Data I/O

# UFS Programming in LumenX

# **Getting Started Guide**

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# Chapter 1: Introduction

## This document provides instructions for programming a Universal Flash Storage (UFS) device using Lumen<sup>™</sup>X technology, including:

- Hardware installation of UFS Interface board
- Hardware installation of UFS socket adapter
- Software configuration of UFS programming job
- Verification of job completion

#### Simplified Ease-of-Use

To maintain consistency and simplify ease-of-use, LumenX streamlines the process of programming a Universal Flash Storage (UFS) device to be the same as programming a standard e-MMC device:

- Select the target device to be programmed
- Select the programming algorithm
- Configure job settings (ex. Load the data/img files to write...)
- Run the job (ex. Program, Verify...)

#### **Benefits**

The UFS programming process in LumenX Data Management Software (DMS) involves no learning curve for existing LumenX users who want to create and run UFS jobs, negating the need for training and transition. It also introduces new UFS users to the proven LumenX platform.

The same LumenX programming hardware used today is capable of programming and outputting an entirely new class of flash memory (UFS) without sacrificing any existing capabilities.

#### **Document Scope**

This document does NOT cover how to configure the hardware and software for running LumenX programming jobs (see the LumenX Getting Started Guide); this document focuses on the UFS-specific steps. It is also beyond the scope of this document to hype the speed and lowpower advantages of UFS.

#### Intended Audience

Readers need the LumenX Getting Started Guide and some familiarity with:

- Configuring the LumenX programmer hardware and networking
- Running jobs in LumenX Data Management Software (DMS)

It is important that readers have a basic understanding of UFS programming.

#### Safety Precautions

To prevent personal injury, lost time, and damage to equipment, please use extra caution when handling the powered programming equipment.

### CAUTION: Electrostatic Discharge Hazard!

Electrostatic discharge (ESD) may damage equipment and integrated circuits. Always discharge static electricity to a common ground. Use ESD prevention devices that contain a 1 M-ohm to 10 M-ohm current-limiting resistor.



### WARNING: Electric Shock Hazard!

Injury or death may result from contact to parts inside the programmer. Do not remove covers. There are no user-serviceable parts.

## Lxcessive Socket Actuator Air Pressure

For automated systems (ex. PSV7000), adjust the socket actuator air pressure down to prolong parts longevity (one LumenX programmer supports 8 LumenX sockets but only 4 UFS sockets).

Refer to Chapter 4 of the PSV7000 Owner's Manual for instructions on adjusting the air pressure down: near the lower-left corner of the Power Panel, pull the collar on the black "Socket Opener Pressure Control" knob out, and then rotate it counter-clockwise to 0.3 - 0.4 MPa (MegaPascals). Ignore this note for Manual/Desktop programmers.

#### **Conceptual Overview**

To simplify programming and enable customers with UFS capability on their existing LumenX programmers, Data I/O built support for UFS by leveraging the existing LumenX programming model. This development extends the value of LumenX programmers because customers can use existing technology to program the newest class of flash memory devices.

The following diagram shows the key difference between standard LumenX and UFS programming models (note the **UFS Interface Board** highlighted in Red color).



The left side of the diagram above shows a standard LumenX programming job with a socket adapter/board that plugs into the programmer. The right side shows a LumenX programming job for UFS where an additional UFS Interface Board is introduced.

From bottom to top, the general process is the same from programmer to device. But with the UFS Interface Board, the resulting device is programmed with superior UFS capabilities.

- \* Note that UFS support in LumenX requires the following minimum software versions:
  - LumenX Data Management Software (DMS) version 1.5.1+.
  - Automated Handler (AH700) version 2.6.2+ for PSV7000 automated systems
  - CH700 version 2.9+ for PSV5000 automated systems

# Chapter 2: Configure the Hardware

This Chapter provides instructions on configuring the UFS hardware, specifically:

- UFS Interface Board insertion
- UFS socket adapter installation
- Hardware validation

Installing UFS hardware is similar to installing LumenX hardware. First, follow the LumenX Getting Started Guide to ensure network connectivity between the programmer and Host PC. Then insert the UFS Interface Board into the programmer.

#### Inserting the UFS Interface Board

1. Open the socket clamp on top of the programmer.



2. Unwrap the UFS Interface Board from the packaging and handle carefully.



3. Rotate the orientation of the UFS Interface Board such that the notched/chamfered corners match the notched corners in the programmer.



**CAUTION:** Possible machine damage! Do not touch connector pins. Bent or damaged pins can cause programming malfunctions and/or reduced production yields.

4. Close the socket clamp after installing the UFS Interface Board.

If 4 UFS Interface Boards are not available, then use 2 boards in the same actuator position (orientation): insert the 2 boards such that they occupy sockets 1 through 4 on the programmer (or sockets 5 through 8). Placing the 2 UFS Interface Boards on the same side of the programmer provides equal mechanical loading of the socket actuator.

With the UFS Interface Board installed, your LumenX hardware is almost ready for UFS programming. To program a UFS device, you install a device-specific UFS socket adapter on top of the UFS Interface Board (the same as installing a standard LumenX socket adapter).

#### Installing a UFS Socket Adapter

- 1. Remove the UFS socket adapter from the packaging and note the PIN1 location.
- 2. Rotate the orientation of the socket adapter such that the notched/chamfered corners match the notched corner shape printed on the UFS Interface Board.

