[31:0]</td>
<td>Output</td>
<td>APB Read Data Bus</td>
</tr>
<tr>
<td>PWDATA[31:0]</td>
<td>Input</td>
<td>APB WriteData Bus</td>
</tr>
<tr>
<td><strong>I2C Bus interface</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SDAi</td>
<td>Input</td>
<td>Serial Data</td>
</tr>
<tr>
<td>SDAO</td>
<td>Output</td>
<td>Serial Data</td>
</tr>
<tr>
<td>SCLi</td>
<td>Input</td>
<td>Serial Clock Line</td>
</tr>
</tbody>
</table>

Table 1: DB-I2C-S-SCL-CLK-APB – I/O Pin Description


Verification Method

The DB-I2C-S-SCL-CLK-APB Controller IP Core contains a test suite that generates & sends I2C transactions, monitors the I2C bus protocol, and checks expected results.

The DB-I2C-S-SCL-CLK-APB Controller IP Core has internally been verified as follows:

- Instantiated within a customer’s series of FPGA for verification and ASICs for production.

Customer Evaluation

Digital Blocks offers a variety of methods for prospective customers to evaluate the DB-I2C-S-SCL-CLK-APB. Please contact Digital Blocks for additional information.

Deliverables

The DB-I2C-S-SCL-CLK-APB is available in synthesizable RTL Verilog or a technology-specific netlist for FPGAs, along with Synopsys Design Constraints, a simulation test bench with expected results, datasheet, and user manual.

Ordering Information

Please contact Digital Blocks for additional technical, pricing, evaluation, and support information.

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