JEDEC STANDARD

Universal Flash Storage (UFS) Card Extension

Version 1.0

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UNIVERSAL FLASH STORAGE (UFS) CARD EXTENSION, VERSION 1.0

Contents

		Page
Foreword		i
Introduction		i
1	Scope	1
2	Normative Reference	1
3	Terms, and definitions	1
3.1	Acronyms	1
3.2	Terms and definitions	2
3.3	Keywords	2
3.4	Abbreviations	3
3.5	Conventions	3
4	Introduction	4
4.1	Overview	4
4.2	Functional Features	4
5	UFS Card System Architecture	5
5.1	Overview	5
5.2	UFS Card Signals	5
6	UFS Card Design	6
7	Feature comParison of embedded UFS and UFS card	9
8	UFS Card initialization	10
8.1	Initialization Sequence	11
9	Power Consumption	12
Annex A (informative) Host Guideline for UFS Card Detection		13

Figures

Figure 5.1 — UFS Card Block Diagram	5
Figure 6.1 — UFS Card Top View	6
Figure 6.2 — UFS Card Bottom View	7
Figure 6.3 — UFS Card Side View	8
Figure 8.1 — UFS Card Initialization	10
Figure 8.2 — UFS Card Initialization Sequence	11

Tables

Table 5.1 — Signal Name and Definitions	5
Table 7.1 — Comparison of embedded UFS and UFS Card	9

UNIVERSAL FLASH STORAGE (UFS) CARD EXTENSION, VERSION 1.0

Foreword

This standard has been prepared by JEDEC. The purpose of this standard is to define a UFS card specification. This document will be extension of the UFS Standard, JESD220.

Introduction

The UFS device (embedded/removable) is a universal data storage and communication media. It is designed to cover a wide area of applications as smart phones, cameras, organizers, PDAs, digital recorders, MP3 players, internet tablets, electronic toys, etc.

UNIVERSAL FLASH STORAGE (UFS) CARD EXTENSION, VERSION 1.0

(From JEDEC Board Ballot JCB-16-12, formulated under the cognizance of the JC-64.1 Subcommittee on Electrical Specifications and Command Protocols (Item 133.69).)

1 Scope

This standard specifies the characteristics of the UFS card electrical interface and the memory device. This document defines the added/modified features in UFS card compared to embedded UFS device. For other common features JESD220, UFS, Version 2.0, will be referenced.

2 Normative Reference

The following normative documents contain provisions that, through reference in this text, constitute provisions of this standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents listed. For undated references, the latest edition of the normative document referred to applies.

[MIPI-M-PHY], MIPI Alliance Specification for M-PHY^{SM} Specification, Version 3.0

[MIPI-UniPro], MIPI Alliance Specification for Unified Protocol (UniPro^{SM}), Version 1.6

[MIPI-DDB], MIPI Alliance Specification for Device Descriptor Block (DDB), Version

[SAM], SCSI Architecture Model – 5 (SAM–5), Revision 05, 19 May 2010

[SPC], T10 Specification: SCSI Primary Commands – 4 (SPC-4), Revision 27, 11 October 2010

[SBC], T10 Specification: SCSI Block Commands – 3 (SBC–3), Revision 24, 05 August 2010

[UFS], JEDEC JESD220B, Universal Flash Storage (UFS), Version 2.0

[UFS], JEDEC JEP95, MO-320, UFS Card Form Factor

3 Terms, and definitions

For the purpose of this standard, the terms and definitions given in the documents included in section 2 “Normative Reference” and the following apply.

3.1 Acronyms

HCI	Host Controller Interface
UFS	Universal Flash Storage
MIPI	Mobile Industry Processor Interface
PWM	Pulse Width Modulation
RPMB	Replay Protected Memory Block
SBC	SCSI Block Commands
SPC	SCSI Primary Commands
LUN	Logical Unit Number
NA	Not applicable
KB	Kilobyte
eUFS	Embedded Universal Flash Storage

3 Terms, and definitions (cont'd)

3.2 Terms and definitions

Byte: An 8-bit data value with most significant bit labeled as bit 7 and least significant bit as bit 0.

Device: An addressable device on the UFS bus usually a target that contains at least one LUN

Host: An addressable device on the UFS bus which is usually the main CPU that hosts the UFS bus

3.3 Keywords

Several keywords are used to differentiate levels of requirements and options, as follow:

Can: A keyword used for statements of possibility and capability, whether material, physical, or causal (*can* equals *is able to*).

Expected: A keyword used to describe the behavior of the hardware or software in the design models assumed by this standard. Other hardware and software design models may also be implemented.

Ignored: A keyword that describes bits, bytes, quadlets, or fields whose values are not checked by the recipient.

Mandatory: A keyword that indicates items required to be implemented as defined by this standard.

May: A keyword that indicates a course of action permissible within the limits of the standard (*may* equals *is permitted*).