**NOTE:** The <u>PIN1</u> writing on the socket adapter reads in the same direction as "Data I/O" on the UFS Interface Board.

3. Gently press down on the socket adapter until it fits into the UFS Interface Board.



**CAUTION:** Possible damage may occur if the socket adapter is not rotated to the proper <u>PIN1</u> orientation and/or excessive force is applied during insertion.

#### Validating the Hardware

Skip this section if using an automated system (such as a PSV7000). Otherwise, the UFS hardware configuration is complete. Before starting software configuration in the next Chapter, now is a good time to double-check that:

- The LumenX programmer is connected by network cable to a LumenX Host PC
- The LumenX programmer is powered on
- The LumenX programmer is reachable from the Host PC by:
- **Ping** command to the IP address of the programmer
- Programmer status in LumenX DMS (see next Chapter)
- **Note:** Programming file sizes greater than 64GB requires a LumenX programmer upgrade to 128GB cache memory.

# Chapter 3: Configure the Software

This Chapter provides instructions on configuring the software for UFS programming, specifically:

- LumenX Data Management Software (DMS) version 1.5.1+ update
- LumenX programmer firmware version 1.5.1+ update

Software configuration for UFS programming consists of updating the version of LumenX Data Management Software on the Host PC, and then updating the firmware on the LumenX programmer(s).

#### Updating LumenX Data Management Software (DMS)

- 1. Download and run the LumenX\_DataManagementSoftware.exe file.
- 2. In the LumenX Setup Wizard, follow the prompts to complete the version update.



3. Restart the Host PC.

4. To complete the installation, start LumenX DMS (click **Start** > **Programs** > **Data IO** > **Data Management Software**), and from the **Tools** menu at the top, click **Algorithm Updater**.



5. If prompted, click **Install** to install the AlgoUpdater.



6. In the lower-right corner of the algorithms dialog box, click Update List.



7. After the algorithm list updates, under the **Remote Algorithms** column on the right, check the box in the upper-left corner (to select all algorithms), and then click **Download Selected**.

1 <sup>1</sup> /x			-	
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Local Algorithms	Remo	ote Algorithms		
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		Micron	MTFC64GAPALBH-AAT ES	TFBGA153
	₹	Micron	MTFC128GAPALNS-AAT ES	TFBGA153
		Toshiba	THGBMHG9C8LBAW8	TFBGA153
	<b>v</b>	SanDisk	SDINBDA4-64G	TFBGA153
	<b>v</b>	SanDisk	SDINBDA4-32G	TFBGA153
	<b>v</b>	Micron	MTFC16GAKAEJP-AIT	VFBGA153
		Micron	MTFC128GAJAECE-5M AIT	LFBGA169
		Micron	MTFC32GAKAEEF-AAT	TFBGA169 🔽
			Update List	
	C		Download Selected	
Updating finished				

8. After the update completes, verify that the **Local Algorithms** column on the left is now populated, and then close the algorithms dialog box. effect

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Manufactur	Part Name	Package	Versio	Sta 🔺	~	Manufactur	Part Name	Package	
Micron	MTFC32GAKAEJP-AIT	VFBGA153	9.3.0	Rele		Micron	MTFC32GAKAEJP-AIT	VFBGA1	53
Micron	MTFC64GAPALBH-AA	TFBGA153	9.3.0	Rele		Micron	MTFC64GAPALBH-AAT ES	TFBGA15	53
Micron	MTFC128GAPALNS-A	TFBGA153	9.3.0	Rele		Micron	MTFC128GAPALNS-AAT ES	TFBGA15	53
Toshiba	THGBMHG9C8LBAW8	TFBGA153	9.4.0	Rele		Toshiba	THGBMHG9C8LBAW8	TFBGA15	53
Toshiba	THGBMHG9C8LBAU8	TFBGA153	9.4.0	Rele	Ţ	SanDisk	SDINBDA4-64G	TFBGA1	
Toshiba SanDisk	THGBMHG9C8LBAWC	TFBGA153 TFBGA153	9.4.0 9.3.0	Rele Rele					
SanDisk	SDINBDA4-64G	TFBGA153	9.3.0 9.3.0	Rele Rele		SanDisk	SDINBDA4-32G	TFBGA15	
Micron	MTFC16GAKAEJP-AIT	VFBGA155	9.3.0 9.3.0	Rele		Micron	MTFC16GAKAEJP-AIT	VFBGA1	53
Micron	MTFC128GAJAECE-5N		9.3.0	Rele		Micron	MTFC128GAJAECE-5M AIT	LFBGA16	69
Micron		TERGA169	930			Micron	MTFC32GAKAEEF-AAT	TFBGA16	59 
							Update List		
							Download Selected		
Algorithm li	ist updated using direct			orithma					

9. Close and restart LumenX Data Management Software (DMS) to recognize the algorithms.

#### Updating the Programmer Firmware

1. From the **Tools** menu at the top, select **Update Programmer(s)**.

le View Alerts Settings	Tools Help			Hello, Local 🛛
Jobs User Authentication	Algorithm Updater Read from Master Device			
Jobs Enter search text here (e.g.	Retrieve all logs			C
Job Name	Update Programmer(s)	Notes	Part Name	Manufacturer
Secure Job 123 for Infineon Optiga	Extensions	otes for the Operator(s)	SLS32AIA020A	Infineon Technolog.
TapeLabelTest0	Ensure that Host PC sees	the Label Printer first	KLMAG1JETD-B041	Samsung

2. In the left pane, check the box(es) for the programmer(s) you want to update.



3. To the right of the **Select from path** box, click the ellipsis (...) button to Browse for an update package to apply.



