Arm® Neoverse™ V2 Core Cryptographic Extension

Revision: r0p2

Technical Reference Manual

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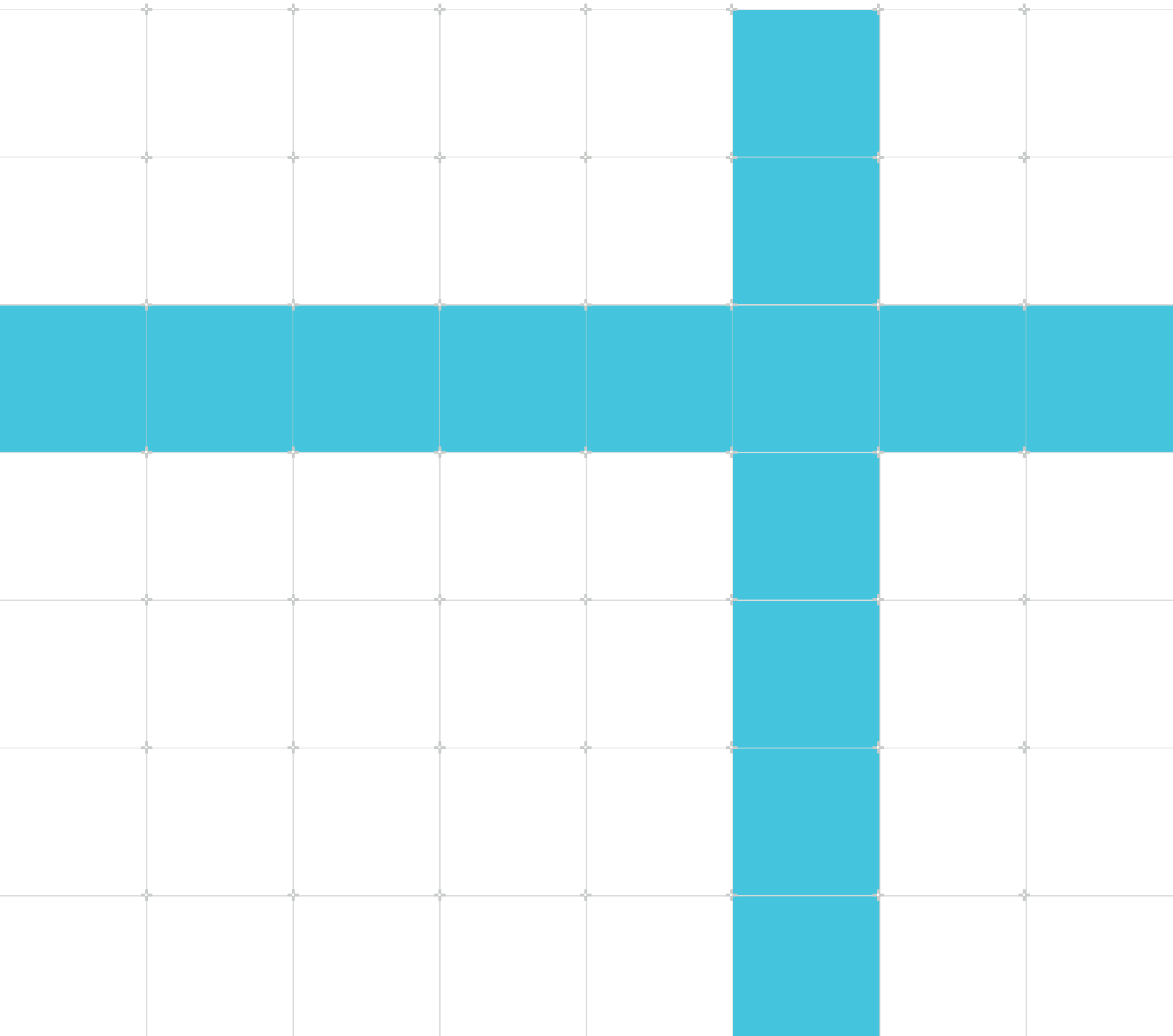

