Data I/O

UFS Programming in LumenX

Getting Started Guide

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Revision History

Comments	Date	Author
Initial Release	May 20, 2018	Andrew Wygle
Noted to reduce socket actuator air pressure and close AH before changing adapters (Rev 002A)	March 15, 2019	Carl Olson
Noted not to use 1 or 3 boards	July 17, 2019	Carl Olson

Chapter 1: Introduction

This document provides instructions for programming a Universal Flash Storage (UFS) device using Lumen[™]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.

1 Excessive Socket Actuator Air Pressure

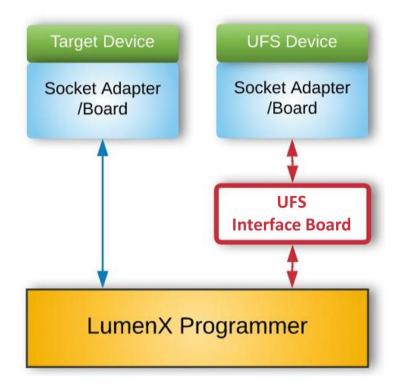
For automated systems (ex. PSV7000), adjust the socket actuator air pressure down to prolong parts longevity (one LumenX programmer supports 8 LumenX sockets but only 4 UFS sockets).

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. [PSV7000 Only] If it is running, close AH software on the Host PC.
- 2. Open the socket clamp on top of the programmer.



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



4. 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.

5. 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.

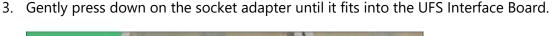
Do NOT use 1 or 3 boards because doing so introduces an imbalance in the mechanical loading of the socket actuator (resulting in compromised socket longevity).

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 <u>PIN1</u> 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.





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 or 256GB cache memory.

For PSV7000 systems, always close AH software before changing UFS adapters. Else, you may need to restart LumenX DMS and/or the LumenX programmer(s).

Chapter 3: Configure the Software

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

- LumenX Data Management Software (DMS) update
- LumenX programmer firmware 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)

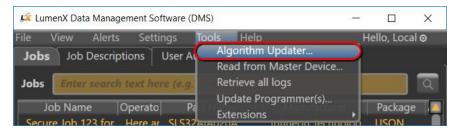
- 1. Download and run the LumenX_DataManagementSoftware.exe file.
- 2. In the LumenX Setup Wizard, follow the prompts to complete the version update.



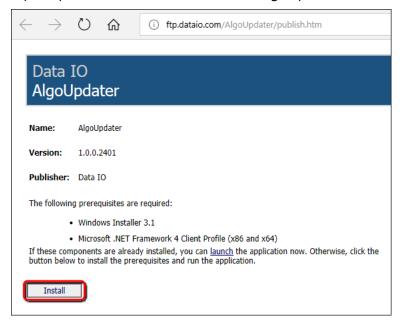
The latest version of LumenX Data Management Software (DMS) is always available for download at <u>http://www.dataio.com/Technology/</u> LumenX/LumenX-Release

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**.

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<u>F</u> ile View <u>W</u> indow <u>H</u> elp				
Local Algorithms	Remo	te Algorithms		
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Manufactur Part Nam Packag Versio Statu Keyword Strin Nam		Manufactur	Part Name	Package 🚺
	\checkmark	Micron	MTFC32GAKAEJP-AIT	VFBGA153
		Micron	MTFC64GAPALBH-AAT ES	TFBGA153
		Micron	MTFC128GAPALNS-AAT ES	TFBGA153
		Toshiba	THGBMHG9C8LBAW8	TFBGA153
		SanDisk	SDINBDA4-64G	TFBGA153
		SanDisk	SDINBDA4-32G	TFBGA153
		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