Must: The use of the word *must* is deprecated and shall not be used when stating mandatory requirements; *must* is used only to describe unavoidable situations.

Optional: A keyword that describes features which are not required to be implemented by this standard. However, if any optional feature defined by the standard is implemented, it shall be implemented as defined by the standard.

Reserved: A keyword used to describe objects—bits, bytes, and fields—or the code values assigned to these objects in cases where either the object or the code value is set aside for future standardization. Usage and interpretation may be specified by future extensions to this or other standards. A reserved object shall be zeroed or, upon development of a future standard, set to a value specified by such a standard. The recipient of a reserved object shall not check its value. The recipient of a defined object shall check its value and reject reserved code values.

Shall: A keyword that indicates a mandatory requirement strictly to be followed in order to conform to the standard and from which no deviation is permitted (*shall* equals *is required to*). Designers are required to implement all such mandatory requirements to assure interoperability with other products conforming to this standard.

Should: A keyword used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required; or that (in the negative form) a certain course of action is deprecated but not prohibited (*should* equals *is recommended that*).

Will: The use of the word *will* is deprecated and shall not be used when stating mandatory requirements; *will* is only used in statements of fact.

3 Terms, and definitions (cont'd)

3.4 Abbreviations

etc. - And so forth (Latin: et cetera)
e.g. - For example (Latin: exempli gratia)
i.e. - That is (Latin: id est)

3.5 Conventions

UFS specification follows some conventions used in SCSI documents since it adopts several SCSI standards.

A binary number is represented in this standard by any sequence of digits consisting of only the Western-Arabic numerals 0 and 1 immediately followed by a lower-case b (e.g., 0101b). Spaces may be included in binary number representations to increase readability or delineate field boundaries (e.g., 0 0101 1010b).

A hexadecimal number is represented in this standard by any sequence of digits consisting of only the Western-Arabic numerals 0 through 9 and/or the upper-case English letters A through F immediately followed by a lower-case h (e.g., FA23h). Spaces may be included in hexadecimal number representations to increase readability or delineate field boundaries (e.g., B FD8C FA23h).

A decimal number is represented in this standard by any sequence of digits consisting of only the Western-Arabic numerals 0 through 9 not immediately followed by a lower-case b or lower-case h (e.g., 25).

A range of numeric values is represented in this standard in the form "a to z", where a is the first value included in the range, all values between a and z are included in the range, and z is the last value included in the range (e.g., the representation "0h to 3h" includes the values 0h, 1h, 2h, and 3h).

When the value of the bit or field is not relevant, x or xx appears in place of a specific value.

The first letter of the name of a Flag is a lower-case f (e.g., fMyFlag).

The first letter of the name of a parameter included a Descriptor or the first letter of the name of an Attribute is:

- a lower-case b if the parameter or the Attribute size is one byte (e.g., bMyParameter),
- a lower-case w if the parameter or the Attribute size is two bytes (e.g., wMyParameter),
- a lower-case d if the parameter or the Attribute size is four bytes (e.g., dMyParameter),
- a lower-case q if the parameter or the Attribute size is eight bytes (e.g., qMyParameter).

4 Introduction

4.1 Overview

The JESD220 standard already defined some features for UFS card (removable). The UFS card uses same protocol as embedded UFS device, but it has few card specific requirements like power consumption.

4.2 Functional Features

UFS card functional features are similar to UFS embedded device. These include:

- Support for MIPI M-PHY PWM-Gear1. HS-Gear2 (optional) and HS-Gear3
- Supports Multiple partitions (LUNs) with partition Management
- Supports Multiple User Data Partition with Enhanced User Data Area options
- Reliable write operation
- Background operations
- Secure operations, Purge and Erase to enhance data security
- Write Protection options, including Permanent and Power-On Write Protection
- Task management operations
- Power management operations

5 UFS Card System Architecture

5.1 Overview

The UFS card will use same protocol as embedded UFS device. There will not be any change in the overall system architecture of removable UFS card compared to embedded card.

5.2 UFS Card Signals

Figure 5.1 shows the conceptual drawing of UFS card.

