OVP Guide to Using Processor Models

Model specific information for Xilinx MicroBlaze_ISA

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Model Release Status

This model is released as part of OVP releases and is included in OVPworld packages. Please visit OVPworld.org.

Contents

Chapter 1

Overview

This document provides the details of an OVP Fast Processor Model variant.

OVP Fast Processor Models are written in C and provide a C API for use in C based platforms. The models also provide a native interface for use in SystemC TLM2 platforms.

The models are written using the OVP VMI API that provides a Virtual Machine Interface that defines the behavior of the processor. The VMI API makes a clear line between model and simulator allowing very good optimization and world class high speed performance. Most models are provided as a binary shared object and also as source. This allows the download and use of the model binary or the use of the source to explore and modify the model.

The models are run through an extensive QA and regression testing process and most model families are validated using technology provided by the processor IP owners. There is a companion document (OVP Guide to Using Processor Models) which explains the general concepts of OVP Fast Processor Models and their use. It is downloadable from the OVPworld website documentation pages.

1.1 Description

Microblaze Processor Model

1.2 Licensing

Apache 2.0 Open Source License

1.3 Features

Instruction Set: This model fully implements the instruction set upto and including V10.

Privileged Instructions: Implemented

Virtual-Memory Management: Implemented

Reset, Interrupts, Exceptions and Break: Implemented

Floating Point Unit: Implemented

Stream Link Interface: Implemented

1.4 Limitations

GDB: There is a known issue in the microblaze gdb, a lockup can occur when disassembling from address 0

1.5 ConfigurationFeatures

1.6 Verification

Models have been validated correct by running through extensive tests using test suites and technology provided by Xilinx

Chapter 2

Configuration

2.1 Location

This model's VLNV is xilinx.ovpworld.org/processor/microblaze/1.0.
The model source is usually at:
$IMPERAS_HOME/ImperasLib/source/xilinx.ovpworld.org/processor/microblaze/1.0
The model binary is usually at:
$IMPERAS_HOME/lib/$IMPERAS_ARCH/ImperasLib/xilinx.ovpworld.org/processor/microblaze/1.0

2.2 GDB Path

The default GDB for this model is: $IMPERAS_HOME/lib/$IMPERAS_ARCH/gdb/microblaze-xilinx-elf-gdb.

2.3 Semi-Host Library

The default semi-host library file is xilinx.ovpworld.org/semihosting/microblazeNewlib/1.0

2.4 Processor Endian-ness

This model can be set to either endian-ness (normally by a pin, or the ELF code).

2.5 QuantumLeap Support

This processor is qualified to run in a QuantumLeap enabled simulator.

2.6 Processor ELF code

ELF codes supported by this model are:0xbd and 0xbaab.

Chapter 3

All Variants in this model

This model has these variants

Variant	Description
V7_00	
V7_10	
V7_20	
V7_30	
V8_00	
V8_10	
V8_20	
V9_50	
V10_00	
ISA	(described in this document)

Table 3.1: All Variants in this model

Chapter 4

Bus Master Ports

This model has these bus master ports.

Name	min	max	Connect?	Description
INSTRUCTION	32	32	mandatory	
DATA	32	32	optional	

Table 4.1: Bus Master Ports

Chapter 5

Bus Slave Ports

This model has no bus slave ports.

Chapter 6

Net Ports

This model has no net ports.

Chapter 7

FIFO Ports

This model has these FIFO ports.

