OVP Guide to Using Processor Models

Model Specific Information for variant ARM_Cortex-A9MPx4

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1.0 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

ARM Processor Model

1.2 Licensing

Usage of binary model under license governing simulator usage.

Note that for models of ARM CPUs the license includes the following terms:

Licensee is granted a non-exclusive, worldwide, non-transferable, revocable licence to:

If no source is being provided to the Licensee: use and copy only (no modifications rights are granted) the model for the sole purpose of designing, developing, analyzing, debugging, testing, verifying, validating and optimizing software which: (a) (i) is for ARM based systems; and (ii) does not incorporate the ARM Models or any part thereof; and (b) such ARM Models may not be used to emulate an ARM based system to run application software in a production or live environment.

If source code is being provided to the Licensee: use, copy and modify the model for the sole purpose of designing, developing, analyzing, debugging, testing, verifying, validating and optimizing software which: (a) (i) is for ARM based systems; and (ii) does not incorporate the ARM Models or any part thereof; and (b) such ARM Models may not be used to emulate an ARM based system to run application software in a production or live environment.

In the case of any Licensee who is either or both an academic or educational institution the purposes shall be limited to internal use.

Except to the extent that such activity is permitted by applicable law, Licensee shall not reverse engineer, decompile, or disassemble this model. If this model was provided to Licensee in Europe, Licensee shall not reverse engineer, decompile or disassemble the Model for the purposes of error correction.

The License agreement does not entitle Licensee to manufacture in silicon any product based on this model.

The License agreement does not entitle Licensee to use this model for evaluating the validity of any ARM patent.

Source of model available under separate Imperas Software License Agreement.

1.3 Limitations

Instruction pipelines are not modeled in any way. All instructions are assumed to complete immediately. This means that instruction barrier instructions (e.g. ISB, CP15ISB) are treated as NOPs, with the exception of any undefined instruction behavior, which is modeled. The model does not implement speculative fetch behavior. The branch cache is not modeled.

Caches and write buffers are not modeled in any way. All loads, fetches and stores complete immediately and in order, and are fully synchronous (as if the memory was of Strongly Ordered or Device-nGnRnE type). Data barrier instructions (e.g. DSB, CP15DSB) are treated as NOPs, with the exception of any undefined instruction behavior, which is modeled. Cache manipulation instructions are implemented as NOPs, with the exception of any undefined instruction behavior, which is modeled.
Real-world timing effects are not modeled: all instructions are assumed to complete in a single cycle.
Performance Monitors are implemented as a register interface only.
TLBs are architecturally-accurate but not device accurate. This means that all TLB maintenance and address translation operations are fully implemented but the cache is larger than in the real device.

1.4 Verification

Models have been extensively tested by Imperas. ARM Cortex-A models have been successfully used by customers to simulate SMP Linux, Ubuntu Desktop, VxWorks and ThreadX on Xilinx Zynq virtual platforms.

1.5 Features

Thumb-2 instructions are supported.
Trivial Jazelle extension is implemented.
SIMD instructions are implemented.
NEON is implemented.
VFP is implemented.
Security extensions are implemented (also known as TrustZone). Non-secure accesses can be made visible externally by connecting the processor to a 41-bit physical bus, in which case bits 39..0 give the true physical address and bit 40 is the NS bit.
VMSA secure and non-secure address translation is implemented.
GIC block is implemented (GICv1, including security extensions). Accesses to GIC registers can be viewed externally by connecting to the 32-bit GICRegisters bus port. Secure register accesses are at offset 0x0 on this bus; for example, a secure access to GIC register ICDDCR can be observed by monitoring address 0x00001000. Non-secure accesses are at offset 0x80000000 on this bus; for example, a non-secure access to GIC register ICDDCR can be observed by monitoring address 0x80001000

2.0 Configuration

2.1 Location

The model source and object file is found in the VLNV tree at:
arm.ovpworld.org/processor/arm/1.0

2.2 GDB Path

The default GDB for this model is found at:
$IMPERAS_HOME/lib/$IMPERAS_ARCH/gdb/arm-none-eabi-gdb

2.3 Semi-Host Library

The default semi-host library file is found in the VLNV tree at :
arm.ovpworld.org/semihosting/armNewlib/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

The ELF code supported by this model is: 0x28

3.0 Other Variants in this Model

Table 1.

Variant
ARMv4T
ARMv4xM
ARMv4
ARMv4TxM
ARMv5xM
ARMv5
ARMv5TxM
ARMv5T
ARMv5TExP
ARMv5TE
ARMv5TEJ
ARMv6
ARMv6K
ARMv6T2
ARMv6KZ
ARMv7
ARM7TDMI
ARM7EJ-S
ARM720T
ARM920T
ARM922T
ARM926EJ-S
ARM940T
ARM946E
ARM966E
ARM968E-S
ARM1020E
ARM1022E
ARM1026EJ-S
ARM1136J-S
ARM1156T2-S
ARM1176JZ-S
Cortex-R4
Cortex-R4F
Cortex-A5UP
Cortex-A5MPx1
Cortex-A5MPx2

Cortex-A5MPx3
Cortex-A5MPx4
Cortex-A8
Cortex-A9UP
Cortex-A9MPx1
Cortex-A9MPx2
Cortex-A9MPx3
Cortex-A9MPx4
Cortex-A7UP
Cortex-A7MPx1
Cortex-A7MPx2
Cortex-A7MPx3
Cortex-A7MPx4
Cortex-A15UP
Cortex-A15MPx1
Cortex-A15MPx2
Cortex-A15MPx3
Cortex-A15MPx4
Cortex-A17MPx1
Cortex-A17MPx2
Cortex-A17MPx3
Cortex-A17MPx4
AArch32
AArch64
Cortex-A53MPx1
Cortex-A53MPx2
Cortex-A53MPx3
Cortex-A53MPx4
Cortex-A57MPx1
Cortex-A57MPx2
Cortex-A57MPx3
Cortex-A57MPx4

4.0 Bus Ports

Table 2.