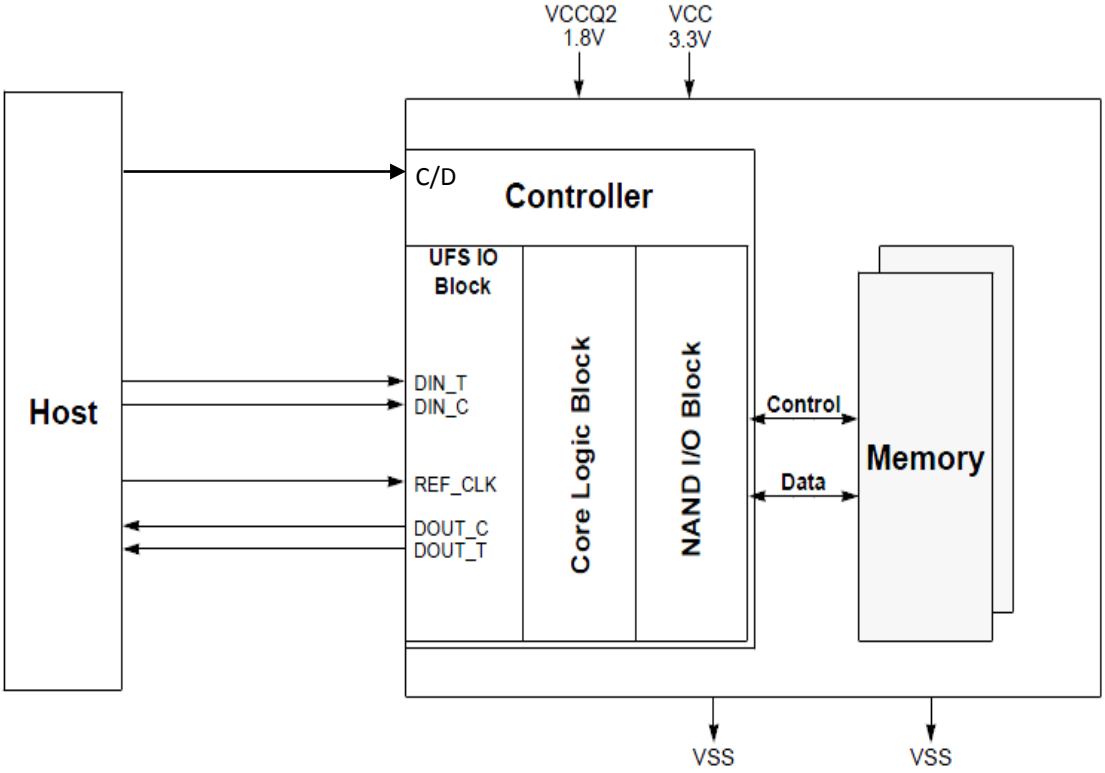


Figure 5.1 — UFS Card Block Diagram

Table 5.1 — Signal Name and Definitions

Name	Type	Description
VCC	Supply	Supply voltage for the memory devices
VCCQ2	Supply	Supply voltage used typically for the PHY interface and the memory controller and any other internal low voltage block
VSS	Supply	Ground
C/D	GND	Card Detection Pin
REF_CLK	Input	Input reference clock. When not active, this signal should be pull-down or driven low by the host SoC.
Differential input signals into UFS device from the host		
DIN_T DIN_C	Input	Downstream data lane 0. DIN_T is the positive node of the differential signal.
Differential output signals from the UFS device to the host		
DOUT_T DOUT_C	Output	Upstream data lane 0. DOUT_T is the positive node of the differential signal.

6 UFS Card Design

The UFS card will follow the shark design and a simplified pictorial representation is shown in Figure 6.1. Refer to JEP95, MO-320, for more detailed mechanical dimensions of Figure 6.1, Figure 6.2 and Figure 6.3.