4. Browse for and select the System Update package to apply (<u>System Update package must</u> <u>be applied BEFORE Firmware Update package</u>), and then click **Update Programmer(s)**.

Upda	te Programmer(s)		
Prog	,rammers	Select from path:	
Fi	10.0.0.2	C:\LumenX\Updates\SystemUpdate.1.5.1.u	updpkg
<b>₹</b> 1 5	Status: I <b>dle</b> Firmware: 1.4.2.22 <u>View Log</u>	Note: Selected update will be stored under C:\Lun downs below for future use. Or choose existing Update Package	nenX\Updates and available in the drop
1		System Update:	<b>–</b>
		Firmware Update:	<b>-</b>
		Note: Using C:\LumenX\Updates, change this local	tion via the Settings window.
			Update Programmer(s)

- 5. In the left pane, verify that the **Status** of each selected programmer changes state from:
  - Idle > Updating > Verifying > Rebooting > Idle
- 6. Repeat the previous steps to select and apply a Firmware Update package.



8. In the left pane under **Programmers**, verify that the **Firmware** version is updated (you can also hover/mouseover **Firmware** to reveal the System version).

Update Programmer(s)		
Programmers	Select from path:	J
FI 10.0.0.2 4.2.22	nX Programmer:	
✓ Status: Idle Firmware: 1.5.1 View Log	Note: Selected update will be stored under C:\L downs below for future use.	LumenX\Updates and available in the drop
Stories Log	Pr choose existing Update Package	
	System Update:	<b>*</b>
	vare Update:	<b>•</b>
	Note: Ung C:\LumenX\Updates, change this loo	cation via the Settings window.
		Update Programmer(s)

# Chapter 4: Run the Job

This Chapter provides instructions on running the UFS job, specifically:

- Job settings configuration
- Device settings configuration
- UFS Descriptors and Attributes configuration
- LUN settings configuration

With the software and firmware updated in the last Chapter, now configure UFS settings in LumenX Data Management Software (DMS) for the programming job.

#### **Configuring Job Settings**

- 1. On the Host PC, start LumenX Data Management Software (DMS).
- 2. Near the lower-right corner, click **New** to create a job.
- 3. On the **Devices** screen, search for "ufs", select your target UFS device, and click **Next**.
- 4. On the Algorithms screen, select the desired algorithm to use, and click Next.
- 5. On the **Create Job** screen, in the **Job Name** box, type a name for the job.
- 6. In the Job section, make the desired job process selections from the drop-down lists.

🍂 LumenX	Data Ma	inagem	ient Software	(DMS)							-		$\times$
File View	Ale	erts	Settings	Tools	Help						He	llo, Loc	al⊚
CREATE JO	B: Sai	nsung	Generic UI	FS 2.0 Alg	orithm TFBG	A153							
Job Name				ob XYZ									
Descriptio				z run 4 fo									
Operator	Notes					der and t		out befo					
0101010		Proce											Ĩ
JOB		_	lame		Value				 	 	 		
1,08	Jo	b Proc	ess Selecti	on: Prog	gramming an	d Verify	<u>.</u>		 	 	 		
	Er	ase Se	lection:	Full	chip Erase		•						Ш.,
	_								 	 	 		

#### **Configuring Device Settings**

1. In the **Device** section, from the **Adapter Id** drop-down list, select the specific adapter.

<u>J</u>	LumenX Da	ita M	anagement Software (DN	AS)				_		×
File	View			ools Help				Hel	lo, Local	0
CRE	EATE JOB:	Sa	msung Generic UFS 2	.0 Algorithm TFBGA15	3					
Jo	b Name		Partner 26 UFS Job	KYZ						
D	escription		This is ufs job xyz ru	n 4 for Partner 26						
0	perator No	otes	No need to re-teach	n pkg; Test tray feeder a	and tape-out before start	ing run				
01	101010		Process: Name	Value		_				Ī
	JOB	l in the		Programming and Vo Full chip Erase	erify ▼ ▼					
	EVICE A	dapt ) No MAR	thm: LUN 0 to 7 Vers er Id: 110103 v otes: No notes.		it and save it to disk	•	Back	Sa	🟓 ve as Jol	

2. To expand the device-specific options, click Settings.



**Note:** The settings and their default values may vary slightly depending on the specific device and algorithm selected.

