AirPrime EM75xx/EM74x1/ MC74x1

USB Driver Developer's Guide

SIERRA WIRELESS®

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Rev 2

Important Notice

Due to the nature of wireless communications, transmission and reception of data can never be guaranteed. Data may be delayed, corrupted (i.e., have errors) or be totally lost. Although significant delays or losses of data are rare when wireless devices such as the Sierra Wireless modem are used in a normal manner with a well-constructed network, the Sierra Wireless modem should not be used in situations where failure to transmit or receive data could result in damage of any kind to the user or any other party, including but not limited to personal injury, death, or loss of property. Sierra Wireless accepts no responsibility for damages of any kind resulting from delays or errors in data transmitted or received using the Sierra Wireless modem, or for failure of the Sierra Wireless modem to transmit or receive such data.

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Note: Some airlines may permit the use of cellular phones while the aircraft is on the ground and the door is open. Sierra Wireless modems may be used at this time.

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Revision History

Revision number	Release date	Changes
1	June 2019	Initial release
2	May 2021	Added EM74x1/MC74x1

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1: Introduction

Purpose of this Guide

This guide is intended for use when designing non-Windows drivers for AirPrime EM75xx/EM74x1/MC74x1 Series modules.

The guide describes the following information:

- Services (protocols) available over the USB connection
- Physical USB interface (device and endpoint descriptors)

2: USB Architecture

This chapter describes the EM75xx/EM74x1/MC74x1 Series module's driver architecture for data transfer, and its physical USB interfaces.

It is assumed that the developer has a good understanding of USB principles and architecture. For detailed information on USB specifications, refer to [3] Universal Serial Bus Class Definitions for Communication Devices, Version 1.1. This (and other resources) are available at www.usb.org.

USB Standards Compliance

AirPrime EM75xx/EM74x1/MC74x1 Series modules comply with USB 3.0 standards, including the following:

- Super-speed (5 Gb/s) data transfer
- Standard USB flow control
- Standard USB power management—Suspends the USB bus when idle, to conserve power.

For consistency across module types, Sierra Wireless modules employ a static Interface numbering strategy for enabled (concurrent) interfaces, which may leave gaps in the interface numbering.

USB Interfaces

The architecture used for AirPrime EM75xx/EM74x1/MC74x1 Series modules is derived from the Abstract Control Model (ACM) described in [3] Universal Serial Bus Class Definitions for Communication Devices, Version 1.1.

These modules do not claim any CDC classes in the descriptors, do not support functional descriptors, and therefore are not normally compatible with native CDC-ACM drivers.

Host drivers must distinguish Sierra Wireless modules by USB VID/PID and interface number.

Interface numbering

AirPrime EM75xx/EM74x1/MC74x1 Series modules may be configured to use one of the following configuration types:

- Legacy—Configuration type used by most Sierra Wireless modules.
- MBIM USBIF—Mobile Broadband Interface Model, used by EM75xx/EM74x1/MC74x1 modules.

Table 2-1 indicates the interface numbers assigned to each interface for both supported configuration types.

USB interfaces are numbered consistently across all Sierra Wireless module types that use the same configuration type. For example, regardless of which interfaces are supported and enabled:

- Legacy configuration type—NMEA is always interface 2 on Sierra Wireless modules using Legacy configuration.
- MBIM USBIF configuration type—NMEA is always interface 3 on Sierra Wireless modules using MBIM USBIF configuration.

Therefore, the host driver must separate services by the Interface Descriptor field bInterfaceNumber.

Table 2-1: Sierra Wireless EM75xx/EM74x1/MC74x1 USB Interface Support

Interface Name[a]	Interface Number[b]	
	Legacy[c]	MBIM USBIF
DIAG (DM)	0 (0x00)	4 (0x04)
NMEA	2 (0x02)	3 (0x03)
Modem	3 (0x03)	2 (0x02)
RMNET0	8 (0x08)	8 (0x08)
MBIM	12 (0x0C) 13 (0x0D)	0 (0x00) 1 (0x01)

a. For descriptions, see Supported Interfaces—Service Descriptions on page 10.
b. Interface numbers not listed are reserved for future use
c. Legacy format is used by WP and other modules.