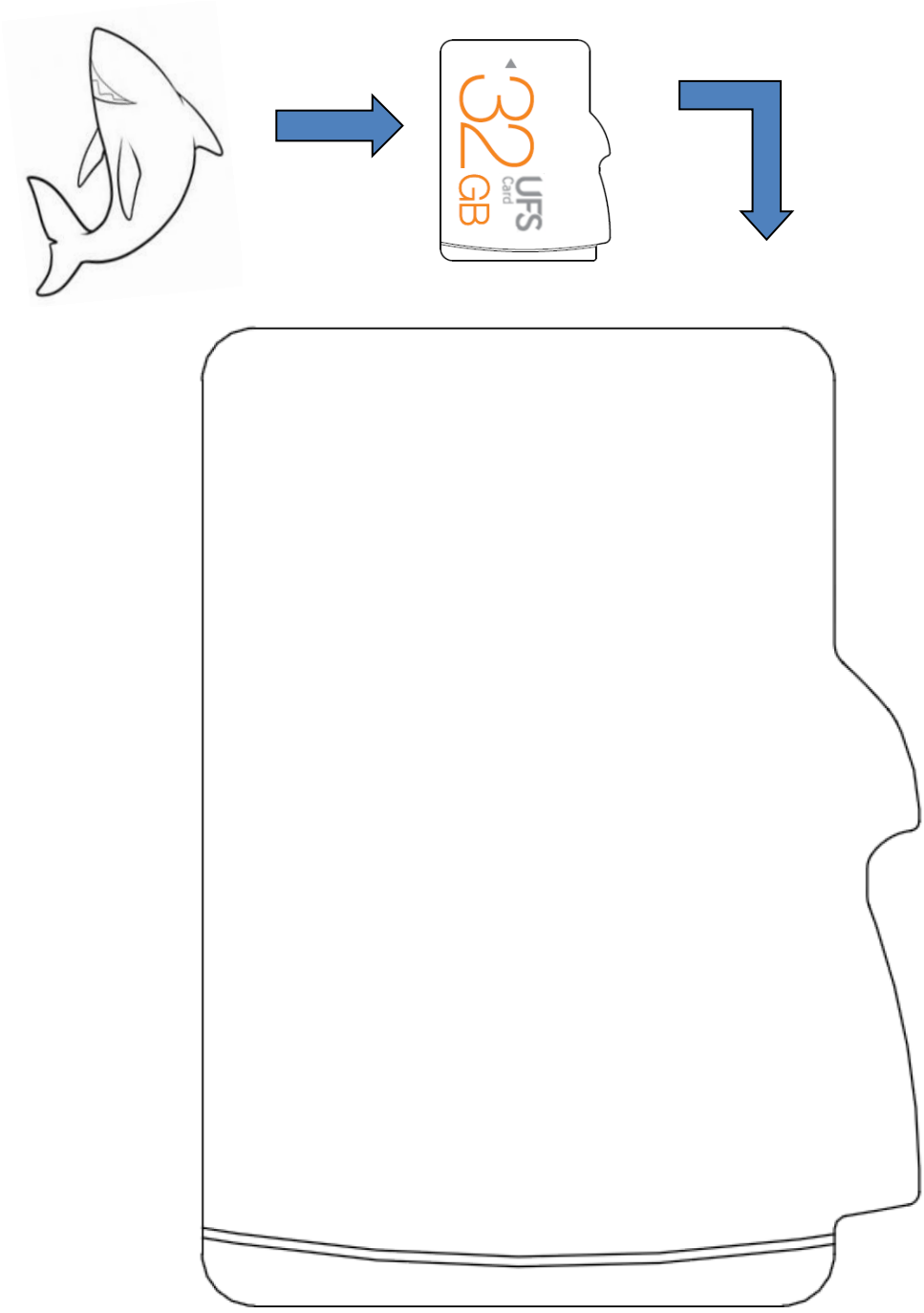
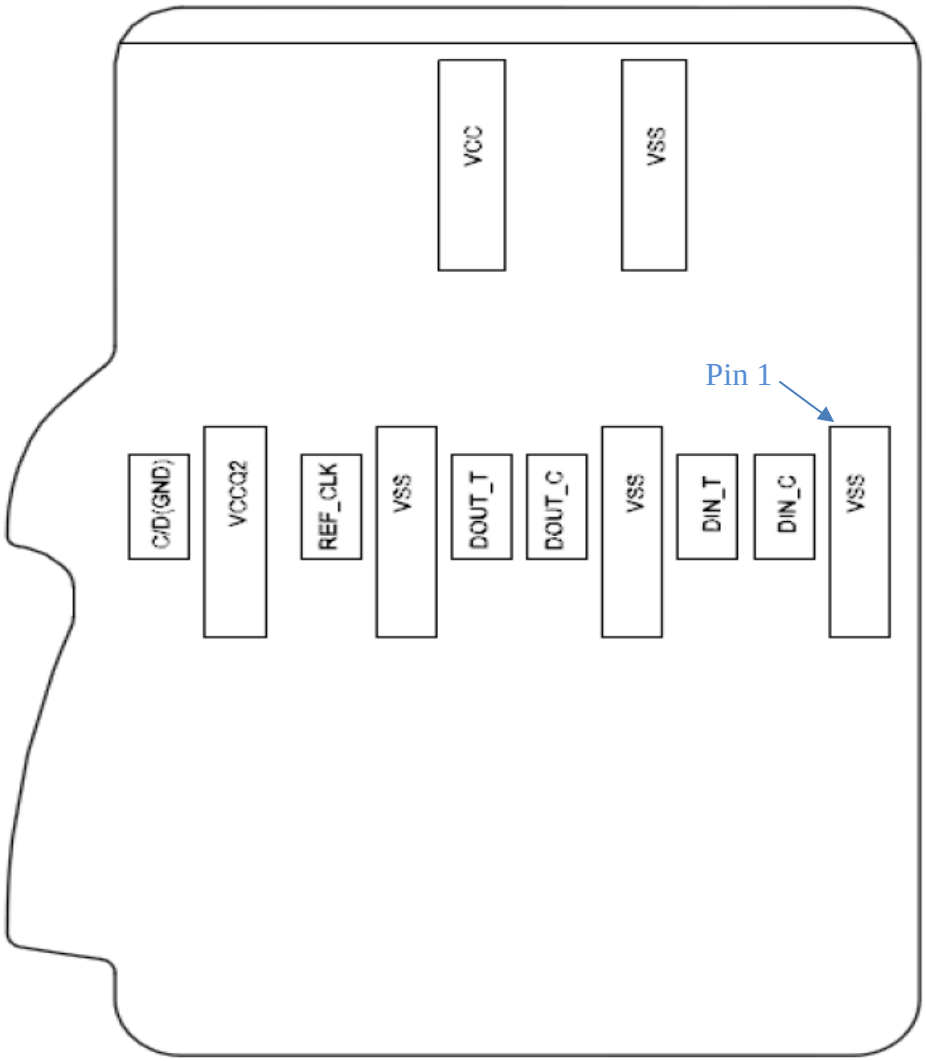