Type	Name	Bits	Description
master (initiator)	INSTRUCTION	32	
master (initiator)	DATA	32	
master (initiator)	GICRegisters	32	GIC memory-mapped register block

5.0 Net Ports

Table 3.

Name	Type	Description
SPI32	input	Shared peripheral interrupt
SPI33	input	Shared peripheral interrupt
SPI34	input	Shared peripheral interrupt
SPI35	input	Shared peripheral interrupt
SPI36	input	Shared peripheral interrupt
SPI37	input	Shared peripheral interrupt
SPI38	input	Shared peripheral interrupt
SPI39	input	Shared peripheral interrupt
SPI40	input	Shared peripheral interrupt
SPI41	input	Shared peripheral interrupt
SPI42	input	Shared peripheral interrupt
SPI43	input	Shared peripheral interrupt
SPI44	input	Shared peripheral interrupt
SPI45	input	Shared peripheral interrupt
SPI46	input	Shared peripheral interrupt
SPI47	input	Shared peripheral interrupt
SPI48	input	Shared peripheral interrupt
SPI49	input	Shared peripheral interrupt
SPI50	input	Shared peripheral interrupt
SPI51	input	Shared peripheral interrupt
SPI52	input	Shared peripheral interrupt
SPI53	input	Shared peripheral interrupt
SPI54	input	Shared peripheral interrupt
SPI55	input	Shared peripheral interrupt
SPI56	input	Shared peripheral interrupt
SPI57	input	Shared peripheral interrupt
SPI58	input	Shared peripheral interrupt
SPI59	input	Shared peripheral interrupt
SPI60	input	Shared peripheral interrupt
SPI61	input	Shared peripheral interrupt
SPI62	input	Shared peripheral interrupt
SPI63	input	Shared peripheral interrupt
SPI64	input	Shared peripheral interrupt
SPI65	input	Shared peripheral interrupt
SPI66	input	Shared peripheral interrupt
SPI67	input	Shared peripheral interrupt
SPI68	input	Shared peripheral interrupt
SPI69	input	Shared peripheral interrupt
SPI70	input	Shared peripheral interrupt
SPI71	input	Shared peripheral interrupt

SPI72	input	Shared peripheral interrupt
SPI73	input	Shared peripheral interrupt
SPI74	input	Shared peripheral interrupt
SPI75	input	Shared peripheral interrupt
SPI76	input	Shared peripheral interrupt
SPI77	input	Shared peripheral interrupt
SPI78	input	Shared peripheral interrupt
SPI79	input	Shared peripheral interrupt
SPI80	input	Shared peripheral interrupt
SPI81	input	Shared peripheral interrupt
SPI82	input	Shared peripheral interrupt
SPI83	input	Shared peripheral interrupt
SPI84	input	Shared peripheral interrupt
SPI85	input	Shared peripheral interrupt
SPI86	input	Shared peripheral interrupt
SPI87	input	Shared peripheral interrupt
SPI88	input	Shared peripheral interrupt
SPI89	input	Shared peripheral interrupt
SPI90	input	Shared peripheral interrupt
SPI91	input	Shared peripheral interrupt
SPI92	input	Shared peripheral interrupt
SPI93	input	Shared peripheral interrupt
SPI94	input	Shared peripheral interrupt
SPI95	input	Shared peripheral interrupt
SPIVector	input	Shared peripheral interrupt vectorized input
periphReset	input	Peripheral reset (active high)
wdResetReq_CPU0	output	Watchdog interrupt request
wdReset_CPU0	input	Watchdog reset (active high)
scuReset	input	SCU reset (active high)
VINITHI_CPU0	input	Configure HIVECS mode (SCTLR.V)
CFGEND_CPU0	input	Configure exception endianness (SCTLR.EE)
TEINIT_CPU0	input	Configure exception state at reset (SCTLR.TE)
CFGNMFI_CPU0	input	Configure non-maskable fast interrupts (SCTLR.NMFI)
reset_CPU0	input	Processor reset, active high
fiq_CPU0	input	FIQ interrupt, active high (negation of nFIQ)
irq_CPU0	input	IRQ interrupt, active high (negation of nIRQ)
AXI_SLVERR_CPU0	input	AXI external abort type (DECERR=0, SLVERR=1)
CP15SDISABLE_CPU0	input	CP15SDISABLE (active high)
wdResetReq_CPU1	output	Watchdog interrupt request
wdReset_CPU1	input	Watchdog reset (active high)
VINITHI_CPU1	input	Configure HIVECS mode (SCTLR.V)