Name	Type	Bit width	Connect?	Description
SFSL0	input	64	optional	FSL Fifo Input port - Controlled by Parameter C_FSL_LINKS
SFSL1	input	64	optional	FSL Fifo Input port - Controlled by Parameter C_FSL_LINKS
SFSL2	input	64	optional	FSL Fifo Input port - Controlled by Parameter C_FSL_LINKS
SFSL3	input	64	optional	FSL Fifo Input port - Controlled by Parameter C_FSL_LINKS
SFSL4	input	64	optional	FSL Fifo Input port - Controlled by Parameter C_FSL_LINKS
SFSL5	input	64	optional	FSL Fifo Input port - Controlled by Parameter C_FSL_LINKS
SFSL6	input	64	optional	FSL Fifo Input port - Controlled by Parameter C_FSL_LINKS
SFSL7	input	64	optional	FSL Fifo Input port - Controlled by Parameter C_FSL_LINKS
SFSL8	input	64	optional	FSL Fifo Input port - Controlled by Parameter C_FSL_LINKS
SFSL9	input	64	optional	FSL Fifo Input port - Controlled by Parameter C_FSL_LINKS
SFSL10	input	64	optional	FSL Fifo Input port - Controlled by Parameter C_FSL_LINKS
SFSL11	input	64	optional	FSL Fifo Input port - Controlled by Parameter C_FSL_LINKS
SFSL12	input	64	optional	FSL Fifo Input port - Controlled by Parameter C_FSL_LINKS
SFSL13	input	64	optional	FSL Fifo Input port - Controlled by Parameter C_FSL_LINKS
SFSL14	input	64	optional	FSL Fifo Input port - Controlled by Parameter C_FSL_LINKS

SFSL15	input	64	optional	FSL Fifo Input port - Controlled by Parameter C_FSL_LINKS
MFSL0	output	64	optional	FSL Fifo Output port - Controlled by Parameter C_FSL_LINKS
MFSL1	output	64	optional	FSL Fifo Output port - Controlled by Parameter C_FSL_LINKS
MFSL2	output	64	optional	FSL Fifo Output port - Controlled by Parameter C_FSL_LINKS
MFSL3	output	64	optional	FSL Fifo Output port - Controlled by Parameter C_FSL_LINKS
MFSL4	output	64	optional	FSL Fifo Output port - Controlled by Parameter C_FSL_LINKS
MFSL5	output	64	optional	FSL Fifo Output port - Controlled by Parameter C_FSL_LINKS
MFSL6	output	64	optional	FSL Fifo Output port - Controlled by Parameter C_FSL_LINKS
MFSL7	output	64	optional	FSL Fifo Output port - Controlled by Parameter C_FSL_LINKS
MFSL8	output	64	optional	FSL Fifo Output port - Controlled by Parameter C_FSL_LINKS
MFSL9	output	64	optional	FSL Fifo Output port - Controlled by Parameter C_FSL_LINKS
MFSL10	output	64	optional	FSL Fifo Output port - Controlled by Parameter C_FSL_LINKS
MFSL11	output	64	optional	FSL Fifo Output port - Controlled by Parameter C_FSL_LINKS
MFSL12	output	64	optional	FSL Fifo Output port - Controlled by Parameter C_FSL_LINKS
MFSL13	output	64	optional	FSL Fifo Output port - Controlled by Parameter C_FSL_LINKS
MFSL14	output	64	optional	FSL Fifo Output port - Controlled by Parameter C_FSL_LINKS
MFSL15	output	64	optional	FSL Fifo Output port - Controlled by Parameter C_FSL_LINKS