1	140° 1 11 1			_	_		-		×	
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Enter sear	ch text here (e.g. Intel	BGA)			Em	ter search tex	t here (e.g. Intel BGA)			
Manufactur	Part Name	Package	Versio	Sta 🔺	~	Manufactur	Part Name	Package	Ţ	
Micron	MTFC32GAKAEJP-AIT	VFBGA153	9.3.0	Rele		Micron	MTFC32GAKAEJP-AIT	VFBGA15	3	
Micron	MTFC64GAPALBH-AA	TFBGA153	9.3.0	Rele		Micron	MTFC64GAPALBH-AAT ES	TFBGA15	3	
Micron	MTFC128GAPALNS-A	TFBGA153	9.3.0	Rele	V	Micron	MTFC128GAPALNS-AAT ES	TFBGA15	3	
Toshiba	THGBMHG9C8LBAW8	TFBGA153	9.4.0	Rele	~	Toshiba	THGBMHG9C8LBAW8	TFBGA15	3	
Toshiba Toshiba	THGBMHG9C8LBAU8	TFBGA153 TFBGA153	9.4.0 9.4.0	Rele Rele	Ţ.	SanDisk	SDINBDA4-64G	TFBGA15		
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SanDisk	SDINBDA4-84G	TFBGA153	9.3.0	Rele						
Micron	MTFC16GAKAEJP-AIT	VFBGA153	9.3.0	Rele		Micron	MTFC16GAKAEJP-AIT	VFBGA15		
Micron	MTFC128GAJAECE-5N		9.3.0	Rele		Micron	MTFC128GAJAECE-5M AIT	LFBGA16	9	
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							Update List			
	Download Selected									
Algorithm li	Algorithm list updated using directory: C:\LumenX\Algorithms									

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

Data j 🛛

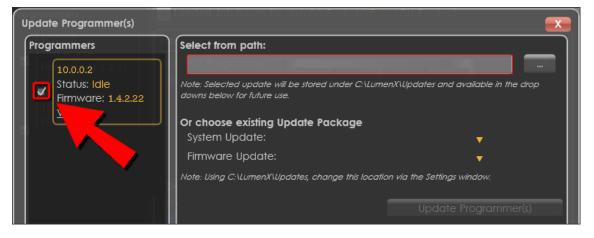
Updating the Programmer Firmware

This example shows updating to version 1.5.1, but you should update to the latest version.

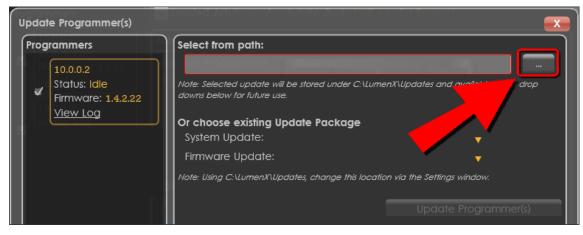
1. From the **Tools** menu at the top, select **Update Programmer(s)**.

🗯 LumenX Data Management Software (D	DMS)			- 🗆 ×
File View Alerts Settings	Tools Help			Hello, Local 🛛
Jobs User Authentication	Algorithm Updater Read from Master Device			
Jobs Enter search text here (e.g.				<u>व</u>
Job Name	Update Programmer(s) Extensions	Notes	Part Name	Manufacturer F
Secure Job 123 for Infineon Optiga	Tust-E Here are some optional no	otes for the Operator(s)	SLS32AIA020A	Infineon Technolog. l
TapeLabelTest0	Ensure that Host PC sees t	he Label Printer first	KLMAG1JETD-B041	Samsung F

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



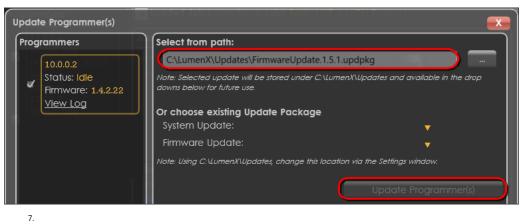
3. To the right of the **Select from path** box, click the ellipsis (...) button to Browse for an update package to apply.



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)**.

Update Progran	Update Programmer(s)										
Programmers	Select from	Select from path:									
10.0.2	4.2.22 C:\Lumer	enX\Updates\SystemUpdate.1.5.1.updpkg									
	: 1.4.2.22 downs below	Note: Selected update will be stored under C:\LumenX\Updates and available in the drop downs below for future use.									
View Loc	Grichoose System U	e existing Update Package Update:									
	Firmware	re Update:									
	Note: Using C	Note: Using C:\LumenX\Updates, change this location 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)	Loaded Job (open for details), basic NX	
Programmers	Select from path:	
TI0.0.0.21 4.2.22	nX Programmer.	
✓ Status: Idle Firmware: 1.5.1 View Log	Note: Selected update will be stored under CA downs below for future use.	LumenX\Updates and available in the drop
status idia	Pr choose existing Update Package	
	System Update:	▼
	ware Update:	•
	Note: Ung C:\LumenX\Updates, change this lo	ocation 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.