Arm® Neoverse™ V2 Core Cryptographic Extension

Technical Reference Manual

Release Information

Document history

Issue	Date	Confidentiality	Change
0000-01	29 October 2021	Confidential	First early access release for r0p0
0001-02	30 September 2022	Non-Confidential	First early access release for r0p1
0002-03	16 December 2022	Non-Confidential	First release for r0p2

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Contents

1. Introduction

1.1 Product revision status

The r*x*p*y* identifier indicates the revision status of the product described in this manual, for example, r1p2, where:

r*x* Identifies the major revision of the product, for example, r1.
p*y* Identifies the minor revision or modification status of the product, for example, p2.

1.2 Intended audience

This manual is for system designers, system integrators, and programmers who are designing or programming a *System-on-Chip* (SoC) that uses the Neoverse™ V2 core with the optional Cryptographic Extension.

1.3 Conventions

The following subsections describe conventions used in Arm documents.

Glossary

The Arm® Glossary is a list of terms used in Arm documentation, together with definitions for those terms. The Arm Glossary does not contain terms that are industry standard unless the Arm meaning differs from the generally accepted meaning.

See the Arm Glossary for more information: developer.arm.com/glossary.

Convention	Use
italic	Citations.
bold	Terms in descriptive lists, where appropriate.
`monospace`	Text that you can enter at the keyboard, such as commands, file and program names, and source code.
`monospace underline`	A permitted abbreviation for a command or option. You can enter the underlined text instead of the full command or option name.

Convention	Use
<and>	Encloses replaceable terms for assembler syntax where they appear in code or code fragments. For example: `MRC p15, 0, <Rd>, <CRn>, <CRm>, <Opcode_2>`
SMALL CAPITALS	Terms that have specific technical meanings as defined in the *Arm® Glossary*. For example, **IMPLEMENTATION DEFINED**, **IMPLEMENTATION SPECIFIC**, **UNKNOWN**, and **UNPREDICTABLE**.

Recommendations. Not following these recommendations might lead to system failure or damage.

Requirements for the system. Not following these requirements might result in system failure or damage.

Requirements for the system. Not following these requirements will result in system failure or damage.

An important piece of information that needs your attention.

A useful tip that might make it easier, better or faster to perform a task.

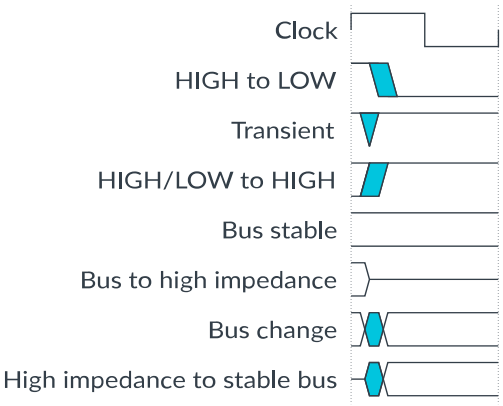
A reminder of something important that relates to the information you are reading.

Timing diagrams

The following figure explains the components used in timing diagrams. Variations, when they occur, have clear labels. You must not assume any timing information that is not explicit in the diagrams.

Shaded bus and signal areas are undefined, so the bus or signal can assume any value within the shaded area at that time. The actual level is unimportant and does not affect normal operation.

Figure 1-1: Key to timing diagram conventions



Signals

The signal conventions are:

Signal level

The level of an asserted signal depends on whether the signal is active-HIGH or active-LOW. Asserted means:

- HIGH for active-HIGH signals.
- LOW for active-LOW signals.

Lowercase n

At the start or end of a signal name, n denotes an active-LOW signal.

1.4 Useful resources

This document contains information that is specific to this product. See the following resources for other useful information.

