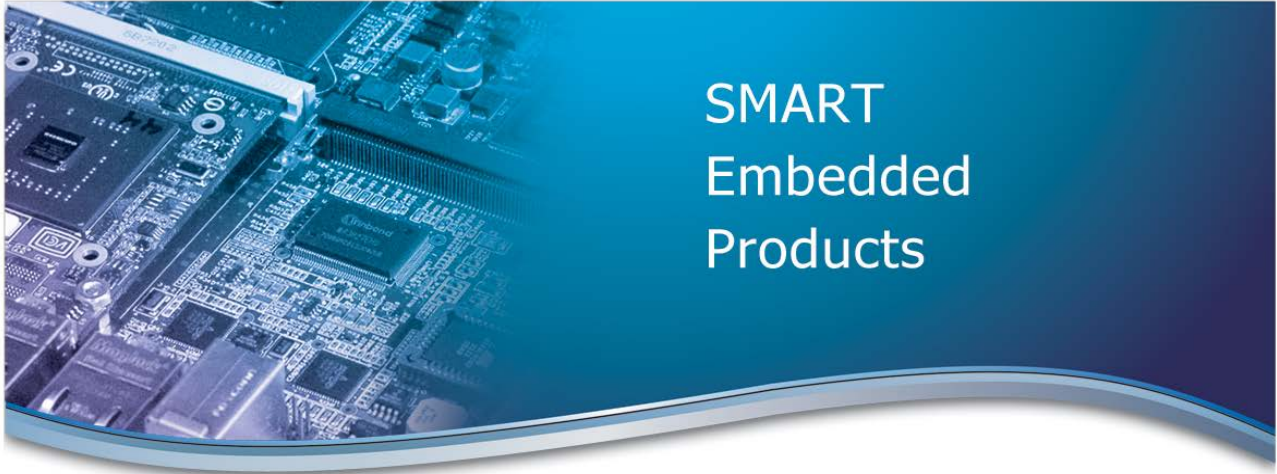


# Product Specification



SMART  
Embedded  
Products

**SMART MODULAR  
eUSB  
SSEUx2xxxxGQxBx**

*December 2015  
DSeU245-AB*



[www.smartm.com](http://www.smartm.com)

# REVISION HISTORY

Date	Revision	Section(s)	Description
October 2015	A	All	Initial release
December 2015	AB	1.1, 1.2, 2.1 2.3	Read and write performance numbers Endurance specification



## ESD Caution – Handling

Static electricity may be discharged through this disk subsystem. In extreme cases, this may temporarily interrupt the operation or damage components. To prevent this, make sure you are working in an ESD-safe environment. For example, before handling the disk subsystem, touch a grounded device, such as a computer case, prior to handling.

## SMART Modular Technologies

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## 1. GENERAL DESCRIPTION

### 1.1. Overview

SMART's INDUSTRIAL GRADE eUSB Drive is a robust SLC flash based hard drive designed for use as the main boot and storage device for embedded systems. The small form factor, low power consumption and fast access time are important advantages a SMART eUSB Drive has over traditional hard drives. The drive uses a USB 2.0 High Speed serial link providing a simple two wire signaling interface to the host.

The SMART eUSB Drive is available in capacities ranging from 1 GB to 4 GB, Commercial or Industrial temperature, and 3.3V or 5V power. The drive is capable of sustained read speeds up to 35 MB/s and writes speeds up to 24 MB/s. The time to access a random location is typically less than 1 ms for the drive.

SMART has built its foundation by providing proven technology and quality products to the most demanding Fortune 100 OEMs. SMART engineers its products to perform at the highest degree of reliability & compatibility while backing these products with outstanding services and technology expertise.

### **About SMART**

*SMART is a leading independent manufacturer of memory and embedded modular sub-systems inclusive of board-level through system-level design, manufacturing, test, and fulfillment services. We offer more than 500 standard and custom products to leading OEMs in the computer, industrial, networking and telecommunications industries worldwide.*

## 1.2. Features

- Universal Serial Bus (USB) 2.0 Hi-Speed compatible
- 2-wire small form factor USB interface to host
- Industry standard header, or low profile stacking header for connecting to the host
- Read speed up to 35 MB/s and Write speed up to 24 MB/s
- BCH Error Correction Code - corrects up to 15 bit errors per 1 Kbyte sector
- Low power Dissipation- less than 1.00 W and less than 32 mW standby
- Dynamic and Static Wear Leveling
- Commercial Temp range 0° C to 70° C
- Industrial Temp range -40° C to 85° C
- Firmware upgradeable via USB bus
- Supports USB Mass Storage Class requirements for Bootability
- Write Protect options available
- Life Monitoring (Vendor Commands)
- Descriptors programmed into 256 Bytes of Attribute Memory
- Output signal can drive external LED

## 2. OPERATIONAL CHARACTERISTICS

All listed values are typical unless otherwise stated.