<u> "</u>	🎉 LumenX Data Management Software (DMS)										-		×		
File	View	Alerts	Settings	Tools	Help								He	llo, Loc	al ⊚
CR	EATE JOB:	Samsu	ng Generic Ul	FS 2.0 Alg	orithm TFBGA1	53									
,	ob Name				r Partner 26										
C	Description														
c	Dperator N	otes													
ſ	101010	🔶 Pro	ocess:				_					_			<u>ה</u>
1			Name		Value										
	JOB	Job P	rocess Selecti	on: Prog	gramming and	Verify 🔻	.								
L		Erase	Selection:	Full	chip Erase						_	_		_	

Configuring Device Settings

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

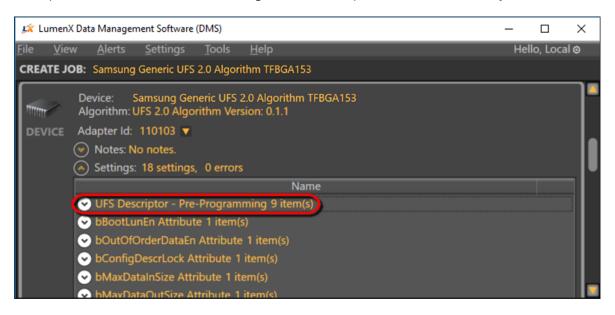
<u>J</u>	LumenX Da	ta Ma	anagement Software ([DMS)					_		×
File	View		erts Settings	Tools Help					Hel	lo, Local	0
CRE	EATE JOB:	Sar	msung Generic UFS	2.0 Algorithm T	FBGA153						
Jo	b Name		Partner 26 UFS Job) XYZ							
D	escription		This is ufs job xyz	run 4 for Partne							
0	perator No	otes	No need to re-tea	ch pkg; Test tray	feeder and f	tape-out before s	starting run				╟
	101010 ЈОВ	lines.	Process: Name ob Process Selection rase Selection:			•					
		dapt	e: Samsung Gen thm: LUN 0 to 7 Ver er Id: 110103 ▼ ttes: No notes.	eric UFS 2.0 Algo rsion: 0.0.0	orithm TFBG/	A153					Ĩ.
	(go ba	ıck t	XY: Edit job, then o job list to run t nd test a job:	. <i>Save</i> job to v he new or cha	validate it a unged job).	nd save it to d	isk •	H Back	Sa	📂 ve as Jo	b

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**.

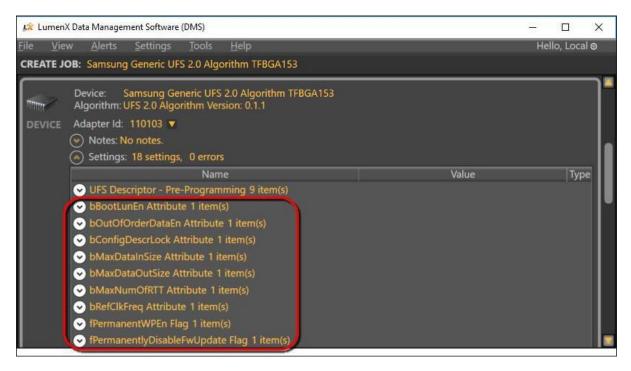


4. Configure the UFS Descriptors as desired.

🍂 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**.

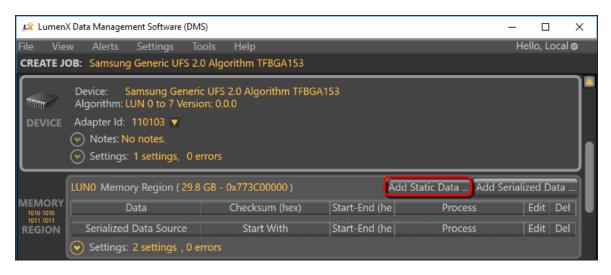
5. To set the UFS Device Attributes, expand the desired attribute and set appropriately.