3. To expand the device-level UFS Configuration Descriptors, click **UFS Descriptor**.



4. Configure the UFS Descriptors as desired.

🍂 Lumer	nX Dat	a Management Software (DMS)	- 0	×
<u>F</u> ile <u>V</u> i	ew	<u>A</u> lerts <u>S</u> ettings <u>T</u> ools <u>H</u> elp	Hello, Local 🤅	>
CREATE J	JOB:	Samsung Generic UFS 2.0 Algorithm TFBGA153		
	•	UFS Descriptor - Pre-Programming 9 item(s)		
		bBootEnable - Enable the Boot feature		
		blnitPowerMode - Initial Power Mode	0x01: Active Mode (default)	
		bHighPriorityLUN - High Priority Logical Unit	7F	
		bDescrAccessEn - Enable access to the Device Descriptor after		
		bSecureRemovalType - Secure Removal Type	0x00: Erase of physical memory	
		blnitActivelCCLevel - Initial Active ICC Level	0	
		wPeriodicRTCUpdate[8:6] - TIME_UNIT	0	
		wPeriodicRTCUpdate[9] - TIME_BASELINE	0	
		wPeriodicRTCUpdate[5:0] - TIME_PERIOD	0	
		hPanti unfin Attributa 1 itam/a)		

**NOTE:** LumenX Data Management Software (DMS) supports the standard set of descriptors defined by the JEDEC specification for UFS Version 2.1 (JESD220C, March 2016). For more information, see **Appendix B: Device Settings, UFS Configuration Descriptors**.

5. To set the UFS Device Attributes, expand the desired attribute and set appropriately.



LumenX supports a standard set of device attributes. For more information about these attributes, see **Appendix C: Device Settings, UFS Device Attributes**.

#### **Configuring LUN Settings**

1. In the **Memory Region** section, click **Add Static Data** for the specific Logical Unit Number (LUN) to program (ex. LUN 0). The number of LUNs is dependent on the specific device.



2. In the **LumenX Edit Memory Region Information** dialog box, click **Browse** to load your data file.

JX I	Lume	enX Edit Memo	ry Range Information			1		×
Г		File					Brov	/se
			File Size		]			
1001	1011		Load Start Address (hex)		Load Range (hex)			
DA	TA	Checksum	Method	32 Bit CRC				
			Result (hex)				Calc	ulate
		Device	Start Offset (hex)					
HELP	t D A d it O	onfirm imag he device to evice Region region on a evice or it m s controlling	if in edit mode, enter o ge, select the part of the place the image. In and Ranges a device is a main area to ay be a layer or it may be algorithm) or it may be a thin this region the job cr	e file to load, and se o be programmed. a sub-area partitione a special area with co	elect the location in It may be the whole ad by the device (and nfiguration data or a	<b>Н</b> ок	Car	

3. (Optional) To program only a specific segment of the loaded data/image file into the selected LUN, specify the starting address and data range.



By default, LumenX writes the entire loaded data/image file starting at address 0x00 (and automatically calculates/populates the **Load Range** based on file size).

4. (Optional) To validate programmed data at the file level (checksum compare), select the desired **Checksum Method**, and then click **Calculate**.

s# Lu	umenX Edit Memo	ory Range Information				_		×
$\square$	File	C:\Users\Desktop\IMG\In	nage123.img				Brow	vse
		File Size	26.2 KB					
10010		Load Start Address (hex)	0	Load Range (hex)	7000		ĺ	
DAT	A Checksum	Method	SHA256	V	)			
		Result (hex)	D133E9289B9B	89636FC4EB69C27A5BC33A3FF	7F0CAC485C	73572D9852	Calc	ulate
	Device	Start Offset (hex)	0					
HELP	select the pa Device Region A region on a be a layer or i may be a spec can place ima Set or Change To add or cha	rt of the file to load, and ns and Ranges a device is a main area to l it may be a sub-area partit cial area with configuratior ge data in some or all of it e Image File Path for the Ra ange the path to the image	select the locat be programmed ioned by the det a data or a OTP a ange	ge file, check CRC to confirm ion in the device to place the . It may be the whole device o vice (and its controlling algorith area. Within this region the job	r it may m) or it creator	<b>н</b> ок	Can	
CRC	calculation finis	shed						

5. (Optional) To program data at a specific starting address on the UFS device, complete the **Device Offset** field. (By default, LumenX writes to the lowest available address on device.)

	File	C:\Users\Desktop\IMG\In	nage123.img	Brows	se
		File Size	26.2 KB		
1001011 0101010 1010101		Load Start Address (hex) <b>ecksum</b> Method	0	Load Range (hex) 7000	
DATA	Checksum		SHA256		
		Result (hex)	D133E9289B9B8	9636FC4EB69C27A5BC33A3FF7F0CAC485CF73572D98522 Calcu	late
	Device	Start Offset (hex)	0		
	• The offer	ets, lengths and checksums	on this dialog ar	a in havidacimal	

- 6. To include additional data in the LUN, repeat this procedure starting from Step 1.
- 7. To include dynamic/serialized data in the programming job, click Add Serialized Data.



8. In the **LumenX Edit Serial Data Information** dialog box, complete the desired fields, and then click **OK**.

J.X	LumenX Edi	t Serial Data Informat	tion				_		×
ſ		Serialized Data	Template						$\neg$
	1001011		Source	Incrementing counte	r			•	
s	RIALIZED		Start Offset (hex)	0	Data Size (bytes) 8				
	DATA	Serial Data File						Broy	vse
L			Edit Starting Number	•					
SUMMARY: Add serialized data range to device region Serialized Data Range placement restrictions:   Range must be either entirely within a static data range or entirely outside.  Two or more serialized data ranges cannot overlap each other. Incrementing Counter Source:  A self-incrementing 64-bit unsigned integer is used. The data is written in little- endian format.								/	