### 2.1. Performance

**Table 1: Performance Characteristics**

FLASH Manufacturer	eUSB Capacity	Performance <sup>(1)</sup> (MB/s)							
		Sequential 128K		Random 512K		Random 4K		Random 4K QD32	
		Read	Write	Read	Write	Read	Write	Read	Write
Spansion	1 GB	35	20	34	5	6	0.1	6	0.1
	2 GB	35	20	34	4	6	0.1	6	0.1
	4 GB	35	24	34	6	6	0.1	6	0.1

1. Test platform used: Intel Core i5-4590@ 3.3GHz, ASUS BM1AF Motherboard, Chipset: Intel B85

2. Test tool used: Crystal Disc Mark.

### 2.2. Power

**Table 2: Power Requirements (5 V)**

Parameter	Symbol	Minimum	Typical	Maximum	Units
Supply Voltage	V <sub>IN</sub>	4.5	5.0	5.5	V
Read Current		-	76	195	mA
Write Current		-	76	189	mA
Idle Current		-	30	55	mA
Suspend Current				5.9	mA

**Table 3: Power Requirements (3.3 V)**

Parameter	Symbol	Minimum	Typical	Maximum	Units
Supply Voltage	V <sub>IN</sub>	3.135	3.3	3.465	V
Read Current		-	112	246	mA
Write Current		-	108	246	mA
Idle Current		-	43	65	mA
Suspend Current				8.5	mA



### 2.3. Reliability

**Table 4: Reliability Characteristics**

Parameter	Value
Data Retention @ 25°C	10 years > 90% life remaining 1 years < 10% life remaining
Endurance (TBW)	40 (1GB); 80 (2GB); 160 (4GB)
Error Correction/Error Detection	Multi-bit correction supported for programmed NAND data.

Note: These TBW numbers are acquired by using persistent 128K SEQ Write pattern to test. The actual number will vary depending on test pattern.

### 2.4. Mean Time Between Failures (MTBF)

**Table 5: MTBF Value**

Drive	MTBF (Hours) @ 40°C
All Capacities	> 3,100,000

### 2.5. Environmental Conditions

**Table 6: Environmental Conditions and Test Conditions**

Parameter	Value
Shock	200 g, 2 msec, 1 shock along each axis, X, Y, and Z
Vibration	1.04g rms, 2 Hz to 200 Hz, 10 minutes each 3 axes
Operating Temperature - Commercial	0°C to 70°C
Operating Temperature - Industrial	-40°C to 85°C
Storage Temperature	-40°C to 85°C
Humidity	0% to 85%, non-condensing, relative humidity

## 2.6. Physical Characteristics

**Table 7: Physical Characteristics**

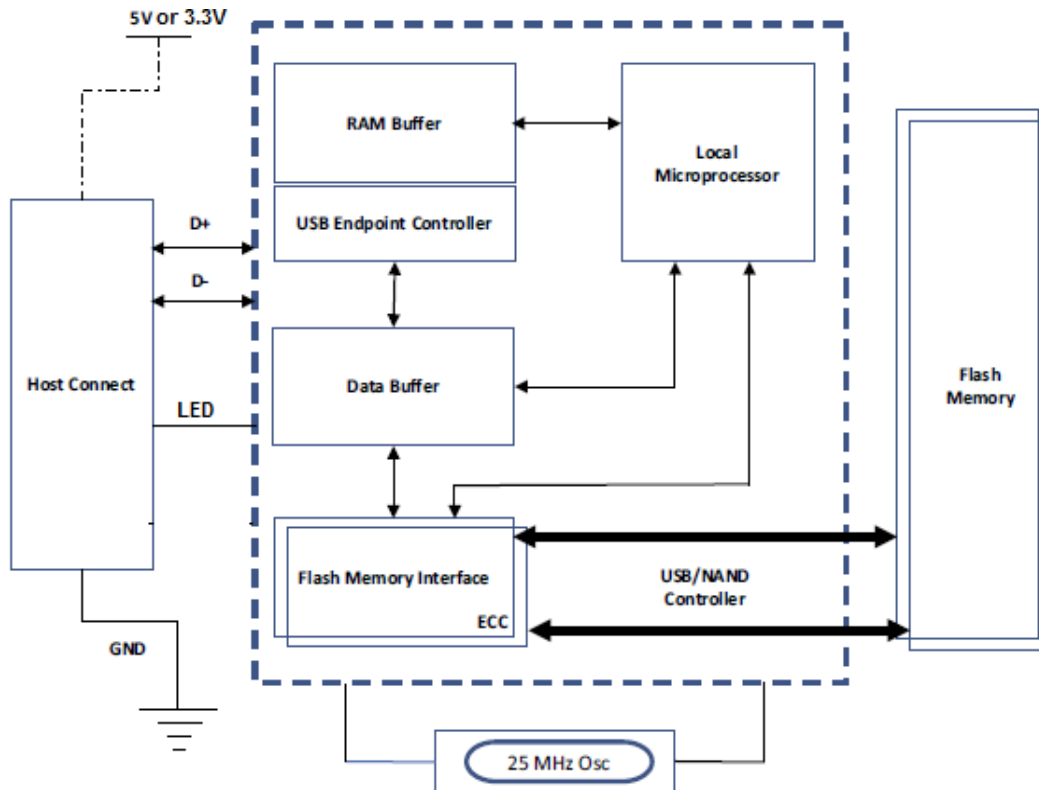
Parameter	Value
Length (L/U/M)	36.9 mm [1.45 in]
Width (L/U/M)	26.60 mm [1.05 in]
Thickness L (including connector)	11.97 mm [0.4713 in]
Thickness U (including connector)	9.84 mm [0.3874 in]
Thickness M (including connector)	6.03 mm [0. 2374 in]

### 3. PRODUCT DESCRIPTION

The SMART eUSB drive contains a USB/NAND controller and a flash memory device in a compact custom housing. The controller interfaces with a host system allowing data to be written to and read from the flash memory device.