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

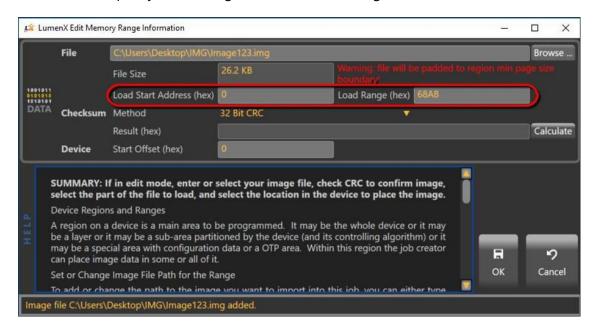
1. In the **Memory Region** section, click **Add Static Data** for the specific Logical Unit Number (LUN) to program (ex. LUN 0). The number of LUNs is dependent on the specific device.



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

JX L	ume	enX Edit Memo	ry Range Information			2. 		×
Г		File					Brow	/se
			File Size]			
1001 0101 1010	011		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 i U O	onfirm imagene 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. Is and Ranges a device is a main area t 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	R OK	Can	

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).

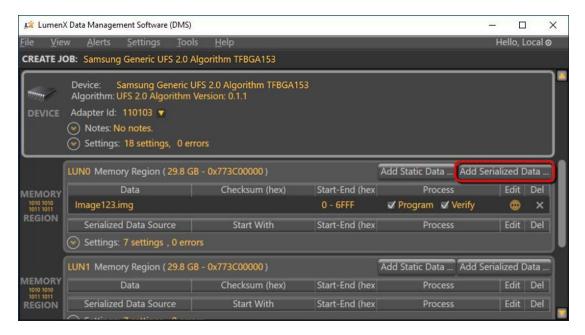
4. (Optional) To validate programmed data at the file level (checksum compare), select the desired **Checksum Method**, and then click **Calculate**.

Jak Lu	umenX Edit Memo	ory Range Information			_	
\square	File	C:\Users\Desktop\IMG\In	nage123.img			Browse
		File Size	26.2 KB			
19010 01010 10101		Load Start Address (hex)	0	Load Range (hex) 7000		
DAT						
		Result (hex)	D133E9289B9B	39636FC4EB69C27A5BC33A3FF7F0CAC485C	F73572D9852;	Calculate
	Device	Start Offset (hex)	0			
HELP	select the pa Device Region A region on a be a layer or i may be a spe can place ima Set or Change To add or char	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 ige 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 dev n data or a OTP a ange	the file, check CRC to confirm image, ion in the device to place the image. It may be the whole device or it may ice (and its controlling algorithm) or it rea. Within this region the job creator	н ок	9 Cancel
CRC	calculation fini	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	1	Browse
		File Size	26.2 KB		
1001011 0101010 1010101		Load Start Address (hex)	0	Load Range (hex) 7000	
DATA	Checksum	Method	SHA256	· · · · · · · · · · · · · · · · · · ·	
		Result (hex)	D133E9289B9B8	9636FC4EB69C27A5BC33A3FF7F0CAC485CF73572D98522	Calculate
	Device	Start Offset (hex)	0		
	 The file a The start to have t The load 	his range start at a differe range or range of the file Enter a different size if de	vill default as the fault to 0 or the sint nt location in this to be programme sired.	image file is loaded. tart of the file. Enter a different offset	9 Cancel

- 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.



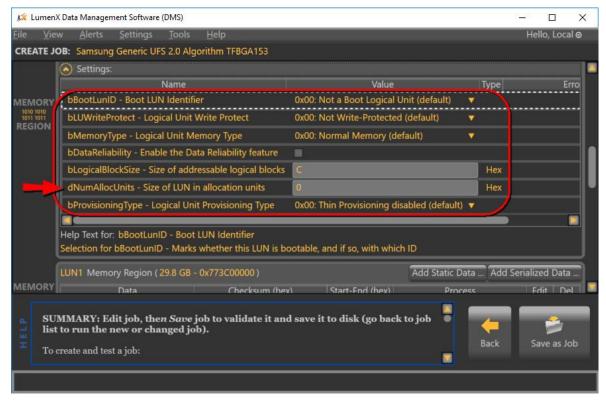
8. In the **LumenX Edit Serial Data Information** dialog box, complete the desired fields, and then click **OK**.