Access to Arm documents depends on their confidentiality:

- Non-Confidential documents are available at developer.arm.com/documentation. Each document link in the following tables goes to the online version of the document.
- Confidential documents are available to licensees only through the product package.

Arm product resources	Document ID	Confidentiality
Arm® Neoverse™ V2 Core Configuration and Integration Manual	102393	Confidential
Arm® Neoverse™ V2 Core Technical Reference Manual	102375	Non-Confidential

Arm architecture and specifications	Document ID	Confidentiality
Arm® Architecture Reference Manual for A-profile architecture	DDI 0487	Non-Confidential

Non-Arm resources	Document ID	Organization
Advanced Encryption Standard	FIPS 197, November 2001	-
Secure Hash Standard (SHS)	FIPS 180-4, August 2015	-
Secure Hash Standard (SHS)	FIPS 202, August 2015	-

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2. Cryptographic extension support in the Neoverse™ V2 core

The Neoverse™ V2 core supports the optional Armv8.0-A and Arm®v8.2-A Cryptographic Extension.

The Armv8.0-A Cryptographic Extension adds A64 instructions to Advanced SIMD that accelerate *Advanced Encryption Standard* (AES) encryption and decryption. It also adds instructions to implement the *Secure Hash Algorithm* (SHA) functions SHA-1, SHA-224, and SHA-256.

The Arm®v8.2-A extensions, Armv8.2-A-SHA and Armv8.2-SM, add A64 instructions to accelerate SHA2-512, SHA3, SM3, and SM4.

The SVE2-AES, SVE2-SHA3, and SVE2-SM extensions add A64 instructions to accelerate SHA3, SM3, SM4, and AES encryption and decryption.

2.1 Product Revisions

The following table indicates the main differences in functionality between product revisions.

Table 2-1: Product revisions

Revision	Notes
r0p0	First release.
r0p1	No functional changes to core for this revision.
r0p2	No functional changes to core for this revision.

Changes in functionality that have an impact on the documentation also appear in A.1 Revisions on page 15.

2.2 Disable the Cryptographic Extension

Disabling the Cryptographic Extension applies to all Neoverse™ V2 cores in a cluster.

To disable the Cryptographic Extension, assert CRYPTODISABLE.

When CRYPTODISABLE is asserted:

- Executing a cryptographic instruction results in an **UNDEFINED** exception.
- ID_AA64ISAR0_EL1 indicates that the Cryptographic Extension is not implemented.

Related information

2.5 ID_AA64ISAR0_EL1, AArch64 Instruction Set Attribute Register 0 on page 11

2.3 Disable the SM3/SM4 Cryptographic instructions

Disabling the SM3/SM4 Cryptographic instructions applies to all Neoverse™ V2 cores in a cluster.

To disable the SM3/SM4 Cryptographic instructions, assert SMCRYPTODISABLE.

When SMCRYPTODISABLE is asserted:

- Executing an SM3 or SM4 cryptographic instruction results in an **UNDEFINED** exception.
- ID_AA64ISAR0_EL1 indicates that the SM3/SM4 instructions are not implemented.


Note

You can only choose to disable the SM3/SM4 cryptographic instructions, when CRYPTODISABLE is not asserted. When CRYPTODISABLE is asserted, then the SM3/SM4 cryptographic instructions are disabled, regardless of the value of SMCRYPTODISABLE.

Related information

2.5 ID_AA64ISAR0_EL1, AArch64 Instruction Set Attribute Register 0 on page 11

2.4 Cryptographic Extensions register summary

Software can identify the cryptographic instructions that are implemented in the Neoverse™ V2 core by reading the ID_AA64ISAR0_EL1 identification register.

The following table shows the instruction identification register for the Neoverse™ V2 core Cryptographic Extension.