#### 3.1. Functional Block Diagram

Figure 1: eUSB Block Diagram



### 4. REGULATORY COMPLIANCE

The SMART eUSB drive meets the following regulatory requirements for North America and the European Union:

- UL Recognized



## 5. MECHANICAL SPECIFICATION

### 5.1. Mechanical Dimensions

Figure 2: eUSB 5V L Connector Dimensions (in mm [inches])

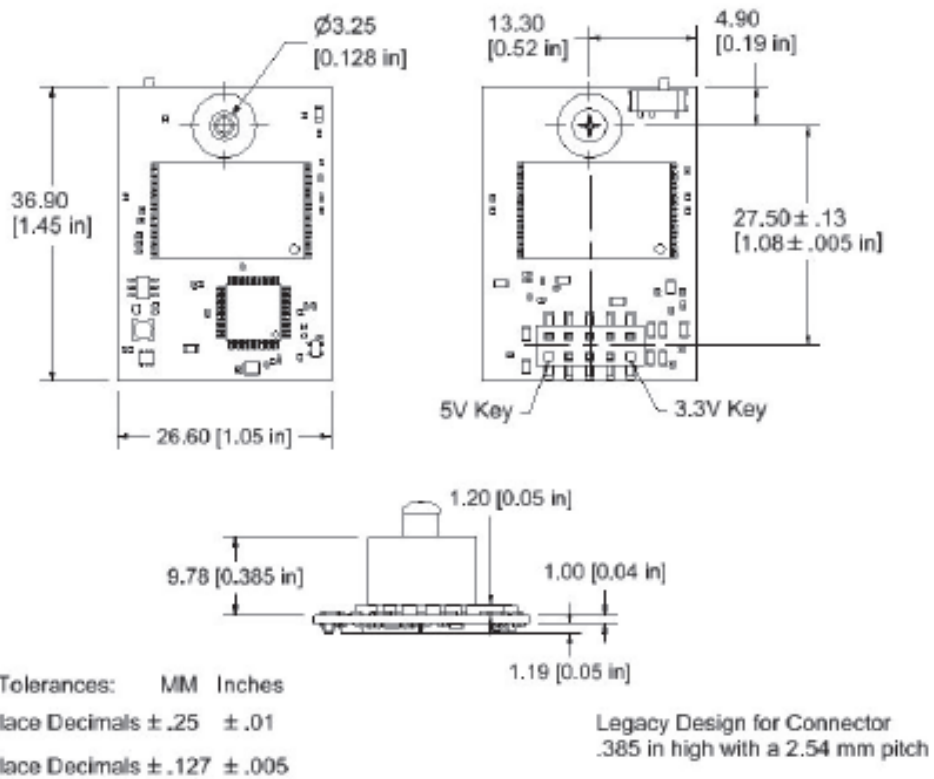


Figure 3: eUSB 3.3V or 5V U Connector Dimensions (in mm [inches])