Figure 6.1 — UFS Card Top View

6 UFS Card Design (cont'd)



Pin No.	Signal Name
1	VSS
2	DIN_C
3	DIN_T
4	VSS
5	DOUT_C
6	DOUT_T
7	VSS
8	REF_CLK
9	VCCQ2
10	C/D(GND)
11	VSS
12	VCC

Figure 6.2 — UFS Card Bottom View

6 UFS Card Design (cont'd)

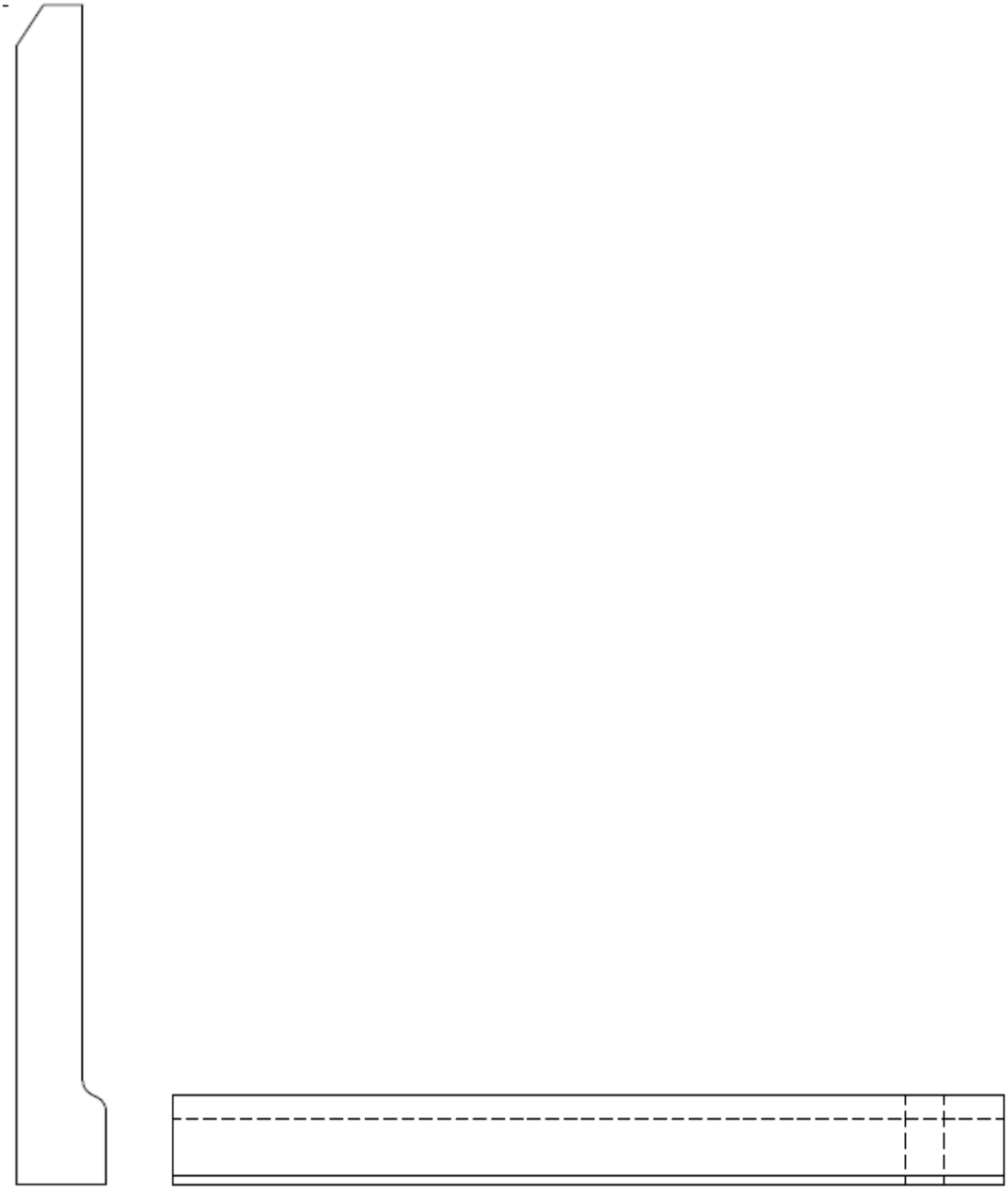


Figure 6.3 — UFS Card Side View

7 Feature comparison of embedded UFS and UFS card

The embedded UFS and UFS card follow the same protocol. But they will be used in different environment, the use cases will differ. So the UFS card shall have differences in supporting few features compared to embedded UFS. Table 7.1 shows the difference between embedded UFS and UFS card.