CFGEND_CPU1	input	Configure exception endianness (SCTLR.EE)
TEINIT_CPU1	input	Configure exception state at reset (SCTLR.TE)
CFGNMFI_CPU1	input	Configure non-maskable fast interrupts (SCTLR.NMFI)
reset_CPU1	input	Processor reset, active high
fiq_CPU1	input	FIQ interrupt, active high (negation of nFIQ)
irq_CPU1	input	IRQ interrupt, active high (negation of nIRQ)
AXI_SLVERR_CPU1	input	AXI external abort type (DECERR=0, SLVERR=1)
CP15SDISABLE_CPU1	input	CP15SDISABLE (active high)
wdResetReq_CPU2	output	Watchdog interrupt request
wdReset_CPU2	input	Watchdog reset (active high)
VINITHI_CPU2	input	Configure HIVECS mode (SCTLR.V)
CFGEND_CPU2	input	Configure exception endianness (SCTLR.EE)
TEINIT_CPU2	input	Configure exception state at reset (SCTLR.TE)
CFGNMFI_CPU2	input	Configure non-maskable fast interrupts (SCTLR.NMFI)
reset_CPU2	input	Processor reset, active high
fiq_CPU2	input	FIQ interrupt, active high (negation of nFIQ)
irq_CPU2	input	IRQ interrupt, active high (negation of nIRQ)
AXI_SLVERR_CPU2	input	AXI external abort type (DECERR=0, SLVERR=1)
CP15SDISABLE_CPU2	input	CP15SDISABLE (active high)
wdResetReq_CPU3	output	Watchdog interrupt request
wdReset_CPU3	input	Watchdog reset (active high)
VINITHI_CPU3	input	Configure HIVECS mode (SCTLR.V)
CFGEND_CPU3	input	Configure exception endianness (SCTLR.EE)
TEINIT_CPU3	input	Configure exception state at reset (SCTLR.TE)
CFGNMFI_CPU3	input	Configure non-maskable fast interrupts (SCTLR.NMFI)
reset_CPU3	input	Processor reset, active high
fiq_CPU3	input	FIQ interrupt, active high (negation of nFIQ)
irq_CPU3	input	IRQ interrupt, active high (negation of nIRQ)
AXI_SLVERR_CPU3	input	AXI external abort type (DECERR=0, SLVERR=1)
CP15SDISABLE_CPU3	input	CP15SDISABLE (active high)

6.0 FIFO Ports

No FIFO Ports in this model.

7.0 Parameters

Table 4.

Name	Type	Description
verbose	Boolean	Specify verbosity of output
showHiddenRegs	Boolean	Show hidden registers during register tracing
UAL	Boolean	Disassemble using UAL syntax

enableVFPAtReset	Boolean	Enable vector floating point (SIMD and VFP) instructions at reset. (Enables cp10/11 in CPACR and sets FPEXC.EN)
compatibility	Enumeration	Specify compatibility mode ISA=0 gdb=1 nopSVC=2
override_debugMask	Uns32	Specifies debug mask, enabling debug output for model components
override_numCPUs	Uns32	Specify the number of cores in a multiprocessor (maximum of 8 for GICv1/ GICv2)
override_affinityMask	Uns32	Specify bitmask of implemented affinity bits in format Aff3:Aff2:Aff1:Aff0 (each a byte)
override_fcsePresent	Boolean	Specifies that FCSE is present (if true)
override_fpexcDexPresent	Boolean	Specifies that the FPEXC.DEX register field is implemented (if true)
override_advSIMDPresent	Boolean	Specifies that Advanced SIMD extensions are present (if true)
override_vfpPresent	Boolean	Specifies that VFP extensions are present (if true)
override_physicalBits	Uns32	Specifies the implemented physical bus bits (defaults to connected physical bus width)
override_timerScaleFactor	Uns32	Specifies the fraction of MIPS rate to use for MPCore timers (generic timers or global/local/watchdogs depending on implementation). Defaults to 20 for generic timers, 2 for others
override_GICD_NSACRPresent	Boolean	Specifies that optional GICD_NSACR distributor registers are present (GICv2 only)
override_GICD_PPISRPresent	Boolean	Specifies that implementation-specific GICD_PPISR distributor register is present (GICv1 ICDPPIS/ICPPISR, GICv1 and GICv2 only)
override_GICD_SPISRPresent	Boolean	Specifies that implementation-specific GICD_SPISR distributor registers are present (GICv1 ICDSPIS/ICSPISR)
override_GIC_PPIMask	Uns32	Specify bitmask of implemented PPIs in the GIC (e.g. ID16 is 0x0001, ID31 is 0x8000)
override_SCTLR_V	Boolean	Override SCTLR.V with the passed value (enables high vectors)
override_SCTLR_CP15BEN_Present	Boolean	Enable ARMv7 SCTLR.CP15BEN bit (CP15 barrier enable)
override_MIDR	Uns32	Override MIDR register
override_CTR	Uns32	Override CTR register
override_TLBTR	Uns32	Override TLBTR register
override_CLIDR	Uns32	Override CLIDR register
override_AIDR	Uns32	Override AIDR register

override_CBAR	Uns32	Override Configuration Base Address Register (Corresponds to value on PERIPHBASE input pins)
override_PFR0	Uns32	Override ID_PFR0 register
override_PFR1	Uns32	Override ID_PFR1 register
override_DFR0	Uns32	Override ID_DFR0 register
override_AFR0	Uns32	Override ID_AFR0 register
override_MMFR0	Uns32	Override ID_MMFR0 register
override_MMFR1	Uns32	Override ID_MMFR1 register
override_MMFR2	Uns32	Override ID_MMFR2 register
override_MMFR3	Uns32	Override ID_MMFR3 register
override_ISAR0	Uns32	Override ID_ISAR0 register
override_ISAR1	Uns32	Override ID_ISAR1 register
override_ISAR2	Uns32	Override ID_ISAR2 register
override_ISAR3	Uns32	Override ID_ISAR3 register
override_ISAR4	Uns32	Override ID_ISAR4 register
override_ISAR5	Uns32	Override ID_ISAR5 register
override_PMCR	Uns32	Override PMCR register (not functionally significant in the model)
override_PMCEID0	Uns32	Override PMCEID0 register (not functionally significant in the model)
override_PMCEID1	Uns32	Override PMCEID1 register (not functionally significant in the model)
override_FPSID	Uns32	Override SIMD/VFP FPSID register
override_MVFR0	Uns32	Override SIMD/VFP MVFR0 register
override_MVFR1	Uns32	Override SIMD/VFP MVFR1 register
override_FPEXC	Uns32	Override SIMD/VFP FPEXC register
override_GICC_IIDR	Uns32	Override GICC_IIDR register (GICv1 ICCIIDR)
override_GICD_TYPER	Uns32	Override GICD_TYPER register (GICv1 ICDICTR)
override_GICD_TYPER_ITLines	Uns32	Override ITLinesNumber field of GICD_TYPER register (GICv1 ICDICTR)
override_GICD_ICFGRN	Uns32	Override reset value of GICD_ICFGR2...GICD_ICFGRn (GICv1 ICDICFR2...ICDICFRn)
override_GICD_IIDR	Uns32	Override GICD_IIDR register (GICv1 ICDIIDR)
override_GICH_VTR	Uns32	Override GICH_VTR register
override_ICCPMRBits	Uns32	Specify the number of writable bits in GICC_PMR (GICv1 ICCPMR)
override_minICCBPR	Uns32	Specify the minimum possible value for GICC_BPR (GICv1 ICCBPR)
override_ERG	Uns32	Specifies exclusive reservation granule

