



Arm[®] Cortex[®]-A715 Core Cryptographic Extension

Revision: r1p3

Technical Reference Manual

Non-Confidential

Issue 07

Copyright © 2020–2023 Arm Limited (or its affiliates). 101592_0103_07_en
All rights reserved.



Arm® Cortex®-A715 Core Cryptographic Extension

Technical Reference Manual

Copyright © 2020–2023 Arm Limited (or its affiliates). All rights reserved.

Release Information

Document history

Issue	Date	Confidentiality	Change
0000-01	30 November 2020	Confidential	First beta release for r0p0
0000-02	7 May 2021	Confidential	First limited access release for r0p0
0100-03	30 September 2021	Confidential	First early access release for r1p0
0101-04	25 May 2022	Confidential	First early access release for r1p1
0101-05	28 June 2022	Non-Confidential	Second early access release for r1p1
0102-06	30 September 2022	Non-Confidential	First release for r1p2
0103-07	28 February 2023	Non-Confidential	First release for r1p3

Proprietary Notice

This document is protected by copyright and other related rights and the practice or implementation of the information contained in this document may be protected by one or more patents or pending patent applications. No part of this document may be reproduced in any form by any means without the express prior written permission of Arm. No license, express or implied, by estoppel or otherwise to any intellectual property rights is granted by this document unless specifically stated.

Your access to the information in this document is conditional upon your acceptance that you will not use or permit others to use the information for the purposes of determining whether implementations infringe any third party patents.

THIS DOCUMENT IS PROVIDED “AS IS”. ARM PROVIDES NO REPRESENTATIONS AND NO WARRANTIES, EXPRESS, IMPLIED OR STATUTORY, INCLUDING, WITHOUT LIMITATION, THE IMPLIED WARRANTIES OF MERCHANTABILITY, SATISFACTORY QUALITY, NON-INFRINGEMENT OR FITNESS FOR A PARTICULAR PURPOSE WITH RESPECT TO THE DOCUMENT. For the avoidance of doubt, Arm makes no representation with respect to, and has undertaken no analysis to identify or understand the scope and content of, patents, copyrights, trade secrets, or other rights.

This document may include technical inaccuracies or typographical errors.

TO THE EXTENT NOT PROHIBITED BY LAW, IN NO EVENT WILL ARM BE LIABLE FOR ANY DAMAGES, INCLUDING WITHOUT LIMITATION ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, PUNITIVE, OR CONSEQUENTIAL DAMAGES, HOWEVER CAUSED AND REGARDLESS OF THE THEORY OF LIABILITY, ARISING OUT OF ANY USE OF THIS DOCUMENT, EVEN IF ARM HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

This document consists solely of commercial items. You shall be responsible for ensuring that any use, duplication or disclosure of this document complies fully with any relevant export laws and regulations to assure that this document or any portion thereof is not exported, directly or indirectly, in violation of such export laws. Use of the word “partner” in reference to Arm’s customers is not intended to create or refer to any partnership relationship with any other company. Arm may make changes to this document at any time and without notice.

This document may be translated into other languages for convenience, and you agree that if there is any conflict between the English version of this document and any translation, the terms of the English version of the Agreement shall prevail.

The Arm corporate logo and words marked with ® or ™ are registered trademarks or trademarks of Arm Limited (or its affiliates) in the US and/or elsewhere. All rights reserved. Other brands and names mentioned in this document may be the trademarks of their respective owners. Please follow Arm’s trademark usage guidelines at <https://www.arm.com/company/policies/trademarks>.

Copyright © 2020–2023 Arm Limited (or its affiliates). All rights reserved.

Arm Limited. Company 02557590 registered in England.

110 Fulbourn Road, Cambridge, England CB1 9NJ.

(LES-PRE-20349|version 21.0)

Confidentiality Status

This document is Non-Confidential. The right to use, copy and disclose this document may be subject to license restrictions in accordance with the terms of the agreement entered into by Arm and the party that Arm delivered this document to.

Unrestricted Access is an Arm internal classification.

Product Status

The information in this document is Final, that is for a developed product.

Feedback

Arm welcomes feedback on this product and its documentation. To provide feedback on the product, create a ticket on <https://support.developer.arm.com>.

To provide feedback on the document, fill the following survey: <https://developer.arm.com/documentation-feedback-survey>.

Inclusive language commitment

Arm values inclusive communities. Arm recognizes that we and our industry have used language that can be offensive. Arm strives to lead the industry and create change.

This document includes language that can be offensive. We will replace this language in a future issue of this document.

To report offensive language in this document, email terms@arm.com.