Table 7.1 — Comparison of embedded UFS and UFS Card

Category	Item	eUFS 2.0	UFS card v1.0
General	Supported PWM Gears	G1, G2, G3, G4 (Mandatory) G5, G6, G7 (optional)	G1 Only (PWM shall be able to be operated without reference clock)
	Supported HS Gears	G1,G2,G3 (optional)	HS-Gear3, HS-Gear2 (optional)
Interface	Power Supplies	VCCQ, VCCQ2, VCC	VCCQ2 (1.8 V), VCC(3.3 V)
	Lanes	Up to 2	Up to 1
	HW Reset	Supported	Not Supported
	Reference Clock	19.2,26,38.4,52MHZ. Default 26 MHZ	26MHz (Default), 19.2 MHz
Functional	bRefClkFreq	Persistent (Default 26 MHz)	Volatile (Default 26 MHz)
	bMaxNumOfRTT	Persistent (Default 2)	Volatile (Default 2)
	bMaxDataInSize	Persistent (Min 4KB)	Volatile (Min 4KB)
	bMaxDataOutSize	Persistent (Min 4KB)	Volatile (Min 4KB)
	bActiveICCLevel	Persistent	Volatile
	Boot Feature	Supported	Not supported
	bOutOfOrderDataEn	Write once (Default 0)	Volatile (Default 0)

The UFS card is supposed to be lite version of embedded UFS. So support for unnecessary gears shall be removed and UFS card shall supports only PWM-Gear1, HS-Gear2 (optional), and HS-Gear3. Similarly the UFS card shall support up to 1 lane compared to embedded UFS supports 2 lanes.

VCCQ : The VCCQ pin is removed from UFS card to reduce the pin count. The UFS card vendors can use embed LDO to get the lower voltage which is aligned to their low voltage core from 3.3 V or 1.8 V source. Also as a power supply, 3.3 V and 1.8 V are mandatory considering the NAND controller, I/O logic. But 1.2 V can be generated wisely from 3.3 V or 1.8 V. So VCCQ pin (1.2 V) is not supported in UFS card.

HW Reset : In case of embedded UFS the chip cannot be detached from the system PCB, so the HW reset pin is required.But in UFS card, card removal is possible, therefore the HW reset pin can be avoided. The minimizing of UFS card pin count can reduce the development and testing cost.

Attributes : In embedded UFS the bRefClkFreq, bMaxNumOfRTT, and bMaxDataInSize, bMaxDataOutSize, bOutOfOrderDataEn and bActiveICCLevel attribute values are persistent. As the embedded UFS chip can't be removed from the host, making these attributes value as persistent avoids re-initialization of these attributes. But in case of UFS card, it can be inserted in to different host which may want to use different values for these parameters. So in UFS card these attributes value shall reset to default value after every reset.

8 UFS Card initialization

The UFS cad initialization follows same sequence as of eUFS. But as this is a removable device, VCC(3.3 V) and VCCQ2(1.8 V) may be provided after the UFS card is fully inserted into the card slot. The C/D pin may be used to support card insertion detection (refer to Annex A).