override_STRoffsetPC12	Boolean	Specifies that STR/STR of PC should do so with 12:byte offset from the current instruction (if true), otherwise an 8:byte offset is used
override_fcseRequiresMMU	Boolean	Specifies that FCSE is active only when MMU is enabled (if true)
override_ignoreBadCp15	Boolean	Specifies whether invalid coprocessor 15 access should be ignored (if true) or cause Invalid Instruction exceptions (if false)
override_SGIDisable	Boolean	Override whether GIC SGIs may be disabled (if true) or are permanently enabled (if false)
override_condUndefined	Boolean	Force undefined instructions to take Undefined Instruction exception even if they are conditional
override_deviceStrongAligned	Boolean	Force accesses to Device and Strongly Ordered regions to be aligned
override_Control_V	Boolean	Override SCTLR.V with the passed value (deprecated, use override_SCTLR_V)
override_MainId	Uns32	Override MIDR register (deprecated, use override_MIDR)
override_CacheType	Uns32	Override CTR register (deprecated, use override_CTR)
override_TLBType	Uns32	Override TLBTR register (deprecated, use override_TLBTR)
override_InstructionAttributes0	Uns32	Override ID_ISAR0 register (deprecated, use override_ISAR0)
override_InstructionAttributes1	Uns32	Override ID_ISAR1 register (deprecated, use override_ISAR1)
override_InstructionAttributes2	Uns32	Override ID_ISAR2 register (deprecated, use override_ISAR2)
override_InstructionAttributes3	Uns32	Override ID_ISAR3 register (deprecated, use override_ISAR3)
override_InstructionAttributes4	Uns32	Override ID_ISAR4 register (deprecated, use override_ISAR4)
override_InstructionAttributes5	Uns32	Override ID_ISAR5 register (deprecated, use override_ISAR5)

8.0 Execution Modes

Table 5.

Name	Code
User	16
FIQ	17
IRQ	18
Supervisor	19
Monitor	22

Abort	23
Undefined	27
System	31

9.0 Exceptions

Table 6.

Name	**Code**
Reset	0
Undefined	1
SupervisorCall	2
SecureMonitorCall	3
PrefetchAbort	5
DataAbort	6
IRQ	8
FIQ	9

10.0 Hierarchy of the model

A CPU core may allow the user to configure it 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.

10.1 Level 1: MPCORE

This level in the model hierarchy has 2 commands.

This level in the model hierarchy has no register groups.

This level in the model hierarchy has 4 children:

PU0, PU1, PU2 and PU3

10.2 Level 2: CPU

This level in the model hierarchy has 4 commands.

This level in the model hierarchy has 20 register groups:

Table 7.

Group name	Registers
Core	16
Control	3
User	7
FIQ	8
IRQ	3
Supervisor	3
Monitor	3
Undefined	3
Abort	3
SIMD_VFP	32
SIMD_VFP_SYS	5
Coprocessor_32_bit	122
Coprocessor_32_bit_secure	20
Coprocessor_32_bit_non_secure	20
Integration_support	2
MPCore_SCR	8
MPCore_distributor	91

MPCore_processor_interface	9
MPCore_timer_and_watchdog	10
MPCore_global_timer	5

This level in the model hierarchy has no children.

11.0 Model Commands

11.1 Level 1: MPCORE

Table 8.

Name	Arguments
isync	specify instruction address range for synchronous execution
itrace	enable or disable instruction tracing

11.2 Level 2: CPU

Table 9.

Name	Arguments
debugflags	
dumpTLB	
isync	specify instruction address range for synchronous execution
itrace	enable or disable instruction tracing

12.0 Registers

12.1 Level 1: MPCORE

No registers.

12.2 Level 2: CPU

12.2.1 Core

Table 10.

Name	Bits	Initial value (Hex)		Description
r0	32	0	rw	
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	frame pointer
r12	32	0	rw	
sp	32	0	rw	stack pointer
lr	32	0	rw	

pc	32	0	rw	program counter

12.2.2 Control

Table 11.

Name	Bits	Initial value (Hex)		Description
fps	32	0	rw	archaic FPSCR view (for gdb)
cpsr	32	1d3	rw	
spsr	32	0	rw	

12.2.3 User

Table 12.

Name	Bits	Initial value (Hex)		Description
r8_usr	32	0	rw	
r9_usr	32	0	rw	
r10_usr	32	0	rw	
r11_usr	32	0	rw	
r12_usr	32	0	rw	
sp_usr	32	0	rw	
lr_usr	32	0	rw	

12.2.4 FIQ

Table 13.

Name	Bits	Initial value (Hex)		Description
r8_fiq	32	0	rw	
r9_fiq	32	0	rw	
r10_fiq	32	0	rw	
r11_fiq	32	0	rw	
r12_fiq	32	0	rw	
sp_fiq	32	0	rw	
lr_fiq	32	0	rw	
spsr_fiq	32	0	rw	

12.2.5 IRQ

Table 14.