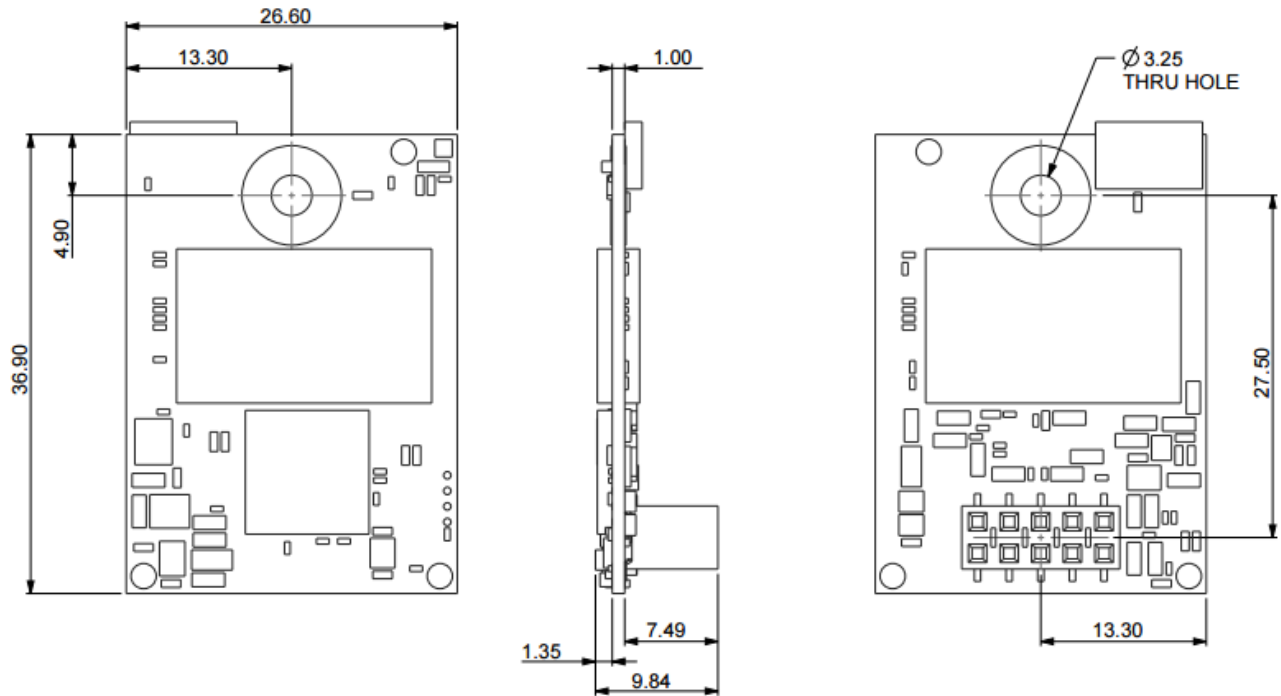
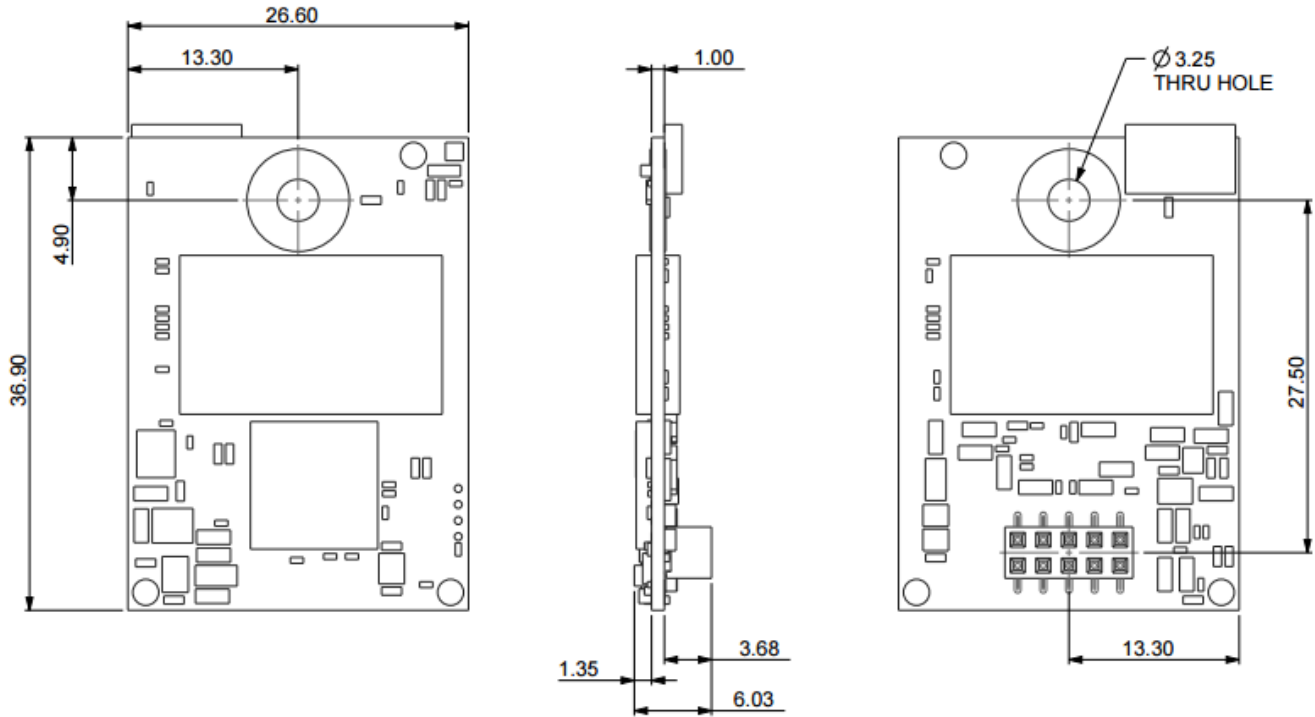


Figure 4: eUSB 3.3V or 5V M Connector (Legacy Design) Dimensions (in mm [inches])



## 6. ELECTRICAL SPECIFICATION

### 6.1. Electrical Interface

The eUSB drive is fully compliant with the USB 2.0 Standard.

**Table 8: Pinout Descriptions**

Pin	Signal Name	Signal Description
1	5V	5 V power (Not used if supply is 3.3V)
2	NC	No connect
3	D-	Data out -
4	NC	No connect
5	D+	Data in +
6	NC	No connect
7	GND	Ground
8	NC	No connect
9	3.3V	3.3 V power (Not used if supply is 5V)
10	LED	Activity LED

### 6.2. Absolute Maximum Ratings

**Table 9: Absolute Maximum Ratings<sup>1</sup>**

Symbol	Parameter	Minimum Value	Maximum Value	Unit
V <sub>CC</sub>	5V Supply Voltage	4.5	5.5	V
V <sub>CC</sub>	3.3V Supply Voltage	3.135	3.465	V
T <sub>A</sub>	Operating Temperature – (Commercial)	0	70	°C
T <sub>A</sub>	Operating Temperature – (Industrial)	-40	+85	°C
T <sub>STG</sub>	Storage Temperature	-40	+85	°C

1. Stress beyond the Absolute Maximum Rating conditions may result in permanent damage to the device. These are stress ratings only and functional operation should be restricted to those indicated in the operational sections of this specification. Exposure to conditions beyond recommended, up to and including the Absolute Maximum Rating conditions, for extended periods may affect device reliability.

