

Arm® PCI Configuration Space Access Firmware Interface 1.0BET0 **Platform Design Document** Non-confidential

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Contents

Release information	3
Arm Non-Confidential Document Licence (“Licence”)	4
About this document	6
Terms and abbreviations	6
References	6
Feedback	6
1 Introduction	7
1.1 Calls defined per ABI version	7
1.2 Calling convention	7
1.3 ABI discovery	7
2 Interface	9
2.1 PCI_VERSION	9
2.1.1 Function definition	9
2.1.2 Usage	9
2.1.3 Caller responsibilities	9
2.1.4 Implementation responsibilities	9
2.2 PCI_FEATURES	10
2.2.1 Function definition	10
2.2.2 Usage	10
2.2.3 Caller responsibilities	10
2.2.4 Implementations responsibilities	10
2.3 PCI_READ	11
2.3.1 Function definition	11
2.3.2 Usage	11
2.3.3 Caller responsibilities	12
2.3.4 Implementation responsibilities	12
2.4 PCI_WRITE	13
2.4.1 Function definition	13
2.4.2 Usage	13
2.4.3 Caller responsibilities	13
2.4.4 Implementation responsibilities	14
2.5 PCI_GET_SEG_INFO	15
2.5.1 Function definition	15
2.5.2 Usage	15
2.5.3 Caller responsibilities	15
2.5.4 Implementation responsibilities	16
2.6 Return codes	17

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Release information

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About this document

Terms and abbreviations

Term	Meaning
CPU	A hardware implementation of the Arm architecture
ECAM	PCIe Enhanced Configuration Access Mechanism. See [1]
EL	Exception Level
FW	Firmware
HVC	Hypervisor Call, an Arm assembler instruction that causes an exception that is taken synchronously into EL2
OS	Operating System
PE	Processing element. An abstract machine defined in the Arm architecture, see [2]
RW1C	Write-one-to-clear PCI registers. See [1]
SMC	Secure Monitor Call. An Arm assembler instruction that causes an exception that is taken synchronously into EL3
SoC	System on Chip

References

This section lists publications by Arm and by third parties.

See Arm Developer (<http://developer.arm.com>) for access to Arm documentation.

[1] *PCI Express Base Specification Revision 5.0, version 1.0*. PCI-SIG.

[2] *Arm® Architecture Reference Manual for Armv8-A architecture profile*. (ARM DDI 0487 E.a) Arm Ltd.

[3] *SMC Calling Convention System Software on Arm® Platforms*. (ARM DEN 0028 C) Arm Ltd.

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Arm welcomes feedback on its documentation.

If you have comments on the content of this manual, send an e-mail to errata@arm.com. Give:

- The title (PCI Configuration Space Access Firmware Interface).
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Arm also welcomes general suggestions for additions and improvements.

1 Introduction

This document defines a firmware interface for a caller, such as an OS or a hypervisor, to access the PCI configuration space.

This interface is defined as a workaround for SoCs that deviate from the Enhanced Configuration Access Mechanism (ECAM) hardware rules defined in the PCIe Specification [1]. This interface abstracts the PCI configuration space access, allowing implementations to hide SoC specific errata and non-compliant behavior.

The interface described in Section 2 enables a caller to:

- Access PCI configuration space reads/writes
- Discover the implemented PCI segment groups, and bus ranges for each segment

1.1 Calls defined per ABI version

Table 3 relates the ABI version to the defined calls and their requirement status.

Table 3: ABI required functions per version

Call name	Mandatory from	Optional from
PCI_VERSION	v1.0	–
PCI_FEATURES	v1.0	–
PCI_READ	v1.0	–
PCI_WRITE	v1.0	–
PCI_GET_SEG_INFO	v1.0	–

1.2 Calling convention

This ABI complies with the SMCCCv1.1 [3] calling convention. The ABI can only be present in a system that is compliant with SMCCCv1.1 or higher.

All specified functions take 32-bit parameters and return 32-bit values. The ABI is designed so that all functions are callable from an AArch32 or AArch64 client context.

In systems that implement EL3, Arm recommends the use of the SMC conduit to call the functions that are defined in this specification. If EL3 is not present, but EL2 is present, then the HVC conduit must be used.

1.3 ABI discovery

The SMCCC mandates the SMCCC implementation to return NOT_SUPPORTED if the called function is not implemented [3].

The presence of the PCI Configuration Space Access ABI must be discovered by calling PCI_VERSION. A PCI Configuration Space Access ABI implementation is present if and only if a call to PCI_VERSION returns a non-negative value in W0.

The `PCI_FEATURES` function must be present in any implementation of this ABI. The `PCI_FEATURES` function is implemented if a call to `PCI_VERSION` returns a non-negative value in `W0`.