Table 7.1: FIFO Ports

Chapter 8

Formal Parameters

Name	Type	Description
variant	Enumeration	Selects variant (either a generic ISA or a specific model)
verbose	Boolean	Specify verbose output messages
endian	Endian	Model endian
C_FAMILY	Uns32	Target Family
C_AREA_OPTIMIZED	Uns32	Select implementation to optimize area with lower instruction throughput
C_INTERCONNECT	Uns32	Select interconnect 1 = PLBv46, 2 = AXI4
C_ENDIANNESS	Uns32	Select endianness 0 = Big endian, 1 = Little endian
C_FAULT_TOLERANT	Uns32	Implement fault tolerance
C_ECC_USE_CE_EXCEPTION	Uns32	Generate Bus Error Exceptions for correctable errors
C_PVR	Uns32	Processor version register mode selection
C_PVR_USER1	Uns32	Processor version register USER1 constant
C_PVR_USER2	Uns32	Processor version register USER2 constant
C_RESET_MSR	Enumeration	Reset value for MSR register (0x00, 0x20, 0x80 or 0xa0)
C_BASE_VECTORS	Uns32	Location of Microblaze Vectors
C_D_PLB	Uns32	Data side PLB interface
C_D_AXI	Uns32	Data side AXI interface
C_D_LMB	Boolean	Data side LMB interface
C_I_PLB	Uns32	Instruction side PLB interface
C_I_AXI	Uns32	Instruction side AXI interface
C_I_LMB	Boolean	Instruction side LMB interface
C_M_AXI_DP_EXCLUSIVE_ACCESS	Uns32	Data Peripheral AXI Interface uses AXI4 protocol, with support for exclusive access
C_M_AXI_DC_EXCLUSIVE_ACCESS	Uns32	Data Cache AXI Interface uses AXI4 protocol, with support for exclusive access
C_USE_BARREL	Boolean	Include barrel shifter
C_USE_DIV	Boolean	Include hardware divider
C_USE_HW_MUL	Uns32	Include hardware integer multiplier
C_USE_FPU	Uns32	Include hardware floating integer point unit
C_USE_MSR_INSTR	Boolean	Enable use of instructions: integer MSRSET and MSRCLR
C_USE_PCMP_INSTR	Boolean	Enable use of instructions: integer CLZ, PCMPBF, PCMPEQ, and PCMPNE
C_USE_REORDER_INSTR	Uns32	Enable use of instructions: LBUR, LHUR, LWR, SBR. SHR, SWR, SWAPB, SWAPH
C_UNALIGNED_EXCEPTIONS	Boolean	Enable exception handling for unaligned data accesses
C_ILL_OPCODE_EXCEPTION	Boolean	Enable exception handling for illegal op-code
C_IPLB_BUS_EXCEPTION	Uns32	Enable exception handling for IPLB bus error

C_DPLB_BUS_EXCEPTION	Uns32	Enable exception handling for DPLB bus error
C_M_AXI_I_BUS_EXCEPTION	Uns32	Enable exception handling for M_AXI_I bus error
C_M_AXI_D_BUS_EXCEPTION	Uns32	Enable exception handling for M_AXI_D bus error
C_DIV_ZERO_EXCEPTION	Boolean	Enable exception handling for division by zero or division overflow
C_FPU_EXCEPTION	Boolean	Enable exception handling for hardware floating point unit exceptions
C_OPCODE_0x0_ILLEGAL	Boolean	Detect opcode 0x0 as an illegal instruction
C_FSL_EXCEPTION	Boolean	Enable exception handling for Stream Links
C_USE_STACK_PROTECTION	Uns32	Generate exception for stack overflow or stack underflow
C_DEBUG_ENABLED	Boolean	MDM Debug interface
C_NUMBER_OF_PC_BRK	Uns32	Number of hardware breakpoints
C_NUMBER_OF_RD_ADDR_BRK	Uns32	Number of read address watchpoints
C_NUMBER_OF_WR_ADDR_BRK	Uns32	Number of write address watchpoints
C_INTERRUPT_IS_EDGE	Uns32	Level/Edge Interrupt
C_EDGE_IS_POSITIVE	Uns32	Negative/Positive Edge integer Interrupt
C_FSL_LINKS	Uns32	Number of stream interfaces (FSL or AXI)
C_USE_EXTENDED_FSL_INSTR	Boolean	Enable use of extended integer stream instructions
C_ICACHE_BASEADDR	Uns32	Instruction cache base address
C_ICACHE_HIGHADDR	Uns32	Instruction cache high address
C_USE_ICACHE	Uns32	Instruction cache
C_ALLOW_ICACHE_WR	Uns32	Instruction cache write enable
C_ICACHE_LINE_LEN	Enumeration	Instruction cache line length (4 or 8)
C_ICACHE_ALWAYS_USED	Uns32	Instruction cache CacheLink used for all memory accesses
C_ICACHE_INTERFACE	Enumeration	Instruction cache CacheLink interface protocol (IXCL or IXCL2)
C_ICACHE_FORCE_TAG_LUTRAM	Uns32	Instruction cache tag always implemented with distributed RAM
C_ICACHE_STREAMS	Uns32	Instruction cache streams
C_ICACHE_VICTIMS	Enumeration	Instruction cache victims (0, 2, 4 or 8)
C_ICACHE_DATA_WIDTH	Uns32	Instruction cache data width, 0 = 32 bits, 1 = Full cache line, 2 = 512 bits
C_ADDR_TAG_BITS	Uns32	Instruction cache address tags
C_CACHE_BYTE_SIZE	Enumeration	Instruction cache size (64, 128, 256, 512, 1024, 2048, 4096, 8192, 16384, 32768 or 65536)
C_ICACHE_USE_FSL	Uns32	Cache over CacheLink instead of peripheral bus for instructions
C_DCACHE_BASEADDR	Uns32	Data cache base address
C_DCACHE_HIGHADDR	Uns32	Data cache high address
C_USE_DCACHE	Uns32	Data cache
C_ALLOW_DCACHE_WR	Uns32	Data cache write enable
C_DCACHE_LINE_LEN	Enumeration	Data cache line length (4 or 8)
C_DCACHE_ALWAYS_USED	Uns32	Data cache CacheLink used for all memory accesses
C_DCACHE_INTERFACE	Enumeration	Data cache CacheLink interface protocol (DXCL or DXCL2)
C_DCACHE_FORCE_TAG_LUTRAM	Uns32	Data cache tag always implemented with distributed RAM
C_DCACHE_USE_WRITEBACK	Uns32	Data cache write-back storage policy used
C_DCACHE_VICTIMS	Enumeration	Data cache victims (0, 2, 4 or 8)
C_DCACHE_DATA_WIDTH	Uns32	Data cache data width, 0 = 32 bits, 1 = Full cache line, 2 = 512 bits
C_DCACHE_ADDR_TAG	Uns32	Data cache address tags
C_DCACHE_BYTE_SIZE	Enumeration	Data cache size (64, 128, 256, 512, 1024, 2048, 4096, 8192, 16384, 32768 or 65536)