### 6.3. Recommended Operating Conditions

**Table 10: Recommended Operating Conditions**

Symbol	Parameter	Minimum Value	Nominal Value	Maximum Value	Units
V <sub>CC</sub>	5V Supply Voltage	4.5	5	5.5	V
V <sub>CC</sub>	3.3V Supply Voltage	3.135	3.3	3.465	V
T <sub>A</sub>	Operating Temperature (Commercial)	0	room	+70	°C
T <sub>A</sub>	Operating Temperature (Industrial)	-40	room	+85	°C

### 6.4. Capacitance

**Table 11: Capacitance Characteristics<sup>1</sup>**

Symbol	Parameter	Ratings (Maximum)	Units
C <sub>IN</sub>	Input Capacitance	15	pF
C <sub>OUT</sub>	Input Capacitance	15	pF

1. T<sub>A</sub> = 0 to +70°C and f = 1.0 MHz, unless otherwise specified.

### 6.5. Input Leakage Current

**Table 12: Input Leakage Current Characteristics<sup>1</sup>**

Symbol	Parameter	Ratings (Minimum)	Ratings (Maximum)	Units	Condition
I <sub>L</sub>	Input Leakage Current		10	μA	V <sub>IN</sub> = V <sub>CC3I</sub> or 0

1. T<sub>A</sub> = 0 to +70°C and f = 1.0 MHz, unless otherwise specified.



## 6.6. DC Characteristics

**Table 13: DC Characteristics (3.3V)**

Symbol	Parameter	Minimum	Maximum	Units	Condition
VCC3IO	Power Supply	3.0	3.6	V	3.3 V I/O
C <sub>OUL</sub>	Output Capacitance	-	10	pF	Component Specification
I <sub>L</sub>	Input Leakage Current		10	μA	Component Specification
V <sub>IH</sub>	Input High Voltage	0.50*VCC3IO	0.65*VCC3IO	V	Component Specification
V <sub>IL</sub>	Input Low Voltage	0.35*VCC3IO	0.5*VCC3IO	V	Component Specification
V <sub>OH</sub>	Output High Voltage	VCC3IO-0.4	-	V	IOH = 2~16 mA
V <sub>OL</sub>	Output Low Voltage	-	0.4	V	IOL = 2~16 mA

## 7. STANDARD DESCRIPTOR

The eUSB drive supports the standard USB descriptors described below.

**Table 14: eUSB Descriptor**

Descriptor	The SMART eUSB Supports...
Device	One device descriptor
Configuration	One default configuration descriptor that supports the bulk-only data interface
Interface	The bulk-only data interface
Endpoint	The following endpoints: <ul style="list-style-type: none"> <li>• Control</li> <li>• Bulk-in</li> <li>• Bulk-out</li> </ul> The host uses the first reported bulk-in and bulk-out endpoints for the selected interface
String	A string field that contains the vendor name, product ID, and a unique serial number

### 7.1. Device Descriptor

The eUSB drive supports the one device descriptor described below.

**Table 15: Device Descriptor**

Offset	Field	Size	Value	Description
0	<i>bLength</i>	Byte	12h	Size of this descriptor, in bytes
1	<i>bDescriptorType</i>	Byte	01h	Device descriptor type
2	<i>bcdUSB</i>	Word	0210h	2 USB specification release number in binary coded decimal
4	<i>bDeviceClass</i>	Byte	00h	The class is specified in the interface descriptor
5	<i>bDeviceSubClass</i>	Byte	00h	The subclass is specified in the interface descriptor
6	<i>bDeviceProtocol</i>	Byte	00h	The device protocol is set to 00h in the interface descriptor
7	<i>bMaxPacketSize0</i>	Byte	40h	Maximum packet size for the zero endpoint. Valid values are: <ul style="list-style-type: none"> <li>• 8 (08h)</li> <li>• 16 (10h)</li> <li>• 32 (20h)</li> <li>• 64 (40h)</li> </ul>
8	<i>idVendor</i>	Word	0E39h	Vendor ID assigned by the USB-IF
10	<i>idProduct</i>	Word	2F00h	SMART Modular product ID
12	<i>bcdDevice</i>	Word	varies	FW encoding
14	<i>iManufactures</i>	Byte	01h	Index of a string descriptor describing the manufacturer
15	<i>iProduct</i>	Byte	02h	Index of a string descriptor describing this product

Offset	Field	Size	Value	Description
16	<i>iSerial Number</i>	Byte	03h	Index of a string descriptor for the device serial number
17	<i>bNumConfiguration</i>	Byte	01h	Number of possible configurations

## 7.2. Configuration Descriptor

The eUSB drive supports the one default configuration descriptor described below.