9. To configure LUN-specific Unit Descriptors, click **Settings** to expand the available options.

🥼 Lumen	X Data Management Software (DMS)				- c	x c		
<u>F</u> ile <u>V</u> ie	w <u>A</u> lerts <u>S</u> ettings <u>T</u> oc	ols <u>H</u> elp			Hello,	Local ⊚		
CREATE J	OB: Samsung Generic UFS 2.0	Algorithm TFBGA153						
	Device: Samsung Generic Algorithm: UFS 2.0 Algorithm Adapter Id: 110103 🔻	UFS 2.0 Algorithm TFBGA153 Version: 0.1.1						
DEVICE	Notes: No notes.     Settings: 18 settings, 0 e	rrors						
	LUN0 Memory Region (29.8 C	GB - 0x773C00000)	Add Static Data Add S	erialized	Data			
	Data	Checksum (hex)	Start-End (hex	Process	Edit	Del		
MEMORY 1010 1010	Image123.img		0 - 6FFF	🗹 Program 🗹 Verify		×		
REGION	Serialized Data Source	Start With	Start-End (hex	Process	Edit	Del		
	Incrementing counter		0 - 7	🗸 Program 🗹 Verify		×		
	Settings: 7 settings , 0 errors							
	LUN1 Memory Region (29.8 C	GB - 0x773C00000 )	Add Static Data Add S	erialized	Data			
MEMORY 1010 1010	Data	Checksum (hex)	Start-End (hex	Process	Edit	Del		
1011 1011	Carlabard Data Cattors	Can and Saliala	Charles Frend Harris	D== = = = =		Del		

10. Configure the Unit Descriptors as desired.



LumenX supports the standard set of LUN descriptors defined by the JEDEC specification for UFS Version 2.1 (JESD220C, March 2016). For more information about these descriptors, see **Appendix D: LUN Settings, UFS Unit Descriptors**.

#### Calculating LUN Size (dNumAllocUnits)

The **dNumAllocUnits** setting (as highlighted by arrow in the preceding screenshot) is unique in that it is <u>REQUIRED</u> (you cannot save UFS jobs if **dNumAllocUnits** is blank or otherwise invalid).

**dNumAllocUnits** simply specifies the desired size of the LUN (similar to partitioning any storage drive), so the size you specify must be equal to or greater than the sum of all the data/image files that you intend to program into the specific LUN/memory region. Also include additional storage as a buffer if your application involves logging (allocate extra space for the log files).

The JEDEC formula for calculating **dNumAllocUnits** is:

 $dNumAllocUnits (hex) = \frac{\text{Desired LUN Size (bytes, decimal) x CapacityAdjFactor}}{bAllocationUnitSize (bytes, decimal) x dSegmentSize x 512}$ 

For the numerator, you set the **desired LUN size** while the **CapacityAdjFactor** is always 1 for Normal memory type. For Enhanced memory types, see the JEDEC specification on how to calculate the **CapacityAdjFactor**.

For the denominator, both of the variables are fixed per device specifications. So calculating **dNumAllocUnits** is relatively easy because 3 of the 4 variables are fixed and you set the 4<sup>th</sup>. For example, <u>if 3 GB is the desired LUN size</u> and your device has the following specifications:

- CapacityAdjFactor = 1
- bAllocationUnitSize = 0x01 (Hex)
- dSegmentSize = 0x00002000 (Hex)

Then calculate **dNumAllocUnits** as follows:

St	ep	Calculation
1.	Determine the desired LUN size, then convert this value to <u>bytes</u> .	3 GB = <u><b>3,000,000,000</b></u>
2.	In the specifications for your device, calculate the <b>CapacityAdjFactor</b> for your device's memory type. (The value is 1 for Normal memory type.)	Hex 0x01 = Decimal <u>1</u>
3.	In your device specifications, lookup the <b>bAllocationUnitSize</b> and <b>dSegmentSize</b> values, then convert them from hexadecimal to decimal.	bAllocationUnitSize= <u>1</u> dSegmentSize= <u>8192</u>
4.	Using the formula above for calculating <b>dNumAllocUnits</b> , plug the values from the first 3 steps into the formula.	<u>3,000,000,000 x 1</u> 1 x 8192 x 512
5.	Convert the quotient in Step 4 from decimal to <u>hexadecimal</u> , and enter this hex value in the <b>dNumAllocUnits</b> box.	Decimal 715 = Hex <u>2CC</u>

#### Starting the Job Run

- 1. Gently insert and place a blank UFS device into its socket adapter (note the <u>PIN1</u> location indicated on the socket adapter board).
- 2. Ensure the system is in the appropriate presenter mode: in the **Settings** group, from the **Presenter Mode** drop-down list, select **Desktop Mode** (vs PSV7000 or PSV5000 for automated systems).