The presence of the remaining functions in the PCI Configuration Space Access ABI is determined through calls to `PCI_FEATURES` passing the FID of the call as the argument in `W1` (`pci_func_id`). See section 2.2 for information on `PCI_FEATURES`.

Mandatory functions are guaranteed to be present if the PCI Configuration Space Access ABI version is greater or equal than the version of the ABI the particular function was mandated on. See section 1.1 for information on ABI versions and mandatory functions.

For platforms that support the ACPI FW interface, the FW must not publish the 'MCFG' ACPI table when this ABI is intended to be used for PCI configuration space access. This is necessary to allow the operating systems and hypervisors to discover this ABI and use it instead of the PCIe ECAM interface described in 'MCFG'.

2 Interface

2.1 PCI_VERSION

The function returns the implemented version of the PCI Configuration Space Access ABI. The version is composed of two revision fields, major and minor.

2.1.1 Function definition

Function ID (W0)	0x8400_0130
Parameters	
	W1–W7 Reserved (MBZ)
Returns	
uint32	Success
	W0[30:16] Major revision
	W0[15:0] Minor revision
	W1 – W3 Reserved (MBZ)

Table 4: PCI_VERSION function definition

2.1.2 Usage

The function returns a 15-bit major revision and a 16-bit minor revision as an aggregate 31-bit value in R0/W0. The 15 bits W0[30:16] contain the major revision, and the least significant 16 bits (W0[15:0]) contain the minor revision. A minor revision increment cannot break backward compatibility with older minor revisions within the same major revision. A major revision can introduce changes which break compatibility with prior major revisions. The caller can use the return value as a discovery mechanism for ABI functions that Section 1.1 lists as mandatory.

2.1.3 Caller responsibilities

The caller has the following responsibilities:

- The caller must ensure that SMCCC_VERSION reports a SMCCC version greater or equal than 1.1 [3] before calling PCI_VERSION.

2.1.4 Implementation responsibilities

The Implementation has the following responsibilities:

- The implementation must guarantee that all the mandatory functions are implemented for the version that it reports, as specified in Section 1.1.

2.2 PCI_FEATURES

The caller discovers PCI Configuration Space Access ABI functions implemented in the FW.

2.2.1 Function definition

Function ID (W0)	0x8400_0131		
Parameters			
	W1	pci_func_id	
	W2–W7	Reserved (MBZ)	
Returns			
	Success ($W0 \geq 0$)		
		SUCCESS	Function is implemented.
		> 0	Function is implemented and has specific capabilities, see function definition.
	Error ($W0 < 0$)		
		NOT_SUPPORTED	Function with FID=pci_func_id is not implemented

Table 5: PCI_FEATURES function definition

2.2.2 Usage

The caller can determine if functions defined in the PCI Configuration Space Access ABI are present in the ABI implementation. The caller can determine function specific features (signaled by a positive return status in W0). The function specific features must be described in the function definition.

2.2.3 Caller responsibilities

The caller has the following responsibilities:

- The caller must ensure the PCI Configuration Space Access ABI is present before calling this function.

2.2.4 Implementations responsibilities

The function implementation has the following responsibilities:

- The implementation must return NOT_SUPPORTED if pci_func_id is a value not defined in the PCI Configuration Space Access ABI.

2.3 PCI_READ

The caller reads a given register address from the PCI configuration space of a given PCI device.

2.3.1 Function definition

Function ID (W0)	0x8400_0132
Parameters	
W1	PCI device address Bits [31:16] : PCI segment group number Bits [15:8] : PCI bus number Bits [7:3] : PCI device number Bits [2:0] : PCI function number
W2	Register offset
W3	Access size for read operations 1 : 1 Byte 2 : 2 Bytes 4 : 4 Bytes All other values reserved
W4 – W7	Reserved (MBZ)
Returns	
Success (W0 = 0)	W0 MBZ W1 Data Read from the PCI device configuration space register
Error (W0 < 0)	W0 NOT_SUPPORTED INVALID_PARAMETER W1 Reserved (MBZ)

Table 6: PCI_READ function definition

2.3.2 Usage

The call returns the data read from the configuration space of the PCI device register identified by the input Parameters.

2.3.3 Caller responsibilities

The caller has the following responsibilities:

- The caller must ensure that this function is implemented before issuing a call. This function is discoverable by calling `PCI_FEATURES` with `pci_func_id` set to `0x8400_0132`.

2.3.4 Implementation responsibilities

The Implementation has the following responsibilities:

- The implementation must return `INVALID_PARAMETER` if any of the `W4–W7` registers differs from zero, or if the `W3` register contains a value other than 1, 2, or 4.
- The implementation must ensure that concurrent calls to any of the functions in the PCI Configuration Space Access ABI are multi-processor safe.
- On some platforms, the SoC may only support 32-bit PCI configuration space reads. On such platforms, calls to this function with access size of 1 or 2 bytes may result in inadvertently corrupting adjacent fields. This could happen, for example, if the adjacent fields have configuration space access read side effects, as defined in [1]. It is the implementation responsibility to be aware of these situations and guard against them if possible.