Name	Bits	Initial value (Hex)		Description
sp_irq	32	0	rw	

lr_irq	32	0	rw	
spsr_irq	32	0	rw	

12.2.6 Supervisor

Table 15.

Name	Bits	Initial value (Hex)		Description
sp_svc	32	0	rw	
lr_svc	32	0	rw	
spsr_svc	32	0	rw	

12.2.7 Monitor

Table 16.

Name	Bits	Initial value (Hex)		Description
sp_mon	32	0	rw	
lr_mon	32	0	rw	
spsr_mon	32	0	rw	

12.2.8 Undefined

Table 17.

Name	Bits	Initial value (Hex)		Description
sp_undef	32	0	rw	
lr_undef	32	0	rw	
spsr_undef	32	0	rw	

12.2.9 Abort

Table 18.

Name	Bits	Initial value (Hex)		Description
sp_abt	32	0	rw	
lr_abt	32	0	rw	
spsr_abt	32	0	rw	

12.2.10 SIMD_VFP

Table 19.

Name	Bits	Initial value (Hex)		Description
d0	64	0	rw	

d1	64	0	rw	
d2	64	0	rw	
d3	64	0	rw	
d4	64	0	rw	
d5	64	0	rw	
d6	64	0	rw	
d7	64	0	rw	
d8	64	0	rw	
d9	64	0	rw	
d10	64	0	rw	
d11	64	0	rw	
d12	64	0	rw	
d13	64	0	rw	
d14	64	0	rw	
d15	64	0	rw	
d16	64	0	rw	
d17	64	0	rw	
d18	64	0	rw	
d19	64	0	rw	
d20	64	0	rw	
d21	64	0	rw	
d22	64	0	rw	
d23	64	0	rw	
d24	64	0	rw	
d25	64	0	rw	
d26	64	0	rw	
d27	64	0	rw	
d28	64	0	rw	
d29	64	0	rw	
d30	64	0	rw	
d31	64	0	rw	

12.2.11 SIMD_VFP_SYS

Table 20.

Name	Bits	Initial value (Hex)		Description
FPSID	32	41033092	r-	floating-point system ID
FPSCR	32	0	rw	floating-point status/control
FPEXC	32	0	rw	floating-point exception
MVFR0	32	10110222	r-	Media/VFP feature 0
MVFR1	32	1111111	r-	Media/VFP feature 1

12.2.12 Coprocessor_32_bit

Table 21.

Name	Bits	Initial value (Hex)		Description
ACTLR	32	0	rw	Auxiliary Control
ADFSR	32	0	rw	Auxilary Data Fault Status
AIDR	32	0	r-	Auxiliary ID
AIFSR	32	0	rw	Auxilary Instruction Fault Status
ATS1CPR	32	-	-w	Address Translate Stage 1 Current State EL1 Read
ATS1CPW	32	-	-w	Address Translate Stage 1 Current State EL1 Write
ATS1CUR	32	-	-w	Address Translate Stage 1 Current State Unprivileged Read
ATS1CUW	32	-	-w	Address Translate Stage 1 Current State Unprivileged Write
ATS12NSOPR	32	-	-w	Address Translate Stages 1 and 2 Non-Secure Only EL1 Read
ATS12NSOPW	32	-	-w	Address Translate Stages 1 and 2 Non-Secure Only EL1 Write
ATS12NSOUR	32	-	-w	Address Translate Stages 1 and 2 Non-Secure Only Unprivileged Read
ATS12NSOUW	32	-	-w	Address Translate Stages 1 and 2 Non-Secure Only Unprivileged Write
BPIALL	32	-	-w	Branch Predictor Invalidate All
BPIALLIS	32	-	-w	Branch Predictor Invalidate All (IS)
BPIMVA	32	-	-w	Branch Predictor Invalidate by VA
CBAR	32	13080000	rw	Configuration Base Address
CCSIDR	32	201fe019	r-	Cache Size ID
CLIDR	32	9200003	r-	Cache Level ID
CONTEXTIDR	32	0	rw	Context ID
CP15DMB	32	-	-w	CP15 Data Memory Barrier
CP15DSB	32	-	-w	CP15 Data Synchronization Barrier
CP15ISB	32	-	-w	CP15 Instruction Synchronization Barrier
CP15NOP	32	-	-w	CP15 NOP
CPACR	32	0	rw	Coprocessor Access Control
CSSELR	32	1	rw	Cache Size Selection
CTR	32	83338003	r-	Cache Type
DACR	32	0	rw	Domain Access Control
DBGDIDR	32	0	r-	Debug ID
DCCIMVAC	32	-	-w	Data Cache Line Clean and Invalidate by VA to PoC
DCCISW	32	-	-w	Data Cache Line Clean and Invalidate by Set/Way
DCCMVAC	32	-	-w	Data Cache Line Clean by VA to PoC
DCCMVAU	32	-	-w	Data Cache Line Clean by VA to PoU
DCCSW	32	-	-w	Data Cache Line Clean by Set/Way