Table 2-2: Cryptographic Extension register summary

Name	Execution state	Description
ID_AA64ISAR0_EL1	AArch64	See 2.5 ID_AA64ISAR0_EL1, AArch64 Instruction Set Attribute Register 0 on page 11

2.5 ID_AA64ISAR0_EL1, AArch64 Instruction Set Attribute Register 0

Provides information about the instructions implemented in AArch64 state.

For general information about the interpretation of the ID registers, see 'Principles of the ID scheme for fields in ID registers'.

Configurations

This register is available in all configurations.

Attributes

Width

64

Functional group

Identification

Reset value

See individual bit resets

Bit descriptions

Figure 2-1: AArch64_id_aa64isar0_el1 bit assignments

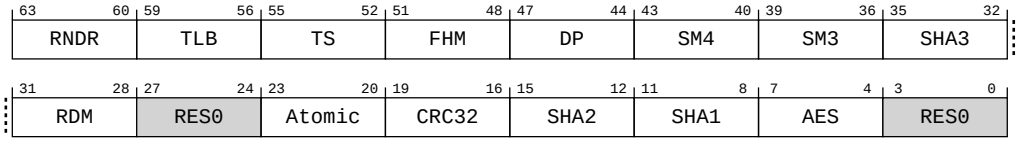

Table 2-3: ID_AA64ISAR0_EL1 bit descriptions

Bits	Name	Description	Reset
[63:60]	RNDR	Indicates support for Random Number instructions in AArch64 state. Defined values are: **0b0000** No Random Number instructions are implemented. **0b0001** AArch64-RNDR and AArch64-RNDRRS registers are implemented, if the core has the RNDR feature configured.	
[59:56]	TLB	Indicates support for Outer Shareable and TLB range maintenance instructions. Defined values are: **0b0010** Outer Shareable and TLB range maintenance instructions are implemented.	
[55:52]	TS	Indicates support for flag manipulation instructions. Defined values are: **0b0010** CFINV, RMIF, SETF16, SETF8, AXFLAG, and XAFLAG instructions are implemented.	
[51:48]	FHM	Indicates support for FMLAL and FMLSL instructions. Defined values are: **0b0001** FMLAL and FMLSL instructions are implemented.	
[47:44]	DP	Indicates support for Dot Product instructions in AArch64 state. Defined values are: **0b0001** UDOT and SDOT instructions implemented.	

Bits	Name	Description	Reset
[43:40]	SM4	Indicates support for SM4 instructions in AArch64 state. Defined values are: **0b0000** When the Cryptographic Extension is not implemented or is disabled or the SM3/SM4 Cryptographic instructions are disabled, then SM4 instructions are not implemented. **0b0001** When the Cryptographic Extension is implemented and the SM3/SM4 Cryptographic instructions are enabled, then SM4 instructions SM4E and SM4EKEY are implemented.	
[39:36]	SM3	Indicates support for SM3 instructions in AArch64 state. Defined values are: **0b0000** When the Cryptographic Extension is not implemented or is disabled, or the SM3/SM4 Cryptographic instructions are disabled, then SM3 instructions are not implemented. **0b0001** When the Cryptographic Extension is implemented and the SM3/SM4 Cryptographic instructions are enabled, then SM3 instructions SM3SS1, SM3TT1A, SM3TT1B, SM3TT2A, SM3TT2B, SM3PARTW1, and SM3PARTW2 are implemented.	
[35:32]	SHA3	Indicates support for SHA3 instructions in AArch64 state. Defined values are: **0b0000** When the Cryptographic Extension is not implemented or disabled, then SHA3 instructions are not implemented. **0b0001** When the Cryptographic Extension is implemented and enabled then SHA3 instructions EOR3, RAX1, XAR, and BCAX are implemented.	
[31:28]	RDM	Indicates support for SQRDMLAH and SQRDMLSH instructions in AArch64 state. Defined values are: **0b0001** SQRDMLAH and SQRDMLSH instructions implemented.	
[27:24]	RES0	Reserved	0b0000
[23:20]	Atomic	Indicates support for Atomic instructions in AArch64 state. Defined values are: **0b0010** LDADD, LDCLR, LDEOR, LDSET, LDSMAX, LDSMIN, LDUMAX, LDUMIN, CAS, CASP, and SWP instructions implemented.	
[19:16]	CRC32	CRC32 instructions implemented in AArch64 state. Defined values are: **0b0001** CRC32B, CRC32H, CRC32W, CRC32X, CRC32CB, CRC32CH, CRC32CW, and CRC32CX instructions implemented.	
[15:12]	SHA2	SHA2 instructions implemented in AArch64 state. Defined values are: **0b0000** When the Cryptographic Extension is not implemented or disabled, then SHA2 instructions are not implemented. **0b0010** When the Cryptographic Extension is implemented and enabled, then SHA256H, SHA256H2, SHA256SU0, SHA256SU1, SHA512H, SHA512H2, SHA512SU0, and SHA512SU1 instructions are implemented. When the CRYPTO configuration parameter is true and the CRYPTODISABLE input is low at reset Cryptographic Extensions are implemented	