Contents

1. Introduction.....	6
1.1 Product revision status.....	6
1.2 Intended audience.....	6
1.3 Conventions.....	6
1.4 Useful resources.....	8
2. Cryptographic extension support in the Cortex®-A715 core.....	10
2.1 Disabling the Cryptographic Extension.....	10
2.2 Product revisions.....	10
3. AArch64 instruction identification system register.....	12
3.1 ID_AA64ISAR0_EL1, AArch64 Instruction Set Attribute Register 0.....	12
4. Document revisions.....	16
4.1 Revisions.....	16

1. Introduction

1.1 Product revision status

The r_xp_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 Cortex®-A715 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
<i>italic</i>	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 <u>underline</u>	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: <pre>MRC p15, 0, <Rd>, <CRn>, <CRm>, <Opcode_2></pre>
SMALL CAPITALS	Terms that have specific technical meanings as defined in the <i>Arm® Glossary</i> . 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.



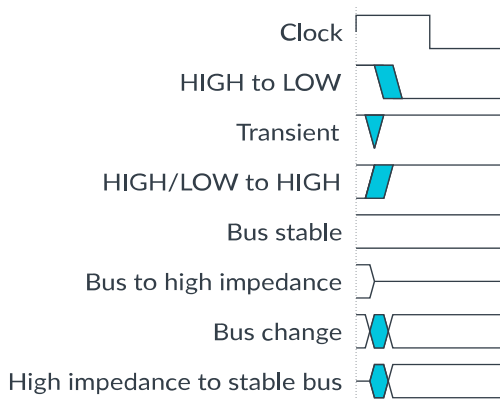
A reminder of something important that relates to the information you are reading.

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.

Register descriptions

Reset definitions

Replication Operator {}

Verilog replication operators are used for reset values over 8-bits.

For example, {16{1'b0}} indicated a binary value of 16 zeros.

x

Resets that are unknown are indicated with x.

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
<i>Arm® Cortex®-A715 Core Configuration and Integration Manual</i>	101591	Confidential
<i>Arm® Cortex®-A715 Core Technical Reference Manual</i>	101590	Non-Confidential

Arm architecture and specifications	Document ID	Confidentiality
<i>Arm® Architecture Reference Manual Supplement Armv9, for Armv9-A architecture profile</i>	DDI0608	Non-Confidential
<i>Arm® Architecture Reference Manual for A-profile architecture</i>	DDI 0487	Non-Confidential

Non-Arm resources	Document ID	Organization
<i>Advanced Encryption Standard (FIPS 197, November 2001)</i>	FIPS 197	The National Institute of Standards and Technology (NIST) www.nist.gov
<i>Secure Hash Standard (SHS) (FIPS 180-4, August 2015)</i>	FIPS 180-4	The National Institute of Standards and Technology (NIST) www.nist.gov
<i>Secure Hash Standard (SHS) (FIPS 202, August 2015)</i>	FIPS 202	The National Institute of Standards and Technology (NIST) www.nist.gov



Arm tests its PDFs only in Adobe Acrobat and Acrobat Reader. Arm cannot guarantee the quality of its documents when used with any other PDF reader.

Adobe PDF reader products can be downloaded at <http://www.adobe.com>.

2. Cryptographic extension support in the Cortex®-A715 core

The Cortex®-A715 core supports the optional Arm®v8.0-A and Arm®v8.2-A Cryptographic Extension.

The Arm®v8.0-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 Disabling the Cryptographic Extension

Disabling of the Cryptographic Extension applies to all Cortex®-A715 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

[3.1 ID_AA64ISAR0_EL1, AArch64 Instruction Set Attribute Register 0](#) on page 12

2.2 Product revisions

The product revision increments at each release.

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

Table 2-1: Product revisions

Revision	Notes
r0p0	First release
r1p0	SPE functionality supported
r1p1	Added support for FEAT_ECBHB, Exploitative Control using Branch History Buffer information between exception levels
r1p2	Errata fixes
r1p3	Errata fixes

Changes in functionality that have an impact on the documentation also appear in [4.1 Revisions](#) on page 16.

3. AArch64 instruction identification system register

This chapter describes the ID_AA64ISAR0_EL1 register. This instruction identification register provides information about the instructions implemented in the Cortex®-A715 core in AArch64 Execution state, including the instructions provided by the Cryptographic Extension.

3.1 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* in the [Arm® Architecture Reference Manual for A-profile architecture](#).

Configurations

This register is available in all configurations.