C_DCACHE_USE_FSL	Uns32	Cache over CacheLink instead of peripheral bus for data
C_USE_MMU	Uns32	0 = None, 1 = Usermode, 2 = Protection, 3 = Virtual
C_MMU_DTLB_SIZE	Uns32	Data shadow Translation Look-Aside Buffer size 1,2,4,8
C_MMU_ITLB_SIZE	Uns32	Instruction shadow Translation Look-Aside Buffer size 1,2,4,8
C_MMU_TLB_ACCESS	Uns32	Access to memory management special registers: 0 = Minimal, 1 = Read, 2 = Write, 3 = Full
C_MMU_ZONES	Uns32	Number of memory protection zones
C_MMU_PRIVILEGED_INSTR	Uns32	Privileged instructions 0 = Full protection, 1 = Allow stream instrs
C_USE_INTERRUPT	Uns32	Enable interrupt handling
C_USE_EXT_BRK	Uns32	Enable external break handling
C_USE_EXT_NM_BRK	Uns32	Enable external non-maskable break handling
C_USE_BRANCH_TARGET_CACHE	Uns32	Enable Branch Target Cache
C_BRANCH_TARGET_CACHE_SIZE	Uns32	Branch Target Cache size: 0 = Default, 1 = 8 entries, 2 = 16 entries, 3 = 32 entries, 4 = 64 entries, 5 = 512 entries, 6 = 1024 entries, 7 = 2048 entries
C_STREAM_INTERCONNECT	Uns32	Select AXI4-Stream integer interconnect

Table 8.1: Parameters

Chapter 9

Execution Modes

Mode	Code	Description
REAL	0	Real mode
VIRTUAL_PRIV	1	Virtual privileged mode
VIRTUAL_USER	2	Virtual user mode

Table 9.1: Modes implemented in this processor

Chapter 10

Exceptions

Exception	Code
STREAM_EXCEPTION	0
UNALIGNED_DATA_ACCESS	1
ILLEGAL_OPCODE_EXCEPTION	2
INSTRUCTION_BUS_ERROR_EXCEPTION	3
DATA_BUS_ERROR_EXCEPTION	4
DIVIDE_EXCEPTION	5
FLOATING_POINT_UNIT_EXCEPTION	6
PRIVILEGED_INSTRUCTION_EXCEPTION	7
STACK_PROTECTION_VIOLATION_EXCEPTION	8
DATA_STORAGE_EXCEPTION	9
INSTRUCTION_STORAGE_EXCEPTION	10
DATA_TLB_MISS_EXCEPTION	11
INSTRUCTION_TLB_MISS_EXCEPTION	12
RESET	13
INTERRUPT	14

Table 10.1: Exceptions implemented by this processor

Chapter 11

Hierarchy of the model

A CPU core may be configured to instance many processors of a Symmetrical Multi Processor (SMP). A CPU core may also have sub elements within a processor, for example hardware threading blocks.
OVP processor models can be written to include SMP blocks and to have many levels of hierarchy. Some OVP CPU models may have a fixed hierarchy, and some may be configured by settings in a configuration register. Please see the register definitions of this model.
This model documentation shows the settings and hierarchy of the default settings for this model variant.