**Table 16: Configuration Descriptor**

Offset	Field	Size	Value	Description
0	<i>bLength</i>	Byte	09h	Size of this descriptor, n bytes
1	<i>bDescriptorType</i>	Byte	02h	Configuration descriptor type
2	<i>wTotalLength</i>	Word	0020h	Total length of data returned for this configuration. This includes combined length of all descriptors (configuration, interface, endpoint, and class-or vendor-specific) returned for this configuration
4	<i>bNumInterfaces</i>	Byte	01h	Number of interfaces supported by this configuration. The device supports the bulk-only data interface only
5	<i>bConfigurationValue</i>	Byte	01h	Value to use as an argument to the SetConfiguration() request to select this configuration
6	<i>iConfiguration</i>	Byte	00h	Index of a string descriptor describing this configuration
7	<i>bmAttributes</i>	Byte	80h	Configuration characteristics: <b>Bit Description</b> 7 Reserved (set to one) 6 Self-powered 5 Remote 4..0 Reserved (reset to zero) bit  7 is reserved and must be set to one. For a full description of the bmAttributes bitmap, refer to the USB 2.0 Standard
8	<i>maxPower</i>	Byte	96h	Maximum power consumption of the eUSB drive from the bus when the device is fully operational. This is expressed in 2 mA units. For example, 50 = 100mA

### 7.3. Interface Descriptor

The SMART eUSB drive supports the bulk-only data interface. The interface descriptor describes a specific interface within a configuration. A configuration provides one or more interfaces, each with zero or more unique endpoint descriptors.

**Table 17: Interface Descriptor**

Offset	Field	Size	Value	Description
0	<i>bLength</i>	Byte	09h	Size of this descriptor, in bytes
1	<i>bDescriptorType</i>	Byte	04h	Interface descriptor type
2	<i>bInterfaceNumber</i>	Byte	00h	Number of the interface. This is a zero-based value that identifies the index in the array of concurrent interfaces supported by this configuration
3	<i>bAlternateSetting</i>	Byte	00h	Value to select an alternate setting for the specified interface
4	<i>bNumEndpoints</i>	Byte	02h	Number of endpoints used by this interface (excluding endpoint zero)
5	<i>bInterfaceClass</i>	Byte	08h	Mass Storage Class
6	<i>bInterfaceSubClass</i>	Byte	06h	Subclass code assigned by the USB-IF that indicates which industry standard command block definition to use
7	<i>bInterfaceProtocol</i>	Byte	50h	Bulk-only transport. See the USB Mass Storage Overview Specification for more information
8	<i>iInterface</i>	Byte	00h	Index to a string descriptor describing this interface

## 7.4. Endpoint Descriptors

The SMART eUSB drive supports control, bulk-in, and bulk-out endpoints. The default control endpoint is 0 (zero) and it does not require a descriptor.

### 7.4.1. Bulk-in Endpoint

The bulk-in endpoint transfers data and status from the eUSB drive to the host.

**Table 18: Bulk-in Endpoint Descriptor**

Offset	Field	Size	Value	Description								
0	<i>bLength</i>	Byte	07h	Size of this descriptor, in bytes								
1	<i>bDescriptorType</i>	Byte	05h	Endpoints descriptor type								
2	<i>bEndpointAddress</i>	Byte	81h	The address of the endpoint on the USB device. The address is encoded as follows. <table border="0"> <tr> <td><b>Bit</b></td> <td><b>Description</b></td> </tr> <tr> <td>3..0</td> <td>The endpoint number</td> </tr> <tr> <td>6..4</td> <td>Reversed, set to 0</td> </tr> <tr> <td>7</td> <td>1 = In</td> </tr> </table>	<b>Bit</b>	<b>Description</b>	3..0	The endpoint number	6..4	Reversed, set to 0	7	1 = In
<b>Bit</b>	<b>Description</b>											
3..0	The endpoint number											
6..4	Reversed, set to 0											
7	1 = In											
3	<i>bAttributes</i>	Byte	02h	The bulk endpoints								
4	<i>wMaxPacketSize</i>	Word	0200h	Maximum packet size								
6	<i>bInterval</i>		FFh	Does not apply to bulk endpoints.								

### 7.4.2. Bulk-out Endpoint

The bulk-out endpoint transfers commands and data from the host to the eUSB drive.

**Table 19: Bulk-out Endpoint Descriptor**

Offset	Field	Size	Value	Description								
0	<i>bLength</i>	Byte	07h	Size of this descriptor, in bytes								
1	<i>bDescriptorType</i>	Byte	05h	Endpoints descriptor type								
2	<i>bEndpointAddress</i>	Byte	81h	The address of the endpoint on the USB device. The address is encoded as follows. <table border="0"> <tr> <td><b>Bit</b></td> <td><b>Description</b></td> </tr> <tr> <td>3..0</td> <td>The endpoint number</td> </tr> <tr> <td>6..4</td> <td>Reversed, set to 0</td> </tr> <tr> <td>7</td> <td>0 = Out</td> </tr> </table>	<b>Bit</b>	<b>Description</b>	3..0	The endpoint number	6..4	Reversed, set to 0	7	0 = Out
<b>Bit</b>	<b>Description</b>											
3..0	The endpoint number											
6..4	Reversed, set to 0											
7	0 = Out											
3	<i>bAttributes</i>	Byte	02h	The bulk endpoints								
4	<i>wMaxPacketSize</i>	Word	0200h	Maximum packet size								
6	<i>bInterval</i>		FFh	Does not apply to bulk endpoints.								