Bits	Name	Description	Reset
[11:8]	SHA1	SHA1 instructions implemented in AArch64 state. Defined values are: **0b0000** When the Cryptographic Extension is not implemented or disabled, then SHA1 instructions are not implemented. **0b0001** When the Cryptographic Extension is implemented and enabled, then SHA1C, SHA1P, SHA1M, SHA1H, SHA1SU0, and SHA1SU1 instructions are implemented. When the CRYPTO configuration parameter is true and the CRYPTODISABLE input is low at reset Cryptographic Extensions are implemented.	
[7:4]	AES	AES instructions implemented in AArch64 state. Defined values are: **0b0000** SVE2-AES instructions are not implemented. This value is reported when the Cryptographic Extension is not implemented or are disabled. **0b0010** SVE2 AESE, AESD, AESMC, and AESIMC instructions are implemented plus SVE2 PMULLB and PMULLT instructions with 64-bit source. This value is reported when the Cryptographic Extension is implemented and enabled. When the CRYPTO configuration parameter is true and the CRYPTODISABLE input is low at reset, Cryptographic Extensions are implemented.	
[3:0]	RES0	Reserved	0b0000

Access

MRS <Xt>, ID_AA64ISAR0_EL1

<systemreg>	op0	op1	CRn	CRm	op2
ID_AA64ISAR0_EL1	0b11	0b000	0b0000	0b0110	0b000

Accessibility

MRS <Xt>, ID_AA64ISAR0_EL1

```
if PSTATE.EL == EL0 then
    if EL2Enabled() && HCR_EL2.TGE == '1' then
        AArch64.SystemAccessTrap(EL2, 0x18);
    else
        AArch64.SystemAccessTrap(EL1, 0x18);
elsif PSTATE.EL == EL1 then
    if EL2Enabled() && HCR_EL2.TID3 == '1' then
        AArch64.SystemAccessTrap(EL2, 0x18);
    else
        return ID_AA64ISAR0_EL1;
elsif PSTATE.EL == EL2 then
    return ID_AA64ISAR0_EL1;
elsif PSTATE.EL == EL3 then
    return ID_AA64ISAR0_EL1;
```

Appendix A Document revisions

This appendix records the changes between released issues of this document.

A.1 Revisions

Changes between released issues of this book are summarized in tables.

The first table is for the first release. Then, each table compares the new issue of the book with the last released issue of the book. Release numbers match the revision history in Release Information on page 2.

Table A-1: Issue 0000-01

Change	Location
First early access release for r0p0	-

Table A-2: Differences between issue 0000-01 and issue 0001-02

Change	Location
First early access release for r0p1	-
No technical changes.	-

Table A-3: Differences between issue 0001-02 and issue 0002-03

Change	Location
First Non-Confidential release for r0p2	-
No technical changes.	-