11.1 Level 1

This level in the model hierarchy has 3 commands.
This level in the model hierarchy has 3 register groups:

Group name	Registers
User	32
System	25
Integration_support	1

Table 11.1: Register groups

This level in the model hierarchy has no children.

Chapter 12

Model Commands

A Processor model can implement one or more **Model Commands** available to be invoked from the simulator command line, from the OP API or from the Imperas Multiprocessor Debugger.

12.1 Level 1

12.1.1 dumpTLB

12.1.1.1 Argument description

Display the current contents of the TLB

12.1.2 isync

specify instruction address range for synchronous execution

Argument	Type	Description
-addresshi	Uns64	end address of synchronous execution range
-addresslo	Uns64	start address of synchronous execution range

Table 12.1: isync command arguments

12.1.3 itrace

enable or disable instruction tracing

Argument	Type	Description
-after	Uns64	apply after this many instructions
-enable	Boolean	enable instruction tracing
-instructioncount	Boolean	include the instruction number in each trace
-off	Boolean	disable instruction tracing
-on	Boolean	enable instruction tracing
-registerchange	Boolean	show registers changed by this instruction
-registers	Boolean	show registers after each trace

Table 12.2: itrace command arguments

Chapter 13

Registers

13.1 Level 1

13.1.1 User

Registers at level:1, group:User

Name	Bits	Initial-Hex	RW	Description
R0	32	0	r-	
R1	32	0	rw	
R2	32	0	rw	
R3	32	0	rw	
R4	32	0	rw	
R5	32	0	rw	
R6	32	0	rw	
R7	32	0	rw	
R8	32	0	rw	
R9	32	0	rw	
R10	32	0	rw	
R11	32	0	rw	
R12	32	0	rw	
R13	32	0	rw	
R14	32	0	rw	
R15	32	0	rw	
R16	32	0	rw	
R17	32	0	rw	
R18	32	0	rw	
R19	32	0	rw	
R20	32	0	rw	
R21	32	0	rw	
R22	32	0	rw	
R23	32	0	rw	
R24	32	0	rw	
R25	32	0	rw	
R26	32	0	rw	
R27	32	0	rw	
R28	32	0	rw	
R29	32	0	rw	
R30	32	0	rw	
R31	32	0	rw	

Table 13.1: Registers at level 1, group:User

13.1.2 System

Registers at level:1, group:System

Name	Bits	Initial-Hex	RW	Description
SPR_PC	32	0	rw	program counter
SPR_MSR	32	0	rw	
SPR_EAR	32	0	rw	
SPR_ESR	32	0	rw	
SPR_FSR	32	0	rw	
SPR_BTR	32	0	rw	
SPR_PVR0	32	10001500	r-	
SPR_PVR1	32	0	r-	
SPR_PVR2	32	54831000	r-	
SPR_PVR3	32	2000000	r-	
SPR_PVR4	32	45000000	r-	
SPR_PVR5	32	47000000	r-	
SPR_PVR6	32	0	r-	
SPR_PVR7	32	3fffffff	r-	
SPR_PVR8	32	0	r-	
SPR_PVR9	32	3fffffff	r-	
SPR_PVR10	32	0	r-	
SPR_PVR11	32	ae00000	r-	
SPR_EDR	32	0	rw	
SPR_PID	32	0	rw	
SPR_ZPR	32	0	rw	
SPR_TLBX	32	0	rw	
SPR_TLBSX	32	0	rw	
SPR_TLBLO	32	0	rw	
SPR_TLBHI	32	0	rw	

Table 13.2: Registers at level 1, group:System

13.1.3 Integration_support

Registers at level:1, group:Integration_support

Name	Bits	Initial-Hex	RW	Description
stop	32	0	rw	

Table 13.3: Registers at level 1, group:Integration_support