Settings		<b>EX</b>				
Programmers	Directories	J				
10.0.0.2 ×	Jobs C:\LumenX\Jobs	Browse Update				
Status: Idle Firmware: 1.5.1	Algorithms C:\LumenX\Algorithms No Algorithms? <u>Algorithm Updater</u> Updates C:\LumenX\Updates	Browse Update Browse Update				
	Settings					
	Presenter Mode Desktop Mode 🔻					
Discover						

3. In the left pane, check the box for the desired programmer(s), and then click **Run**.

🎉 LumenX Data Management Soft	ware (DMS)				
<u>File V</u> iew <u>A</u> lerts <u>S</u> etti	ngs <u>I</u> ools <u>H</u> elp	Hello, Local 🛛			
Programmers	Loaded Job (open for details): Partner 26 UFS Job XYZ				
10.0.2 Status: Idle Firmware: 1.5.1	Job Progress				
SUMMARY: Select programmer(s), run job. INSERT DEVICES BEFORE RUNNING. To run a job: Change Programmer selections if desired, load devices and click Run Job button to run this joł					

- 4. View the **Job Progress** pane for the current status:
  - **DUT** = Device Under Test = Socket
  - **IDLE** = Job is downloading/no activity in slots
  - **BUSY** = Job is programming
  - **PASS** = Job has successfully completed
  - **FAIL** = Error occurred

🎉 Li	imenX Data Management Soft	vare (DMS)					
<u>F</u> ile	<u>V</u> iew <u>A</u> lerts <u>S</u> ettir	ngs <u>T</u> ools <u>H</u> elp	Hello, Local 🛛				
Pro	grammers	Loaded Job (open for details): Partner 26 UFS Job XYZ					
	10.0.0.2 Status: Running	Job Progress					
V	Firmware: 1.5.1 <u>View Log</u>	LumenX Programmer: 10.0.0.2 DUT 1 DUT 2 IDLE IDLE DUT 3 DUT 4 BUSY IDLE	Status: Running				
		Download: Processed: 0 B Duration: Programming: Processed: 1.4 GB Duration: 49 s					
		Programming Data					
		Pre-Programming Chip Operations: 3.8 s Main Programming Socket Operations Program> Speed: 35.8 MB/s Duration: 41 s Status: In Program Verify> Speed: N/A Duration: Status: Pending	ess				
L		Post-Programming Chip Operations: 0.0 s					
HELP							
Ru	nning Job						

When a specific job is run for the first time, there may be an apparent delay between the **Downloading** and **Programming** states because LumenX may need to update the bitstream version of the UFS Interface Board. If needed, the bitstream update takes approximately one minute (the yellow LED remains lit until the update completes).

# Chapter 5: Verify Job Completion

This Chapter provides instructions to verify that the job completed, specifically:

- Programmer and socket status confirmation
- Socket adapter LEDs check
- Error alert notification

After configuring and running the programming job in the last Chapter, now verify in LumenX that the job completed properly. Ultimately, verifying that the part/device was programmed properly involves reading from it (not addressed in this document).

#### **Confirming Status**

1. In the left pane under **Programmers**, verify that the **Status** entry shows **Done**.



2. To confirm socket status, verify that the **Job Progress** pane shows **PASS** for each socket and programmer used.

🎉 L	umenX Data Manage	ement Soft	tware (DMS)				_		х
<u>F</u> ile	<u>V</u> iew <u>A</u> lerts	<u>S</u> etti	ngs <u>T</u> ools	<u>H</u> elp			Hel	llo, Local	0
Pro	grammers		🐱 Loaded J	l <b>ob</b> (open foi	r details): Portner 26	UFS Job XYZ			
	10.0.0.2 Status: Idle Firmware: 1.5.1 <u>View Log</u>		Job Progres	Job Progress					
N			LumenX Pro 10.0.0.2	ogrammer:	DUT 1 IDLE	DUT 2 IDLE		Status: Done	
					DUT 3 PASS	DUT 4 IDLE		-	
			Download Processed:	: 0 B Duratio	on:				
			Programm	i <b>ng:</b> Proces	ssed: 1.0 MB Duration Job Com				
			Pre-Programming Chip Operations: 0.3 s Main Programming Socket Operations						
S	elect All Deselec	t All			eed: 17.7 MB/s Dura I: 66.3 MB/s Duratio				
	SUMMARY: S		rogrammer(s	s), run job.		•	<b>H</b> Back	Run	~
	To run a iob:								
Job	completed.								

### Checking Socket Adapter LEDs

All LEDs will light simultaneously at startup and go off when the startup process is complete.

- **Green** = PASS
- Yellow = BUSY
- **Red** = FAIL
- White = Continuity Error

#### Checking for Alerts

If an error occurs (red-color LED of socket stays lit or flashes on-and-off repeatedly), check for alert notifications at the top and bottom of LumenX Data Management Software (DMS).



# Appendices

The following Appendices provide additional details about UFS configuration:

- Appendix A: Job Settings, Job Process Selection
- Appendix B: Device Settings, UFS Configuration Descriptors
- Appendix C: Device Settings, UFS Device Attributes
- Appendix D: LUN Settings, UFS Unit Descriptors
- Appendix E: Sample UFS Job with Default Settings
- Appendix F: User Interface Legend

To avoid disrupting the workflow of running the programming job, many of the UFS settings are detailed here rather than inline with the steps earlier.

**Note:** The settings and default values shown here are for sample purposes only; they may vary slightly from those of your specific device and algorithm.

### Appendix A: Job Settings, Job Process Selection

Make the desired job process selection(s) from the drop-down lists in the **Job** section.