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

🛵 Lumen	X Data Management Software (DMS))			- 0) ×	
<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	Device: Samsung Generic Algorithm: UFS 2.0 Algorithm Adapter Id: 110103 ♥ (♥) Notes: No notes. (♥) Settings: 18 settings, 0 e						
	LUN0 Memory Region (29.8 C	GB - 0x773C00000)		Add Static Data Add S	Serialized	Data	1
	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	
- 11 BANDI	Incrementing counter		0 - 7	🗸 Program 🗹 Verify		×	U
	Settings: 7 settings , 0 err	ors					
	LUN1 Memory Region (29.8 C	Add Static Data Add S	Serialized	Data			
MEMORY 1010 1010	Data	Checksum (hex)	Start-End (hex	Process	Edit	Del	
1011 1011	Cardalina d Data Calvara	Car at 18 Cale	Charles Frend Harris	Da	te	Dell	V

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**.

Note: At this point (before starting the job run), double-check that the air pressure for socket actuators is reduced to approximately 0.3 to 0.4 Megapascals (MPa). Else, excessive socket actuator air pressure can compromise parts longevity (because one LumenX programmer supports 8 LumenX sockets but only 4 UFS sockets).



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 4th. 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>3,000,000,000</u>
2.	In the specifications for your device, calculate the CapacityAdjFactor 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 bAllocationUnitSize and dSegmentSize values, then convert them from hexadecimal to decimal.	bAllocationUnitSize= <u>1</u> dSegmentSize= <u>8192</u>
4.	Using the formula above for calculating dNumAllocUnits , 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 dNumAllocUnits 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		X			
Programmers	Directories]			
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				
Discover	Presenter Mode Desktop Mode				

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

🗾 LumenX Data Management Software (DMS)					
<u>File V</u> iew <u>A</u> lerts <u>S</u> ettings <u>T</u> ools <u>H</u> elp	Hello, Local 🛛				
Programmers O Loaded Job (open for details): Partner 26 UFS Job	ХҮХ				
10.0.2 Status: Idle Firmware: 1.5.1					
SUMMARY: Select programmer(s), run job. INSERT DEVICES BEFORE RUNNING. To run a iob: Change Programmer selections if desired, load devices and click Run Job buttor	Back Run				

- 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	SUMMARY: Select p INSERT DEVICES B To run a iob:	rogrammer(s), run job. EFORE RUNNING.	c Run
Ru	nning Job		

When you run a specific algorithm 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 programmer takes approximately one minute (the yellow LED remains lit) to complete the bitstream update.

Chapter 5: Verify Job Completion

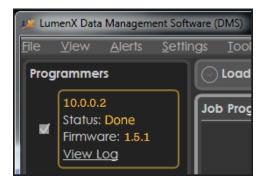
This Chapter provides instructions to verify that the job completed, specifically:

- 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 Management So	ftware (DMS)				-		х
<u>F</u> ile	<u>V</u> iew <u>A</u> lerts <u>S</u> ett	ings <u>T</u> ools	<u>H</u> elp			Hel	llo, Local (0
Pro	grammers	오 Loaded J	ob (open for	details): Partner 26	UFS Job XYZ			
	10.0.0.2 Status: Idle	Job Progress	5					ור
	Firmware: 1.5.1 <u>View Log</u>	LumenX Pro 10.0.0.2	grammer:	DUT 1	DUT 2	1	Status: Done	
				IDLE	IDLE			
				DUT 3 PASS	DUT 4 IDLE			
			0 B Duratio	on: ssed: 1.0 MB Duratic	10	_		
		Programm	ing: Proces	Job Comp				
				Operations: 0.3 s ket Operations				
s	elect All Deselect All			eed: 17.7 MB/s Dura				
		Veri	fy> Speed	: 66.3 MB/s Duration	n: 0.1 s Status: Co	omplete		
	SUMMARY: Select p				•	+	010101	
	INSERT DEVICES B					Back	Run	
Job	completed.							

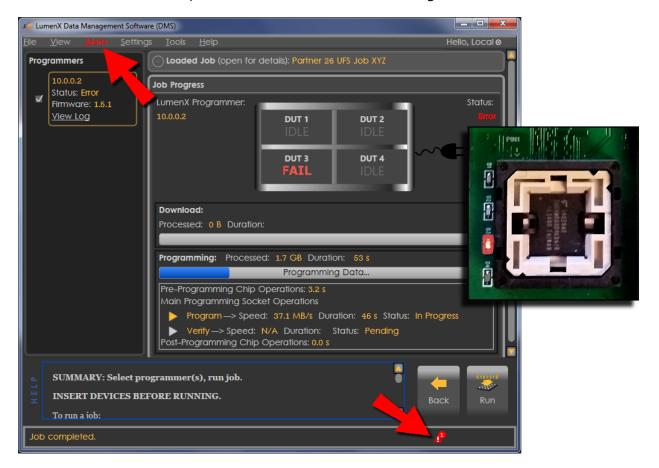
Checking Socket Adapter LEDs

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 JOB	0101010 Process: Name Value						
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	Program and Verify (default)Verify Only	Specifies the programming operation(s) to perform on the device.
Erase Selection	DisabledFull Chip Erase (default)	Specifies if Full Chip Erase is enabled.