2.4 PCI_WRITE

The caller writes a value to a given register address in the PCI configuration space of a given PCI device.

2.4.1 Function definition

Function ID (W0)	0x8400_0133
Parameters	
W1	PCI device address Bits [31:16] : PCI segment group number Bits [15:8] : PCI bus number Bits [7:3] : PCI device number Bits [2:0] : PCI function number
W2	Register offset
W3	Access size for write operation 1 : 1 Byte 2 : 2 Bytes 4 : 4 Bytes All other values reserved
W4	Data to write to the PCI device configuration space register
W5 – W7	Reserved (MBZ)
Returns	
Success (W0 = 0)	W0 MBZ
Error (W0 < 0)	W0 NOT_SUPPORTED INVALID_PARAMETER

Table 7: PCI_WRITE function definition

2.4.2 Usage

The call writes the requested input data to the configuration space of the PCI device register identified by the input Parameters.

2.4.3 Caller responsibilities

The caller has the following responsibilities:

- The caller must ensure that this function is implemented before issuing a call. This function is discoverable by calling PCI_FEATURES with pci_func_id set to 0x8400_0133.

2.4.4 Implementation responsibilities

The Implementation has the following responsibilities:

- The implementation must return INVALID_PARAMETER if any of the W5–W7 registers differs from zero, or if the W3 register contains a value other than 1, 2, or 4.
- The implementation must complete the PCI configuration space write operation before returning to the caller.
- The implementation must ensure that concurrent calls to any of the functions in the PCI Configuration Space Access ABI are multi-processor safe.
- On some platforms, the SoC may only support 32-bit PCI configuration space writes. On such platforms, calls to this function with access size of 1 or 2 bytes may require the implementation of this function to perform a PCI configuration read, following by the write. This could result in inadvertently corrupting adjacent RW1C fields. It is the implementation responsibility to be aware of these situations and guard against them if possible.

2.5 PCI_GET_SEG_INFO

The caller gets information on the available PCI segment groups in the platform, and the PCI bus ranges for each segment.

2.5.1 Function definition

Function ID (W0)	0x8400_0134
Parameters	
	W1
	Bits [31:16] Reserved (MBZ)
	Bits [15:0] pci_seg : PCI segment group number
	W2 – W7 Reserved (MBZ)
Returns	
	Success (W0 = 0)
	W0 MBZ
	W1 Bits [31:16] : Reserved (MBZ)
	Bits [15:8] : Ending PCI Bus number
	Bits [7:0] : Starting PCI Bus number
	W2 pci_next_seg : Next PCI segment group number, or zero if pci_seg is the last segment.
	Error (W0 < 0)
	W0 NOT_SUPPORTED
	INVALID_PARAMETER
	NOT_IMPLEMENTED
	W1 Reserved (MBZ)
	W2 Reserved (MBZ)

Table 8: PCI_GET_SEG_INFO function definition

2.5.2 Usage

The call checks if a requested PCI segment group in pci_seg is implemented, and returns the PCI bus range for that segment. It also returns the next implemented pci_next_seg, if there are any, or zero if this is the last segment. This allows the caller to discover all implemented PCI segments and their PCI bus ranges.

2.5.3 Caller responsibilities

The caller has the following responsibilities:

- The caller must ensure that this function is implemented before issuing a call. This function is discoverable by calling `PCI_FEATURES` with `pci_func_id` set to `0x8400_0134`.
- The caller may use this function to iterate through all the supported PCI segments in the platform. This can be done by calling this function with the value of zero in the `pci_seg` parameter, then using the value returned in `pci_next_seg` as the `pci_seg` input for subsequent calls to this function, until a value of zero is returned in `pci_next_seg`.

2.5.4 Implementation responsibilities

The Implementation has the following responsibilities:

- The implementation must return `INVALID_PARAMETER` if any of the `W3–W7` registers differs from zero, or if the `W1[31:16]` differ from zero.
- The implementation must ensure that concurrent calls to any of the functions in the PCI Configuration Space Access ABI are multi-processor safe.
- The implementation must implement PCI segment group zero.
- The implementation must return `NOT_IMPLEMENTED` if the segment specified in register `W1[15:0]` is not implemented by the platform.
- For platforms that support the ACPI FW interface, the implementation must ensure that the PCI segment group numbers used in this ABI correspond to the values used in the ACPI name space for the applicable host bridge device.

2.6 Return codes

The following status return codes are defined for the PCI Configuration Space Access ABI calls.

Name	Value
SUCCESS	0
NOT_SUPPORTED	-1
INVALID_PARAMETER	-2
NOT_IMPLEMENTED	-3