🍂 LumenX Da	ta Management Software (DMS)	_		х			
<u>F</u> ile <u>V</u> iew	<u>A</u> lerts <u>S</u> ettings <u>T</u> ools <u>H</u> elp	He	llo, Loca	l⊗			
CREATE JOB:	Samsung Generic UFS 2.0 Algorithm TFBGA153						
Job Name	Partner 8 UFS Job XYZ			78			
Description	This is UFS job XYZ, Run #4 for Partner 8						
Operator No	No need to re-teach pkg; test tray feeder before starting job run						
Job ID	75618fe1-ddfc-4da0-9525-190122411fc0						
Job Checksu	m CD5302FD						
0101010							
Device: 32GB Automotive UFS 2.1 Algorithm TFBGA153 Algorithm: UFS 2.1 Algorithm Version: 0.1.1 DEVICE Adapter Id: 110103							

Setting	Available Options	Description
Job Process Selection	<ul><li>Program and Verify (default)</li><li>Verify Only</li></ul>	Specifies the programming operation(s) to perform on the device.
Erase Selection	<ul><li>Disabled</li><li>Full Chip Erase (default)</li></ul>	Specifies if Full Chip Erase is enabled.

### Appendix B: Device Settings, UFS Configuration Descriptors

Configure the desired descriptors in the **Device** section.

<u> 1</u>	LumenX Dat	a Managem	nent Software (	DMS)					_		>	<
<u>F</u> ile	<u>V</u> iew	<u>A</u> lerts	<u>S</u> ettings	Tools	<u>H</u> elp				н	ello, Loc	al⊚	
CRE	ATE JOB:	Samsung	g Generic UF	5 2.0 Algo	orithm TFBG	A153						
	•	UFS Desc	criptor - Pre-	Program	ming 9 item	n(s)						
		bBootEr	nable - Enab	le the Boo	ot feature							
		bInitPov	werMode - Ir	nitial Pow	er Mode		0)	01: Active	Mode (de	efault)		
	bHighPriorityLUN - High Priority Logical Unit			Unit	7							
		bDescr/	AccessEn - Er	hable acco	ess to the D	evice Descriptor	after 📃					U
		bSecure	eRemovalTyp	e - Secur	e Removal T	Гуре	0)	(00: Erase (	of physica	l memor	у	
		blnitAct	tivelCCLevel	- Initial A	ctive ICC Lev	vel	0					
		wPeriod	dicRTCUpdate	e[8:6] - TI	ME_UNIT		0					
		wPeriod	dicRTCUpdate	e[9] - TIM	E_BASELINE		0					
		wPeriod	dicRTCUpdate	e[5:0] - TI	ME_PERIOD		0					
		L.D All an	m [m. Attailar.t.	1								

Setting	Available Options	Description
bBootEnable	• 00h Disabled (default)	Specifies if the device is bootable.
bInitPowerMode	00h UFS-Sleep Mode	Specifies the initial power mode.
	<ul> <li>01h Active Mode (default)</li> </ul>	
bHighPriorityLUN	• 7Fh (default)	Specifies which LUN has the
	• 0 to <b>n</b> , where <b>n</b> = # of LUNs	command queue with the highest
	specified by bMaxNumberLU	priority. Default value <b>7F</b> means
		equal priority across all LUNs.
bDescrAccessEn	• 00h Disabled (default)	Specifies if Device Descriptors are
	• 01h Enable	accessible after initialization.
bSecureRemovalType	• 00h Erase (default)	Specifies the method by which
	• 01h Overwrite once, then erase	information is removed.
	• 02h Overwrite thrice, then erase	
	O3h Remove by vendor method	
bInitActiveICCLevel	• 0 (default)	Specifies the <b>bActiveICCLevel</b>
	• 00h to 0Fh	after power on or reset.
wPeriodicRTCUpdate[8:6]	<ul> <li>Ob Undefined (default)</li> </ul>	Specifies the TIME_UNIT of real-
		time clock updates.
wPeriodicRTCUpdate[9]	Ob Time from last update	Specifies the TIME_BASELINE of
		real-time clock updates.
wPeriodicRTCUpdate[5:0]	• 0b	Specifies the TIME_PERIOD of
		real-time clock updates.

### Appendix C: Device Settings, UFS Device Attributes

Configure the desired device attributes in the **Device** section.

J.K	LumenX Data Management Software (DMS)		100		×
File	<u>V</u> iew <u>A</u> lerts <u>S</u> ettings <u>T</u> ools <u>H</u> elp		He	llo, Loca	al o
CRE	EATE JOB: Samsung Generic UFS 2.0 Algorithm TFBGA153				
٢	<ul> <li>Settings: 18 settings, 0 errors</li> </ul>				
	Name	Value		Тур	be
	Superior - Pre-Programming 9 item(s)				
	📀 bBootLunEn Attribute 1 item(s)				<b></b>
	SoutofOrderDataEn Attribute 1 item(s)				
	SconfigDescrLock Attribute 1 item(s)				
	😔 bMaxDataInSize Attribute 1 item(s)				
	bMaxDataOutSize Attribute 1 item(s)				
	bMaxNumOfRTT Attribute 1 item(s)				
	SkefClkFreq Attribute 1 item(s)				
	📀 fPermanentWPEn Flag 1 item(s)				
	FPermanentlyDisableFwUpdate Flag 1 item(s)				