## 8. REDUCED BLOCK COMMANDS

This section describes the host interface commands supported by the USB memory controller. The SMART eUSB drive supports bulk and control transport modes. It does not support the Interrupt or isochronous transfer protocols.

### 8.1. Reduced Block Command Definitions

The following table defines the terms associated with the Reduced Block commands.

**Table 20: Reduced Block Command Definitions**

Term	Description
Bulk Only Interface	Communication method to store data requiring data integrity. This interface uses bulk endpoints
Command Block Wrapper (CBW)	A packet containing a command block and associated information
Command Status Wrapper (CSW)	A packet containing the status of a command block
Configuration Descriptor	A string of data that describes the functionality and operation of the device
Data-In	Indicates a transfer of data IN from the device to the host
Data-Out	Indicates a transfer of data OUT from the host to the device
Device Descriptor	A string of data that describes a USB device. Examples of data within this descriptor are Class, Subclass, Product ID, and Version
Device Request	Low level communication from the host to query the device using the control pipe
Endpoint	A unique address portion of a USB device that is the source of information in a communication flow between the host and device
Interface Descriptor	Binds a driver to a USB software interface. USB devices support one or multiple software interfaces
Processed	Data received and controlled internally by the device and not the host
Relevant	Amount of data sent to the host by the device
Reset Recovery	An error recovery procedure where the host prepares the device for further. command block wrappers (CBWs). This is performed below RBC level through a special low level control packet
Thin Diagonal	Cases where the host and device are in complete agreement about the data transfer
SPC-2	SCSI Primary Command-2

### 8.2. Reduced Block Command Descriptors

The Reduced Block Commands (RBC) - simplified versions of SCSI Block Commands - 2(SBC-2), along with the required SCSI Primary Commands - 2(SPC-2), fully specify the complete command set for RBC logical block devices.

**Table 21: Reduced Block Command Descriptors**

Command	OpCode	Command Support	SMART Supported	Revised Spec
FORMAT UNIT	04h	O	No	RBC
INQUIRY	12h	M	Yes	SPC-2
MODE SELECT (6)	15h	M	Yes	SPC-2
MODE SENSE (6)	1Ah	M	Yes	SPC-2
PERSISTENT RESERVE IN	5Eh	O	No	SPC-2
PERSISTENT RESERVE OUT	5Fh	O	No	SPC-2
PREVENT.ALLOW MEDIUM REMOVAL	1Eh	M	Yes	SPC-2
READ (10)	28h	M	Yes	RBC
READ CAPACITY	25h	M	Yes	RBC
RELEASE (6)	17h	O	No	SPC-2
REQUEST SENSE	03h	O	Yes	SPC-2
RESERVE (6)	16h	O	No	SPC-2
START STOP UNIT	1Bh	M	Yes	RBC
SYNCHRONIZE CACHE	35h	O	No	RBC
TEST UNIT READY	00h	M	Yes	SPC-2
VERIFY (10)	2Fh	M	Yes	RBC
WRITE (10)	2Ah	M	Yes	RBC
WRITE BUFFER	3Bh	O	No	SPC-2
MODE SENSE (10)	5Ah	B	Yes	USB-Boot

The CONTROL byte (last byte of CDB) is set to zero.

When a reduced block command is not supported, the eUSB drive returns STALL and waits for the host to send a Clear Feature command to reset the drive.

Command Support Key:

M = Mandatory

N/A = Not applicable

O = Optional

B = Bootability

## 9. PART NUMBERS

### 9.1. Part Numbering Information

**Table 22: Part Numbering Information (5V devices)**

Connector	Part Number	Capacity	Unformatted Capacity	Flash Manufacturer	Flash Density	Number of devices
U Connector (.290" Height)	SSEU52U001GQ4Bx	1 GB	993001472	Spansion	4 Gb	2
	SSEU52U002GQ9Bx	2 GB	2001731584		8 Gb	2
	SSEU52U004GQABx	4 GB	3964665856		16 Gb	2
M Connector (.144" Height)	SSEU52M001GQ4Bx	1 GB	993001472	Spansion	4 Gb	2
	SSEU52M002GQ9Bx	2 GB	2001731584		8 Gb	2
	SSEU52M004GQABx	4 GB	3964665856		16 Gb	2
L Connector (.385" Height)	SSEU52L001GQ4Bx	1 GB	993001472	Spansion	4 Gb	2
	SSEU52L002GQ9Bx	2 GB	2001731584		8 Gb	2
	SSEU52L004GQABx	4 GB	3964665856		16 Gb	2