DCIMVAC	32	-	-w	Data Cache Line Invalidate by VA to PoC
DCISW	32	-	-w	Data Cache Line Invalidate by Set/Way
DFAR	32	0	rw	Data Fault Address
DFSR	32	0	rw	Data Fault Status
DTLBIALL	32	-	-w	Invalidate Entire Data TLB
DTLBIASID	32	-	-w	Invalidate Data TLB by ASID
DTLBIMVA	32	-	-w	Invalidate Data TLB by VA
DTLBIMVAA	32	-	-w	Invalidate Data TLB by VA, all ASID
DTLBLR	32	0	rw	TLB Lockdown
ICIALLU	32	-	-w	Instruction Cache Invalidate All
ICIALLUIS	32	-	-w	Instruction Cache Invalidate All (IS)
ICIMVAU	32	-	-w	Instruction Cache Invalidate by VA
ID_AFR0	32	0	r-	Auxiliary Feature 0
ID_DFR0	32	0	r-	Debug Feature 0
ID_ISAR0	32	101111	r-	Instruction Set Attribute 0
ID_ISAR1	32	13112111	r-	Instruction Set Attribute 1
ID_ISAR2	32	21232041	r-	Instruction Set Attribute 2
ID_ISAR3	32	11112131	r-	Instruction Set Attribute 3
ID_ISAR4	32	11142	r-	Instruction Set Attribute 4
ID_ISAR5	32	0	r-	Instruction Set Attribute 5
ID_MMFR0	32	100103	r-	Memory Model Feature 0
ID_MMFR1	32	20000000	r-	Memory Model Feature 1
ID_MMFR2	32	1230000	r-	Memory Model Feature 2
ID_MMFR3	32	102111	r-	Memory Model Feature 3
ID_PFR0	32	1231	r-	Processor Feature 0
ID_PFR1	32	11	r-	Processor Feature 1
IFAR	32	0	rw	Instruction Fault Address
IFSR	32	0	rw	Instruction Fault Status
ISR	32	0	r-	Interrupt Status
ITLBIALL	32	-	-w	Invalidate Entire Instruction TLB
ITLBIASID	32	-	-w	Invalidate Instruction TLB by ASID
ITLBIMVA	32	-	-w	Invalidate Instruction TLB by VA
ITLBIMVAA	32	-	-w	Invalidate Instruction TLB by VA, all ASID
JIDR	32	0	rw	Jazelle ID
JMCR	32	0	rw	Jazelle Main Configuration
JOSCR	32	0	rw	Jazelle OS Control
MIDR	32	411fc090	r-	Main ID
MPIDR	32	80000000	r-	Multiprocessor Affinity
MVBAR	32	0	rw	Monitor Vector Base Address
NEONB	32	0	r-	NEON Busy
NMRR	32	44e048e0	rw	Normal Memory Remap
NSACR	32	0	rw	Non-Secure Access Control

PAR	32	0	rw	Physical Address
PCR	32	200	rw	Power Control
PLEASR	32	0	r-	PLE Activity Status
PLEFSR	32	0	r-	PLE FIFO Status
PLEIDR	32	0	r-	PLE ID
PMCCNTR	32	0	rw	Performance Monitors Cycle Count
PMCNTENCLR	32	0	rw	Performance Monitors Count Enable Clear
PMCNTENSET	32	0	rw	Performance Monitors Count Enable Set
PMCR	32	41093000	rw	Performance Monitors Control
PMINTENCLR	32	0	rw	Performance Monitors Interrupt Enable Clear
PMINTENSET	32	0	rw	Performance Monitors Interrupt Enable Set
PMOVSR	32	0	rw	Performance Monitors Overflow Flag Status
PMSELR	32	0	rw	Performance Monitors Event Counter Selection
PMSWINC	32	-	-w	Performance Monitors Software Increment
PMUSERENR	32	0	rw	Performance Monitors User Enable
PMXEVCNTR	32	0	rw	Performance Monitors Selected Event Count
PMXEVTYPER	32	0	rw	Performance Monitors Selected Event Type
PRRR	32	98aa4	rw	Primary Region Remap
SCR	32	0	rw	Secure Configuration
SCTLR	32	c50078	rw	System Control
SDER	32	0	rw	Secure Debug Enable
TCMTR	32	0	r-	TCM Type
TEECR	32	0	rw	T32EE Configuration
TEEHBR	32	0	rw	T32EE Handler Base
TLBIALL	32	-	-w	Invalidate Entire Unified TLB
TLBIALLIS	32	-	-w	Invalidate Entire Unified TLB (IS)
TLBIASID	32	-	-w	Invalidate Unified TLB by ASID
TLBIASIDIS	32	-	-w	Invalidate Unified TLB by ASID (IS)
TLBIMVA	32	-	-w	Invalidate Unified TLB by VA
TLBIMVAA	32	-	-w	Invalidate Unified TLB by VA, all ASID
TLBIMVAAIS	32	-	-w	Invalidate Unified TLB by VA, all ASID (IS)
TLBIMVAIS	32	-	-w	Invalidate Unified TLB by VA (IS)
TLBLDATTR	32	0	rw	TLB Lockdown Attributes
TLBLDPA	32	0	rw	TLB Lockdown PA
TLBLDRI	32	-	-w	TLB Lockdown Read Index
TLBLDVA	32	0	rw	TLB Lockdown VA
TLBLDWI	32	-	-w	TLB Lockdown Write Index
TLBTR	32	400	r-	TLB Type
TPIDRPRW	32	0	rw	PL0 Read/Write Software Thread ID
TPIDRURO	32	0	rw	PL0 Read-Only Software Thread ID
TPIDRURW	32	0	rw	PL1 Software Thread ID
TTBCR	32	0	rw	Translation Table Base Control

TTBR0	32	0	rw	Translation Table Base 0
TTBR1	32	0	rw	Translation Table Base 1
VBAR	32	0	rw	Vector Base Address
VCR	32	0	rw	Virtualization Control
VIR	32	0	rw	Virtualization Interrupt

12.2.13 Coprocessor_32_bit_secure

Table 22.