Attributes

Width

64

Functional group

Identification registers

Access type

See bit descriptions

Reset value

0000 0010 0010 0001 0001 xxxx xxxx xxxx 0001 0000 0010 0001 xxxx xxxx xxxx
xxxx



Note

Where the reset reads xxxx, see individual bits

Bit descriptions

Figure 3-1: AArch64_id_aa64isar0_el1 bit assignments

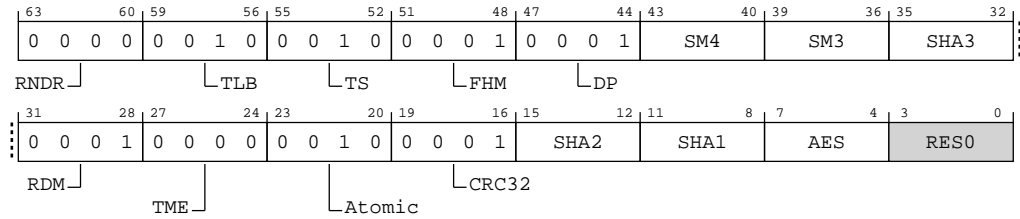


Table 3-1: ID_AA64ISAR0_EL1 bit descriptions

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.	0b0000
[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.	0b0010
[55:52]	TS	Indicates support for flag manipulation instructions. Defined values are: 0b0010 CFINV, RMIF, SETF16, SETF8, AXFLAG, and XAFLAG instructions are implemented.	0b0010
[51:48]	FHM	Indicates support for FMLAL and FMLSL instructions. Defined values are: 0b0001 FMLAL and FMLSL instructions are implemented.	0b0001
[47:44]	DP	Indicates support for Dot Product instructions in AArch64 state. Defined values are: 0b0001 UDOT and SDOT instructions implemented.	0b0001
[43:40]	SM4	Indicates support for SM4 instructions in AArch64 state. Defined values are: 0b0000 No SM4 instructions implemented. This value is reported when the Cryptographic Extension is not implemented or is disabled. 0b0001 SM4E and SM4EKEY instructions implemented. 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 the Cryptographic Extension is implemented	The reset values can be the following: 0b0000, 0b0001, respective to the value.

Bits	Name	Description	Reset
[39:36]	SM3	<p>Indicates support for SM3 instructions in AArch64 state. Defined values are:</p> <p>0b0000 No SM3 instructions implemented. This value is reported when the Cryptographic Extension is not implemented or is disabled.</p> <p>0b0001 SM3SS1, SM3TT1A, SM3TT1B, SM3TT2A, SM3TT2B, SM3PARTW1, and SM3PARTW2 instructions implemented. This value is reported when the Cryptographic Extension is implemented and enabled.</p> <p>When the CRYPTO configuration parameter is true and the CRYPTODISABLE input is low at reset the Cryptographic Extension is implemented</p>	The reset values can be the following: 0b0000, 0b0001, respective to the value.
[35:32]	SHA3	<p>Indicates support for SHA3 instructions in AArch64 state. Defined values are:</p> <p>0b0000 No SHA3 instructions implemented. This value is reported when the Cryptographic Extension is not implemented or is disabled.</p> <p>0b0001 EOR3, RAX1, XAR, and BCAX instructions implemented. This value is reported when the Cryptographic Extension is implemented and enabled.</p> <p>When the CRYPTO configuration parameter is true and the CRYPTODISABLE input is low at reset the Cryptographic Extension is implemented</p>	The reset values can be the following: 0b0000, 0b0001, respective to the value.
[31:28]	RDM	<p>Indicates support for SQRDMLAH and SQRDMLSH instructions in AArch64 state. Defined values are:</p> <p>0b0001 SQRDMLAH and SQRDMLSH instructions implemented.</p>	0b0001
[27:24]	TME	<p>Indicates support for TME instructions. Defined values are:</p> <p>0b0000 TME instructions are not implemented.</p>	0b0000
[23:20]	Atomic	<p>Indicates support for Atomic instructions in AArch64 state. Defined values are:</p> <p>0b0010 LDADD, LDCLR, LDEOR, LDSET, LDSMAX, LDSMIN, LDUMAX, LDUMIN, CAS, CASP, and SWP instructions implemented.</p>	0b0010
[19:16]	CRC32	<p>Indicates support for CRC32 instructions in AArch64 state. Defined values are:</p> <p>0b0001 CRC32B, CRC32H, CRC32W, CRC32X, CRC32CB, CRC32CH, CRC32CW, and CRC32CX instructions implemented.</p>	0b0001
[15:12]	SHA2	<p>Indicates support for SHA2 instructions in AArch64 state. Defined values are:</p> <p>0b0000 No SHA2 instructions implemented. This value is reported when the Cryptographic Extension is not implemented or is disabled.</p> <p>0b0010 SHA256H, SHA256H2, SHA256SU0, SHA256SU1, SHA512H, SHA512H2, SHA512SU0, and SHA512SU1 instructions implemented. This value is reported when the Cryptographic Extension is implemented and enabled.</p> <p>When the CRYPTO configuration parameter is true and the CRYPTODISABLE input is low at reset the Cryptographic Extension is implemented</p>	The reset values can be the following: 0b0000, 0b0010, respective to the value.