Appendix B: Device Settings, UFS Configuration Descriptors

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

ا 🍂	LumenX Dat	a Managen	nent Software	(DMS)					_		×	<
<u>F</u> ile	<u>V</u> iew	<u>A</u> lerts	<u>S</u> ettings	Tools	<u>H</u> elp				He	llo, Loca	l⊚	
CRE	ATE JOB:	Samsung	g Generic UF	S 2.0 Algo	orithm TFBG	GA153						
	•	UFS Des	criptor - Pre-	-Program	ming 9 iten	n(s)						
		bBootE	nable - Enab	le the Bo	ot feature							
	1	bInitPov	werMode - II	nitial Pow	er Mode		0)	x01: Active	Mode (de	fault)		
		bHighP	riorityLUN -	High Prio	rity Logical	Unit	7					
		bDescr/	AccessEn - Ei	nable acc	ess to the D	evice Descripto	r after 🛛 🗖	l				U
		bSecure	eRemovalTyp	e - Secur	e Removal ⁻	Туре	0)	x00: Erase o	of physical	memory	у	
		blnitAct	tivelCCLevel	- Initial A	ctive ICC Le	vel	0					
		wPeriod	dicRTCUpdat	e[8:6] - TI	ME_UNIT		0					
		wPeriod	dicRTCUpdat	e[9] - TIM	IE_BASELINI	E	0					
		wPeriod	dicRTCUpdat	e[5:0] - TI	ME_PERIOD)	0					
		L.C.										

Setting	Available Options	Description
bBootEnable	O0h Disabled (default)	Specifies if the device is bootable.
blnitPowerMode	00h UFS-Sleep Mode01h Active Mode (default)	Specifies the initial power mode.
bHighPriorityLUN	 7Fh (default) 0 to <i>n</i>, where <i>n</i> = # of LUNs specified by bMaxNumberLU 	Specifies which LUN has the command queue with the highest priority. Default value 7F means equal priority across all LUNs.
bDescrAccessEn	00h Disabled (default)01h Enable	Specifies if Device Descriptors are accessible after initialization.
bSecureRemovalType	 00h Erase (default) 01h Overwrite once, then erase 02h Overwrite thrice, then erase 03h Remove by vendor method 	Specifies the method by which information is removed.
blnitActivelCCLevel	0 (default)00h to 0Fh	Specifies the bActivelCCLevel after power on or reset.
wPeriodicRTCUpdate[8:6]	Ob Undefined (default)	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)		1275		×
File	<u>V</u> iew <u>A</u> lerts <u>S</u> ettings <u>T</u> ools <u>H</u> elp		Hello	o, Loca	l o
CRE	EATE JOB: Samsung Generic UFS 2.0 Algorithm TFBGA153				
ſ	Settings: 18 settings, 0 errors				
	Name	Value		Тур	e
	UFS Descriptor - Pre-Programming 9 item(s)				
	📀 bBootLunEn Attribute 1 item(s)				II.
	😔 bOutOfOrderDataEn Attribute 1 item(s)				ш.
	SconfigDescrLock Attribute 1 item(s)				ш.
	Some service state of the service of				ш.
	Solution Size Attribute 1 item(s)				ш.
	Solution bound the second seco				ш.
	SefClkFreq Attribute 1 item(s)				Ш.,
	✓ fPermanentWPEn Flag 1 item(s)				ш.
	PermanentlyDisableFwUpdate Flag 1 item(s)				