Name	Bits	Initial value (Hex)		Description
ADFSR_S	32	0	rw	Auxilary Data Fault Status
AIFSR_S	32	0	rw	Auxilary Instruction Fault Status
CONTEXTIDR_S	32	0	rw	Context ID
CSSELR_S	32	1	rw	Cache Size Selection
DACR_S	32	0	rw	Domain Access Control
DFAR_S	32	0	rw	Data Fault Address
DFSR_S	32	0	rw	Data Fault Status
IFAR_S	32	0	rw	Instruction Fault Address
IFSR_S	32	0	rw	Instruction Fault Status
NMRR_S	32	44e048e0	rw	Normal Memory Remap
PAR_S	32	0	rw	Physical Address
PRRR_S	32	98aa4	rw	Primary Region Remap
SCTLR_S	32	c50078	rw	System Control
TPIDRPRW_S	32	0	rw	PL0 Read/Write Software Thread ID
TPIDRURO_S	32	0	rw	PL0 Read-Only Software Thread ID
TPIDRURW_S	32	0	rw	PL1 Software Thread ID
TTBCR_S	32	0	rw	Translation Table Base Control
TTBR0_S	32	0	rw	Translation Table Base 0
TTBR1_S	32	0	rw	Translation Table Base 1
VBAR_S	32	0	rw	Vector Base Address

12.2.14 Coprocessor_32_bit_non_secure

Table 23.

Name	Bits	Initial value (Hex)		Description
ADFSR_NS	32	0	rw	Auxilary Data Fault Status
AIFSR_NS	32	0	rw	Auxilary Instruction Fault Status
CONTEXTIDR_NS	32	0	rw	Context ID
CSSELR_NS	32	1	rw	Cache Size Selection
DACR_NS	32	0	rw	Domain Access Control
DFAR_NS	32	0	rw	Data Fault Address
DFSR_NS	32	0	rw	Data Fault Status

IFAR_NS	32	0	rw	Instruction Fault Address
IFSR_NS	32	0	rw	Instruction Fault Status
NMRR_NS	32	44e048e0	rw	Normal Memory Remap
PAR_NS	32	0	rw	Physical Address
PRRR_NS	32	98aa4	rw	Primary Region Remap
SCTLR_NS	32	c50078	rw	System Control
TPIDRPRW_NS	32	0	rw	PL0 Read/Write Software Thread ID
TPIDRURO_NS	32	0	rw	PL0 Read-Only Software Thread ID
TPIDRURW_NS	32	0	rw	PL1 Software Thread ID
TTBCR_NS	32	0	rw	Translation Table Base Control
TTBR0_NS	32	0	rw	Translation Table Base 0
TTBR1_NS	32	0	rw	Translation Table Base 1
VBAR_NS	32	0	rw	Vector Base Address

12.2.15 Integration_support

Table 24.

Name	Bits	Initial value (Hex)		Description
transactPL	32	1	r-	privilege level of current memory transaction
transactAT	32	0	r-	current memory transaction type: PA=1, VA=0

12.2.16 MPCore_SCR

Table 25.

Name	Bits	Initial value (Hex)		Description
SCUCPUPowerStatus	32	0	rw	SCU CPU Power Status
SCUConfiguration	32	5503	r-	SCU Configuration
SCUControl	32	0	rw	SCU Control
SCUFilteringEnd	32	0	rw	SCU Filtering End
SCUFilteringStart	32	0	rw	SCU Filtering Start
SCUInvalidateSecure	32	0	-w	SCU Invalidate Secure
SCUNSAC	32	0	rw	SCU Non-secure Access Control
SCUSAC	32	f	rw	SCU Secure Access Control

12.2.17 MPCore_distributor

Table 26.

Name	Bits	Initial value (Hex)		Description
COMPONENT_ID0	32	d	r-	Component ID 0
COMPONENT_ID1	32	f0	r-	Component ID 1
COMPONENT_ID2	32	5	r-	Component ID 2
COMPONENT_ID3	32	b1	r-	Component ID 3

ICDABR0	32	0	rw	Interrupt Set-Active 0
ICDABR1	32	0	rw	Interrupt Set-Active 1
ICDABR2	32	0	rw	Interrupt Set-Active 2
ICDDCR	32	0	rw	Distributor Control
ICDICER0	32	ffff	rw	Interrupt Clear-Enable 0
ICDICER1	32	0	rw	Interrupt Clear-Enable 1
ICDICER2	32	0	rw	Interrupt Clear-Enable 2
ICDICFR0	32	aaaaaaaa	rw	Interrupt Configuration 0
ICDICFR1	32	7dc00000	rw	Interrupt Configuration 1
ICDICFR2	32	55555555	rw	Interrupt Configuration 2
ICDICFR3	32	55555555	rw	Interrupt Configuration 3
ICDICFR4	32	55555555	rw	Interrupt Configuration 4
ICDICFR5	32	55555555	rw	Interrupt Configuration 5
ICDICPR0	32	0	rw	Interrupt Clear-Pending 0
ICDICPR1	32	0	rw	Interrupt Clear-Pending 1
ICDICPR2	32	0	rw	Interrupt Clear-Pending 2
ICDICTR	32	fc62	r-	Interrupt Controller Type
ICDIIDR	32	102043b	r-	Distributor Implementor ID
ICDIPR0	32	0	rw	Interrupt Priority 0
ICDIPR1	32	0	rw	Interrupt Priority 1
ICDIPR2	32	0	rw	Interrupt Priority 2
ICDIPR3	32	0	rw	Interrupt Priority 3
ICDIPR4	32	0	rw	Interrupt Priority 4
ICDIPR5	32	0	rw	Interrupt Priority 5
ICDIPR6	32	0	rw	Interrupt Priority 6
ICDIPR7	32	0	rw	Interrupt Priority 7
ICDIPR8	32	0	rw	Interrupt Priority 8
ICDIPR9	32	0	rw	Interrupt Priority 9
ICDIPR10	32	0	rw	Interrupt Priority 10
ICDIPR11	32	0	rw	Interrupt Priority 11
ICDIPR12	32	0	rw	Interrupt Priority 12
ICDIPR13	32	0	rw	Interrupt Priority 13
ICDIPR14	32	0	rw	Interrupt Priority 14
ICDIPR15	32	0	rw	Interrupt Priority 15
ICDIPR16	32	0	rw	Interrupt Priority 16
ICDIPR17	32	0	rw	Interrupt Priority 17
ICDIPR18	32	0	rw	Interrupt Priority 18
ICDIPR19	32	0	rw	Interrupt Priority 19
ICDIPR20	32	0	rw	Interrupt Priority 20
ICDIPR21	32	0	rw	Interrupt Priority 21
ICDIPR22	32	0	rw	Interrupt Priority 22
ICDIPR23	32	0	rw	Interrupt Priority 23