Bits	Name	Description	Reset
[11:8]	SHA1	<p>Indicates support for SHA1 instructions in AArch64 state. Defined values are:</p> <p>0b0000 No SHA1 instructions implemented. This value is reported when the Cryptographic Extension is not implemented or is disabled.</p> <p>0b0001 SHA1C, SHA1P, SHA1M, SHA1H, SHA1SU0, and SHA1SU1 instructions implemented. This value is reported when the Cryptographic Extension is implemented and enabled.</p> <p>When the CRYPTO configuration parameter is true and the CRYPTODISABLE input is low at reset the Cryptographic Extension is implemented</p>	The reset values can be the following: 0b0000, 0b0001, respective to the value.
[7:4]	AES	<p>Indicates support for AES instructions in AArch64 state. Defined values are:</p> <p>0b0000 No AES instructions implemented. This value is reported when the Cryptographic Extension is not implemented or is disabled.</p> <p>0b0010 AESE, AESD, AESMC, and AESIMC instructions are implemented plus PMULL/PMULL2 instructions operating on 64-bit data quantities. This value is reported when the Cryptographic Extension is implemented and enabled.</p> <p>When the CRYPTO configuration parameter is true and the CRYPTODISABLE input is low at reset the Cryptographic Extension is implemented</p>	The reset values can be the following: 0b0000, 0b0010, respective to the value.
[3:0]	RES0	Reserved	RES0

Access

MRS <Xt>, ID_AA64ISAR0_EL1

op0	op1	CRn	CRm	op2
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);
elseif PSTATE.EL == EL1 then
    if EL2Enabled() && HCR_EL2.TID3 == '1' then
        AArch64.SystemAccessTrap(EL2, 0x18);
    else
        return ID_AA64ISAR0_EL1;
elseif PSTATE.EL == EL2 then
    return ID_AA64ISAR0_EL1;
elseif PSTATE.EL == EL3 then
    return ID_AA64ISAR0_EL1;

```

4. Document revisions

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

4.1 Revisions

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

The first table is for the first release. Subsequent tables compare the new issue of the document with the previously released issue of the document. Release numbers match the revision history in [Release Information](#) on page 2.

Table 4-1: Issue 0000-01

Change	Location
First Confidential beta release for r0p0	-

Table 4-2: Differences between issue 0000-01 and issue 0000-02

Change	Location
First Confidential limited access release for r0p0	-
Updated the pdf style including wider tables, notes presentation, tables numbering, figures numbering	Throughout document
ID_AA64ISAR0_EL1 bits [3:0] reset value set to 0b0000 instead of 0b0	3.1 ID_AA64ISAR0_EL1, AArch64 Instruction Set Attribute Register 0 on page 12

Table 4-3: Differences between issue 0000-02 and issue 0100-03

Change	Location
First Confidential early access release for r1p0	-
Added <i>Arm® Architecture Reference Manual Supplement Armv9, for Armv9-A architecture profile</i>	Additional reading
Reset values set to x	3.1 ID_AA64ISAR0_EL1, AArch64 Instruction Set Attribute Register 0 on page 12

Table 4-4: Differences between issue 0100-03 and issue 0101-04

Change	Location
First Confidential early access release for r1p1	-
Editorial changes	Throughout document
Added revision r1p1	2.2 Product revisions on page 10
Updated reset values	3.1 ID_AA64ISAR0_EL1, AArch64 Instruction Set Attribute Register 0 on page 12

Table 4-5: Differences between issue 0101-04 and issue 0101-05

Change	Location
Second early access release for r1p1	-

Change	Location
Updated product name	Throughout document

Table 4-6: Differences between issue 0101-05 and issue 0102-06

Change	Location
First release for r1p2	-
Added revision r1p2	2.2 Product revisions on page 10
Changed topic title 'Additional reading' to 'Useful resources'	1.4 Useful resources on page 8

Table 4-7: Differences between issue 0102-06 and issue 0103-07

Change	Location
First release for r1p3	-
Editorial changes	Throughout document
Added revision r1p3	2.2 Product revisions on page 10