X = C for Commercial Temperature grade; X = I for Industrial Temperature grade

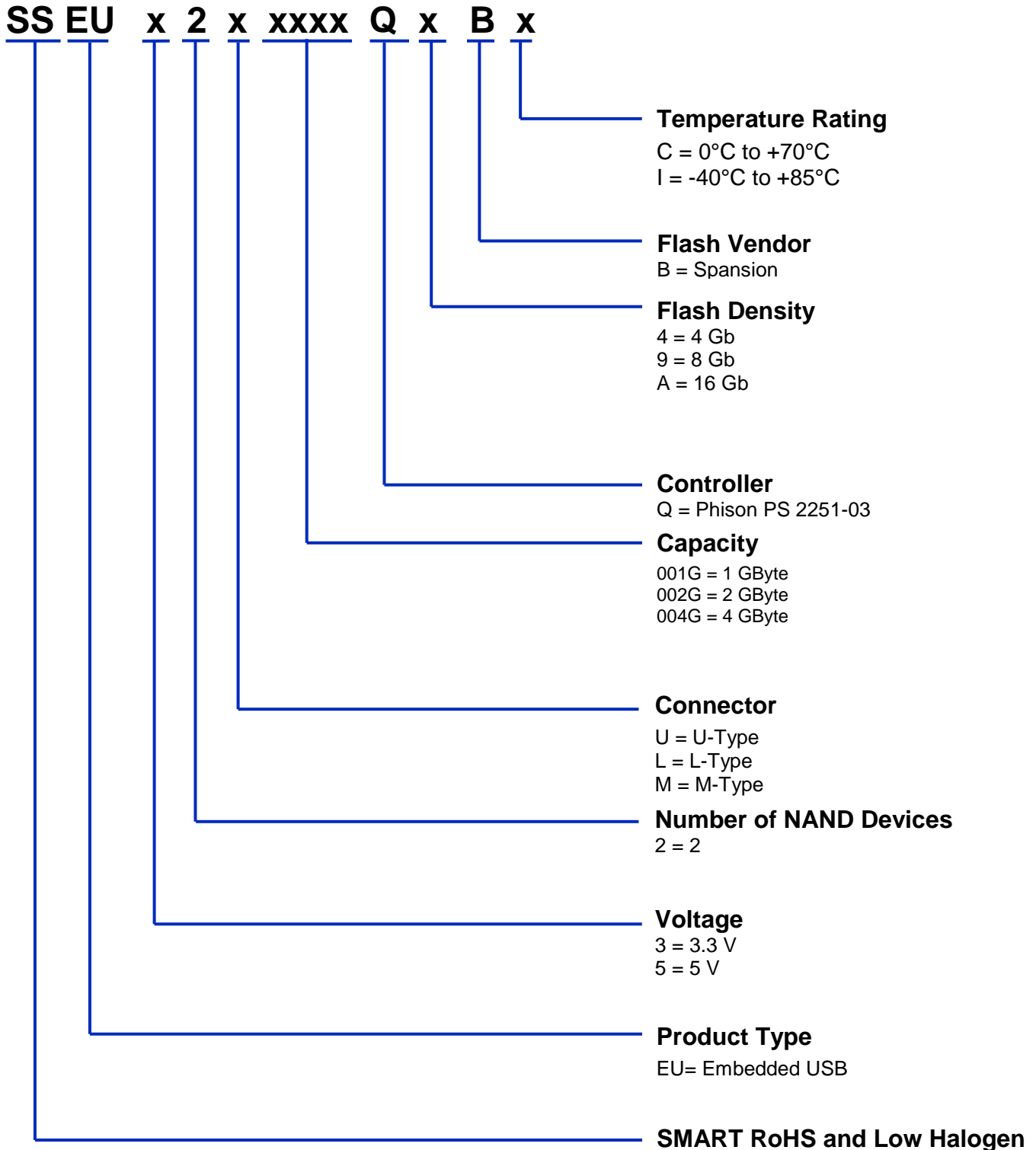
**Table 23: Part Numbering Information (3V devices)**

Connector	Part Number	Capacity	Unformatted Capacity	Flash Manufacturer	Flash Density	Number of devices
U Connector (.290" Height)	SSEU32U001GQ4Bx	1 GB	993001472	Spansion	4 Gb	2
	SSEU32U002GQ9Bx	2 GB	2001731584		8 Gb	2
	SSEU32U004GQABx	4 GB	3964665856		16 Gb	2
M Connector (.144" Height)	SSEU32M001GQ4Bx	1 GB	993001472	Spansion	4 Gb	2
	SSEU32M002GQ9Bx	2 GB	2001731584		8 Gb	2
	SSEU32M004GQABx	4 GB	3964665856		16 Gb	2

X = C for Commercial Temperature grade; X = I for Industrial Temperature grade



## 9.2. Part Number Decoder



## 10. DECLARATION OF CONFORMITY

Responsible Party Name: SMART Modular Technologies, Inc.  
Address: 39870 Eureka Drive  
Newark, CA 94560-4809, USA  
Phone: +1-510-623-1231

hereby declares that the products:

### **SHEUx2xxxxGQxBx**

to which this declaration relates are in conformity with the following Directives and other normative documents:

#### **RoHS Directive 2011/65/EU**

Restriction of the use of certain hazardous substances in electrical and electronic equipment

- **EN 50581:2012**

Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances

Name: Jeffrey Milano  
Title: Director, Worldwide Quality  
Date: December 7, 2015 9:49 AM

**Representative in the European Union (for regulatory topics only):**

Mr. Graham Kyle  
SMART Modular Technologies (Europe) Ltd.  
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East Kilbride, Scotland, G75 0QR

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