ICDIPTR0	32	1010101	rw	Interrupt Processor Targets 0
ICDIPTR1	32	1010101	rw	Interrupt Processor Targets 1
ICDIPTR2	32	1010101	rw	Interrupt Processor Targets 2
ICDIPTR3	32	1010101	rw	Interrupt Processor Targets 3
ICDIPTR4	32	0	rw	Interrupt Processor Targets 4
ICDIPTR5	32	0	rw	Interrupt Processor Targets 5
ICDIPTR6	32	1000000	rw	Interrupt Processor Targets 6
ICDIPTR7	32	1010101	rw	Interrupt Processor Targets 7
ICDIPTR8	32	0	rw	Interrupt Processor Targets 8
ICDIPTR9	32	0	rw	Interrupt Processor Targets 9
ICDIPTR10	32	0	rw	Interrupt Processor Targets 10
ICDIPTR11	32	0	rw	Interrupt Processor Targets 11
ICDIPTR12	32	0	rw	Interrupt Processor Targets 12
ICDIPTR13	32	0	rw	Interrupt Processor Targets 13
ICDIPTR14	32	0	rw	Interrupt Processor Targets 14
ICDIPTR15	32	0	rw	Interrupt Processor Targets 15
ICDIPTR16	32	0	rw	Interrupt Processor Targets 16
ICDIPTR17	32	0	rw	Interrupt Processor Targets 17
ICDIPTR18	32	0	rw	Interrupt Processor Targets 18
ICDIPTR19	32	0	rw	Interrupt Processor Targets 19
ICDIPTR20	32	0	rw	Interrupt Processor Targets 20
ICDIPTR21	32	0	rw	Interrupt Processor Targets 21
ICDIPTR22	32	0	rw	Interrupt Processor Targets 22
ICDIPTR23	32	0	rw	Interrupt Processor Targets 23
ICDISER0	32	ffff	rw	Interrupt Set-Enable 0
ICDISER1	32	0	rw	Interrupt Set-Enable 1
ICDISER2	32	0	rw	Interrupt Set-Enable 2
ICDISPR0	32	0	rw	Interrupt Set-Pending 0
ICDISPR1	32	0	rw	Interrupt Set-Pending 1
ICDISPR2	32	0	rw	Interrupt Set-Pending 2
ICDISR0	32	0	rw	Interrupt Group 0
ICDISR1	32	0	rw	Interrupt Group 1
ICDISR2	32	0	rw	Interrupt Group 2
ICDPPIS	32	0	r-	PPI STATUS
ICDSGIR	32	0	-w	Software-Generated Interrupt
ICDSPIS0	32	0	r-	SPI Status 0
ICDSPIS1	32	0	r-	SPI Status 1
PERIPH_ID0	32	4	r-	Peripheral ID 0
PERIPH_ID1	32	0	r-	Peripheral ID 1
PERIPH_ID2	32	0	r-	Peripheral ID 2
PERIPH_ID3	32	0	r-	Peripheral ID 3
PERIPH_ID4	32	90	r-	Peripheral ID 4

PERIPH_ID5	32	b3	r-	Peripheral ID 5
PERIPH_ID6	32	1b	r-	Peripheral ID 6
PERIPH_ID7	32	0	r-	Peripheral ID 7

12.2.18 MPCore_processor_interface

Table 27.

Name	Bits	Initial value (Hex)		Description
ICCABPR	32	3	rw	Aliased Binary Point
ICCBPR	32	2	rw	Binary Point
ICCEOIR	32	0	-w	End of Interrupt
ICCHPIR	32	3ff	r-	Highest Priority Pending Interrupt
ICCIAR	32	3ff	r-	Interrupt Acknowledge
ICCICR	32	0	rw	CPU Interface Control
ICCIIDR	32	3901243b	r-	CPU Interface ID
ICCPMR	32	0	rw	Interrupt Priority Mask
ICCRPR	32	ff	r-	Running Priority

12.2.19 MPCore_timer_and_watchdog

Table 28.

Name	Bits	Initial value (Hex)		Description
PTControl	32	0	rw	Private Timer Control
PTCounter	32	0	rw	Private Timer Counter
PTInterruptStatus	32	0	rw	Private Timer Interrupt Status
PTLoad	32	0	rw	Private Timer Load
WTControl	32	0	rw	Watchdog Timer Control
WTCounter	32	0	rw	Watchdog Timer Counter
WTDisable	32	0	-w	Watchdog Timer Disable
WTInterruptStatus	32	0	rw	Watchdog Timer Interrupt Status
WTLoad	32	0	rw	Watchdog Timer Load
WTResetStatus	32	0	rw	Watchdog Timer Reset Status

12.2.20 MPCore_global_timer

Table 29.

Name	Bits	Initial value (Hex)		Description
GTAutoIncrement	32	0	rw	Global Timer Auto-Increment
GTComparator	64	0	rw	Global Timer Comparator

GTControl	32	0	rw	Global Timer Control
GTCounter	64	0	rw	Global Timer Counter
GTInterruptStatus	32	0	rw	Global Timer Interrupt Status

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