Setting	Available Options	Description		
bBootLunEn	O0h Boot disabled (default)	Specifies if a particular LUN is active during boot.		
bOutOfOrderDateEn	<ul><li>00h Disabled (default)</li><li>01h Enabled</li></ul>	Specifies if out of order sequencing is enabled.		
bConfigDescrLock	<ul><li> 0h Disabled (default)</li><li> 1h Enabled</li></ul>	Specifies if device configuration (Configuration Descriptor) is locked.		
bMaxDataInSize	<ul> <li>0 to n, where n = bMaxInBufferSize</li> </ul>	Specifies the maximum size of data in (number of 512-byte units).		
bMaxDataOutSize	<ul> <li>0 to n, where n = bMaxOutBufferSize</li> </ul>	Specifies the maximum size of data out (number of 512-byte units).		
bMaxNumOfRTT	<ul> <li>0 to n, where n = bDeviceRTTCap</li> </ul>	Specifies the maximum number of outstanding RTTs allowed.		
bRefClkFreq	<ul> <li>0x00h - 19.2 MHz</li> <li>0x01h - 26 MHz (default)</li> <li>0x02h - 38.4 MHz</li> <li>0x03h - 52 MHz</li> <li>Others: Reserved</li> </ul>	Specifies the reference clock frequency.		
fPermanentWPEn	<ul><li>00h Disabled (default)</li><li>01h Enabled</li></ul>	Specifies if permanent write protection is enabled.		
fPermanentlyDisableFwUpdate	<ul><li> 0b Disabled (default)</li><li> 1b Enabled</li></ul>	Specifies if firmware updates are permanently disallowed.		

### Appendix D: LUN Settings, UFS Unit Descriptors

Configure the desired LUN descriptors in the **Memory Region** section.

1	LUN0 Memory Region ( 29.8 GB - 0x773C00000 )				Add Static Data	Add	Seria	lized [	Data
	Data	Checksum (hex)		Start-End (hex)	Process			Edit	Del
	Serialized Data Source	Start With		Start-End (hex)	Process			Edit	Del
	Settings:								
	Name		Value				Туре		
	bBootLunID - Boot LUN Identifier		0x00: Not a Boot Logical Unit (default)			▼			
MEMORY	bLUWriteProtect - Logical Unit Write Protect		0x00: Not Write-Protected (default)			•	<b>•</b>		
1010 1010 1011 1011 REGION	bMemoryType - Logical Unit Memory Type		0x00: Normal Memory (default)		▼				
REGION	bDataReliability - Enable the Data Reliability feature		•						
	bLogicalBlockSize - Size of addressable logical blocks		С		Hex				
	dNumAllocUnits - Size of LUN in allocation units		0		Hex				
bProvisioningType - Logical Unit Provisioning Type		nit Provisioning Type	0x00: Thin Provisioning disabled (default) 🔻						

Setting	Available Options	Description
bBootLunID	• 00h Not Bootable (default)	Specifies if a particular LUN is bootable.
	• 01h Boot LUN A	
	O2h Boot LUN B	
bLUWriteProtect	00h Not Write-Protected	Specifies if the LUN is write-protected.
bMemoryType	O0h Normal Memory	Specifies a particular memory type (as supported by <b>wSupportedMemoryTypes</b> ).
bDataReliability	• 00h Disabled (default)	Specifies device behavior when a power failure
	• 01h Enable	occurs while writing to the LUN.
bLogicalBlockSize	• C (default)	Specifies the logical block size.
dNumAllocUnits	• 0 (default)	Specifies the size of the LUN.
bProvisioningType	• 00h Disabled (default)	Specifies if thin provisioning is enabled.
	• 01h Enabled and TPRZ=0	
	• 02h Enabled and TPRZ=1	

### Appendix E: Sample UFS Job with Default Settings

The following table shows the default UFS settings applied to a UFS job/device in LumenX Data Management Software (DMS). At a minimum, you only need to 1) load the intended data/image file(s) to program into the device and 2) set the LUN size/capacity with **dNumAllocUnits**.

Level	Setting	Options
Job	Job Process Selection	Program and Verify
	Erase Selection	Full Chip Erase
Device	Descriptor: <b>bBootEnable</b>	• 00h Disabled
	Descriptor: blnitPowerMode	01h Active Mode
	Descriptor: bHighPriorityLUN	• 7F (all LUNs equally prioritized)
	Descriptor: bDescrAccessEn	O0h Disabled
	Descriptor: bSecureRemovalType	O0h Erase
	Descriptor: blnitActivelCCLevel	• 0
	Descriptor: <b>bPeriodicRTCUpdate[8:6]</b> TIME_UNIT	Ob Undefined
	Descriptor: <b>bPeriodicRTCUpdate[9]</b> TIME_BASELINE	Ob Undefined
	Descriptor: <b>bPeriodicRTCUpdate[5:0]</b> TIME_PERIOD	Ob Undefined
	Attribute: <b>bBootLunEn</b>	O0h Boot disabled
	Attribute: bOutOfOrderDataEn	O0h Disabled
	Attribute: bConfigDescrLock	Oh Disabled
	Attribute: <b>bMaxDataInSize</b>	• 8
	Attribute: bMaxDataOutSize	• 8
	Attribute: bMaxNumOfRTT	• 2
	Attribute: <b>bRefClkFreq</b>	• 0x01h - 26 MHz
	Attribute: bPermanentWPEn	00h Disabled
	Attribute: bPermanentlyDisableFwUpdate	Ob Disabled
LUN	bBootLunID	00h Not Bootable
	bLUWriteProtect	00h Not Write-Protected
	bMemoryType	00h Normal Memory
	bDataReliability	00h Disabled
	bLogicalBlockSize	• C
	dNumAllocUnits	• 0
	bProvisioningType	O0h Disabled

#### Appendix F: User Interface Legend



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