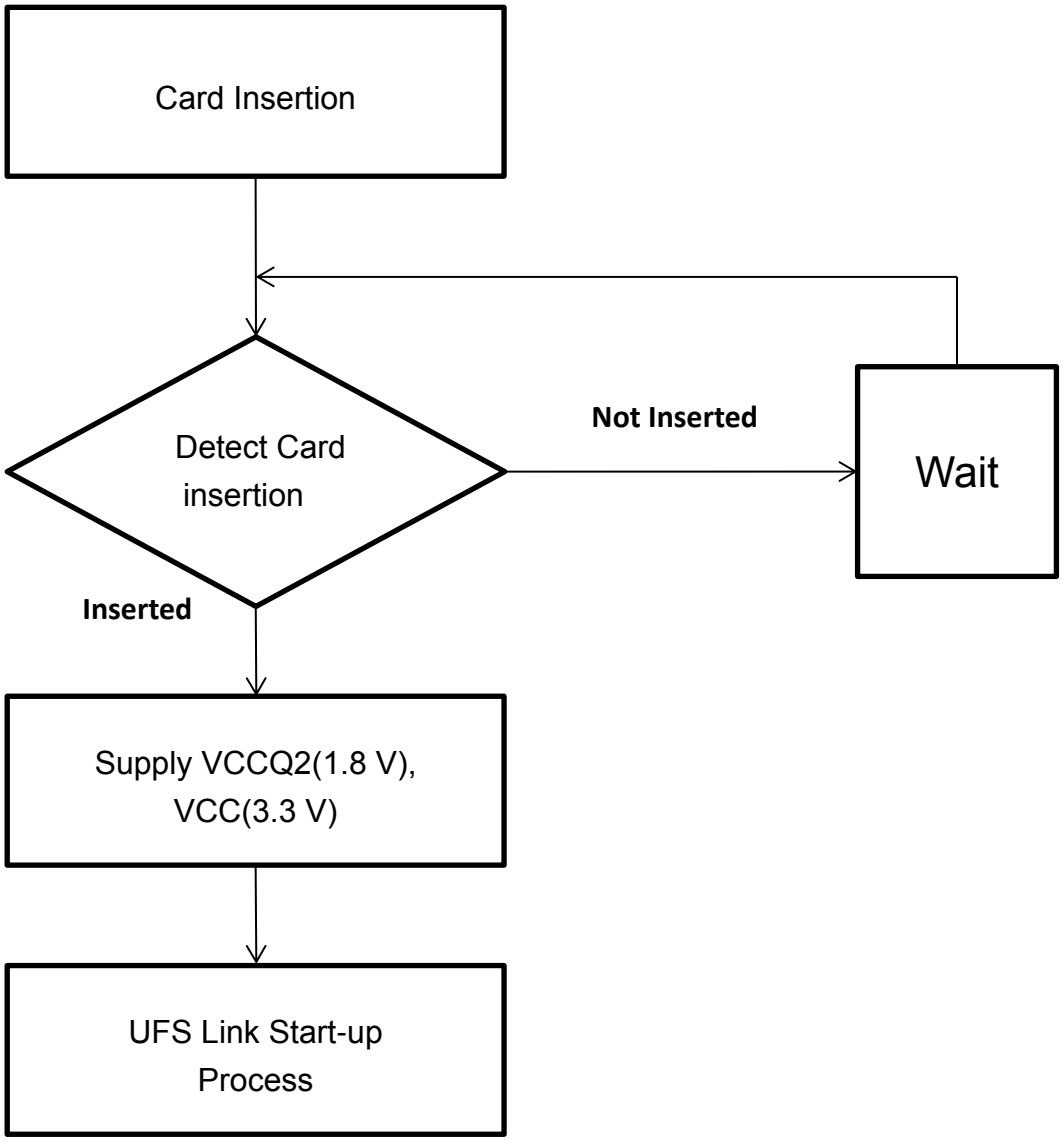


Figure 8.1 — UFS Card Initialization

8.1 Initialization Sequence

Once the reset is done, the host will set the attributes to make the card compatible with the particular host.