Setting	Available Options	Description		
bBootLunEn	O0h Boot disabled (default)	Specifies if a particular LUN is active during boot.		
bOutOfOrderDateEn	00h Disabled (default)01h Enabled	Specifies if out of order sequencing is enabled.		
bConfigDescrLock	Oh Disabled (default)1h Enabled	Specifies if device configuration (Configuration Descriptor) is locked.		
bMaxDataInSize	 0 to n, where n = bMaxInBufferSize 	Specifies the maximum size of data in (number of 512-byte units).		
bMaxDataOutSize	 0 to n, where n = bMaxOutBufferSize 	Specifies the maximum size of data out (number of 512-byte units).		
bMaxNumOfRTT	 0 to n, where n = bDeviceRTTCap 	Specifies the maximum number of outstanding RTTs allowed.		
bRefClkFreq	 0x00h – 19.2 MHz 0x01h – 26 MHz (default) 0x02h – 38.4 MHz 0x03h – 52 MHz Others: Reserved 	Specifies the reference clock frequency.		
fPermanentWPEn	00h Disabled (default)01h Enabled	Specifies if permanent write protection is enabled.		
fPermanentlyDisableFwUpdate	 0b Disabled (default) 1b Enabled	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 1010 1010 1011 1011 REGION	bLUWriteProtect - Logical Unit Write Protect		0x00: Not Write-Protected (default)			•	▼		
	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 U	nit Provisioning Type	0x0): Thin Provisioni	ng disabled (defaul	t) 🔻			

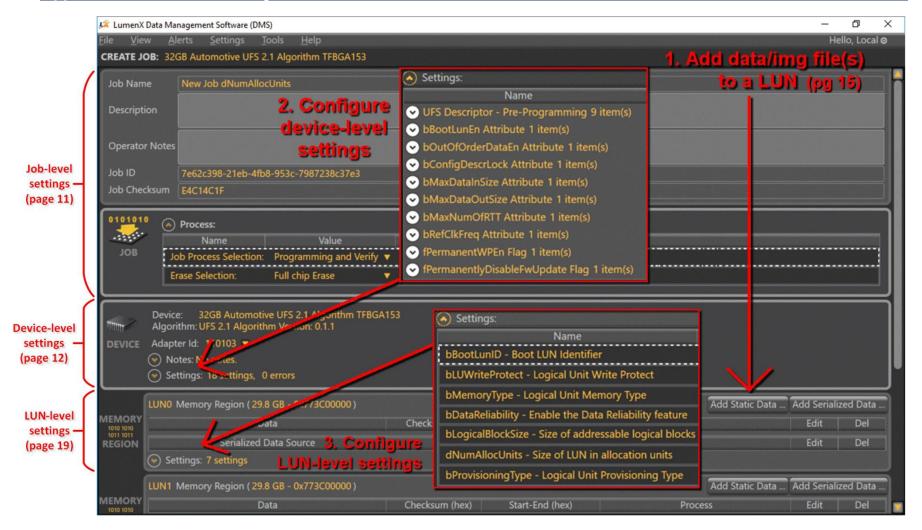
Setting	Available Options	Description
bBootLunID	• 00h Not Bootable (default)	Specifies if a particular LUN is bootable.
	• 01h Boot LUN A	
	O2h Boot LUN B	
bLUWriteProtect	00h Not Write-Protected	Specifies if the LUN is write-protected.
bMemoryType	00h Normal Memory	Specifies a particular memory type (as supported by wSupportedMemoryTypes).
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: bBootEnable	O0h 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: bPeriodicRTCUpdate[8:6] TIME_UNIT	Ob Undefined					
	Descriptor: bPeriodicRTCUpdate[9] TIME_BASELINE	Ob Undefined					
	Descriptor: bPeriodicRTCUpdate[5:0] TIME_PERIOD	Ob Undefined					
	Attribute: bBootLunEn	O0h Boot disabled					
	Attribute: bOutOfOrderDataEn	O0h Disabled					
	Attribute: bConfigDescrLock	Oh Disabled					
	Attribute: bMaxDataInSize	• 8					
	Attribute: bMaxDataOutSize	• 8					
	Attribute: bMaxNumOfRTT	• 2					
	Attribute: bRefClkFreq	• 0x01h - 26 MHz					
	Attribute: bPermanentWPEn	00h Disabled					
	Attribute: bPermanentlyDisableFwUpdate	Ob Disabled					
LUN	bBootLunID	O0h Not Bootable					
	bLUWriteProtect	O0h Not Write-Protected					
	bMemoryType	O0h Normal Memory					
	bDataReliability	O0h Disabled					
	bLogicalBlockSize	• C					
	dNumAllocUnits	• 0					
	bProvisioningType	O0h Disabled					

Appendix F: User Interface Legend



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