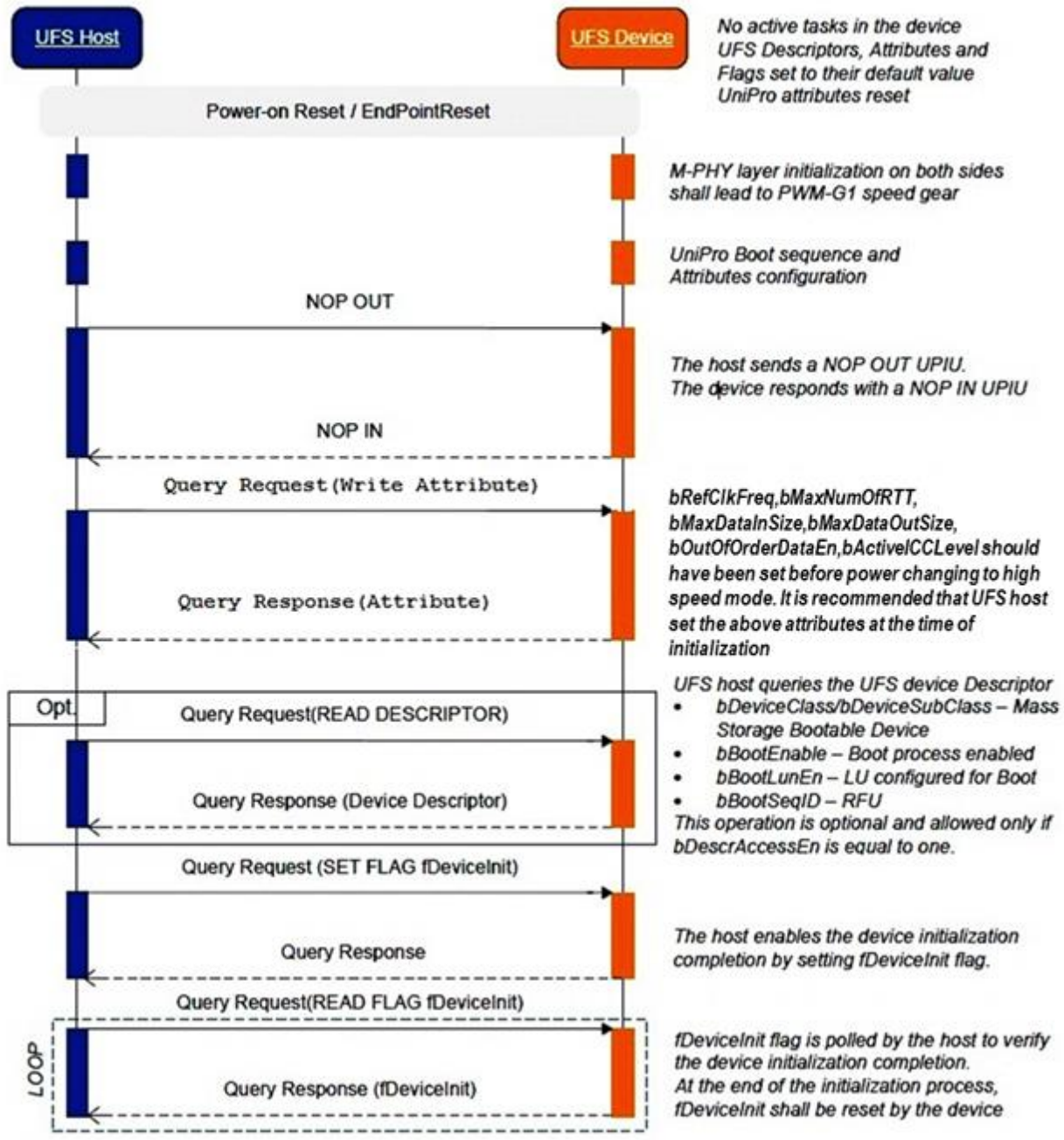


Figure 8.2 — UFS Card Initialization Sequence

The UFS card initialization is same as of embedded UFS, except the bRefClkFreq, bMaxNumOfRTT, bMaxDataInSize, bMaxDataOutSize,bOutOfOrderDataEn and bActiveICClevel attributes value will be set by the host. In embedded UFS these attributes will retain the value after the reset. But since the UFS card can be inserted into different host, these attribute values will be reset to their default value. The host has to set appropriate value before changing the mode to high speed mode.

9 Power Consumption

The UFS card shall be able to work in any host. Therefore power level which any UFS card can work shall be defined for host to provide required amount of power. So considering the removable card industry, the 1.6 watt would be needed for power consumption of the UFS card . The UFS card shall consume maximum 300 mA from VCC(3.3 V) and maximum 300 mA from VCCQ2(1.8 V).

Annex A (informative) Host Guideline for UFS Card Detection

The card detection (C/D) pin may be utilized to detect card insertion, by adding pull-up resistor to the C/D pin in the host-side C/D pin. When the UFS card is not inserted, host-side C/D pin shows non-zero voltage value. When the UFS card is inserted, host-side C/D pin shows zero voltage value because C/D pin of device is tied to ground.

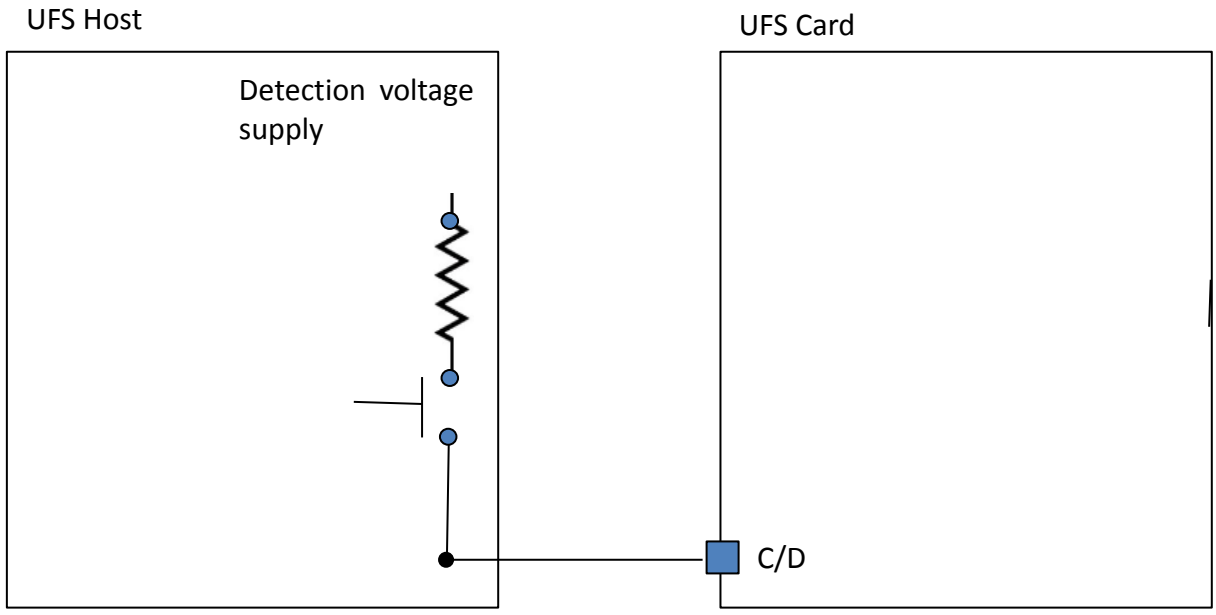


Figure A.1 — Host guideline for UFS Card Detection

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