Changing USB Interface Configuration

The USB interface configuration can be modified by enabling/disabling supported interfaces, using AT commands as described below, or using QMI commands.

Important: *Do not use !USBCOMP to change the module's configuration type (e.g. Legacy or MBIM_USBIF). Changing the type may make the module unusable. Use !USBCOMP only to enable/disable specific interfaces (e.g. NMEA, Modem, etc.).*

For example, to modify the current USB configuration using AT commands:

1. Establish a serial connection:
   - (Linux) # microcom /dev/ttyUSB*n* (where *n* is the enumerated AT port number)
   - (Windows) Use a terminal emulator to connect to the Sierra Wireless Modem port enumerated for the EM75xx/EM74x1/MC74x1 module.
2. Unlock access to required AT commands:

   AT!ENTERCND="A710"
3. Display the current USB composition:

   AT!USBCOMP?

Note: To display usage instructions including parameter details, use AT!USBCOMP=?

4. Set the desired configuration type and interfaces:
   AT!USBCOMP=<Config Index>,<Config Type>,<Interface bitmask>

Note: The <Interface bitmask> must enable either RMNET0 or MBIM (but not both). These are mutually exclusive interfaces.

Important: *The Legacy configuration type uses the Modem interface to enter AT commands. If the <Interface bitmask> does not enable the Modem interface:*

- *Windows host—The SetUSBComp tool can be used to re-enable the Modem interface when needed.*
- *Linux host—If the host does not have a tool similar to SetUSBComp to re-enable the Modem interface, AT commands will not be allowed.*

5. Reset the module to use the new configuration:
   AT!RESET

USB Endpoints

USB endpoints are uniquely addressable portions of a USB device used to transfer information between the host and module.

- Each defined endpoint is a unidirectional link from the modem to the host (Input) or from the host to the modem (Output).
- Maximum number of assignable endpoints—15 input, 15 output (Endpoint 0x00 (Input/Output) is reserved for USB Control.)
- Endpoint numbering—Inputs (0x81–0x8F); Outputs (0x01–0x0F)
- Endpoint numbers are assigned dynamically as the USB interfaces are enumerated, starting at 0x81/0x01, with the following exceptions:
  - RMNET0—Bulk output and input endpoints enumerate as 0x8E and 0x0F.
  - MBIM—Bulk output and input endpoints enumerate as 0x8E and 0x0F.

Note: The following figures and tables illustrate the architecture of an EM75xx/EM74x1/MC74x1 Series module with all supported interfaces enabled for each configuration type (Legacy and MBIM). Because endpoints are dynamically allocated, the endpoint addresses shown in the table will vary depending on which interfaces are enabled or disabled. When developing your drivers, you must use the actual physical endpoints for enumerated interfaces.

Supported Interfaces—Service Descriptions

The following services are available over the supported interfaces described in Table 2-1 on page 9:

- DIAG (DM)—Diagnostic (or DM) interface intended for use with Qualcomm tools, such as QXDM, during product development.
- NMEA—Provides external application with standard NMEA messages.
- MODEM—AT command interface

- RMNET0—Intended for wireless data transfer between host and wireless network through device modem stack.

  If data path routing support is required (e.g. high QoS traffic on one interface, regular traffic on another), the USB driver must implement QMAP mode, which enables multiple virtual channels over the physical RMNET0 channel. (Older Sierra Wireless modules supported only 2–3 channels using dedicated physical channels (RMNET0, RMNET1, RMNET2)). Contact Sierra Wireless for details.
- MBIM—Mobile Broadband Interface Model

Legacy Configuration Type

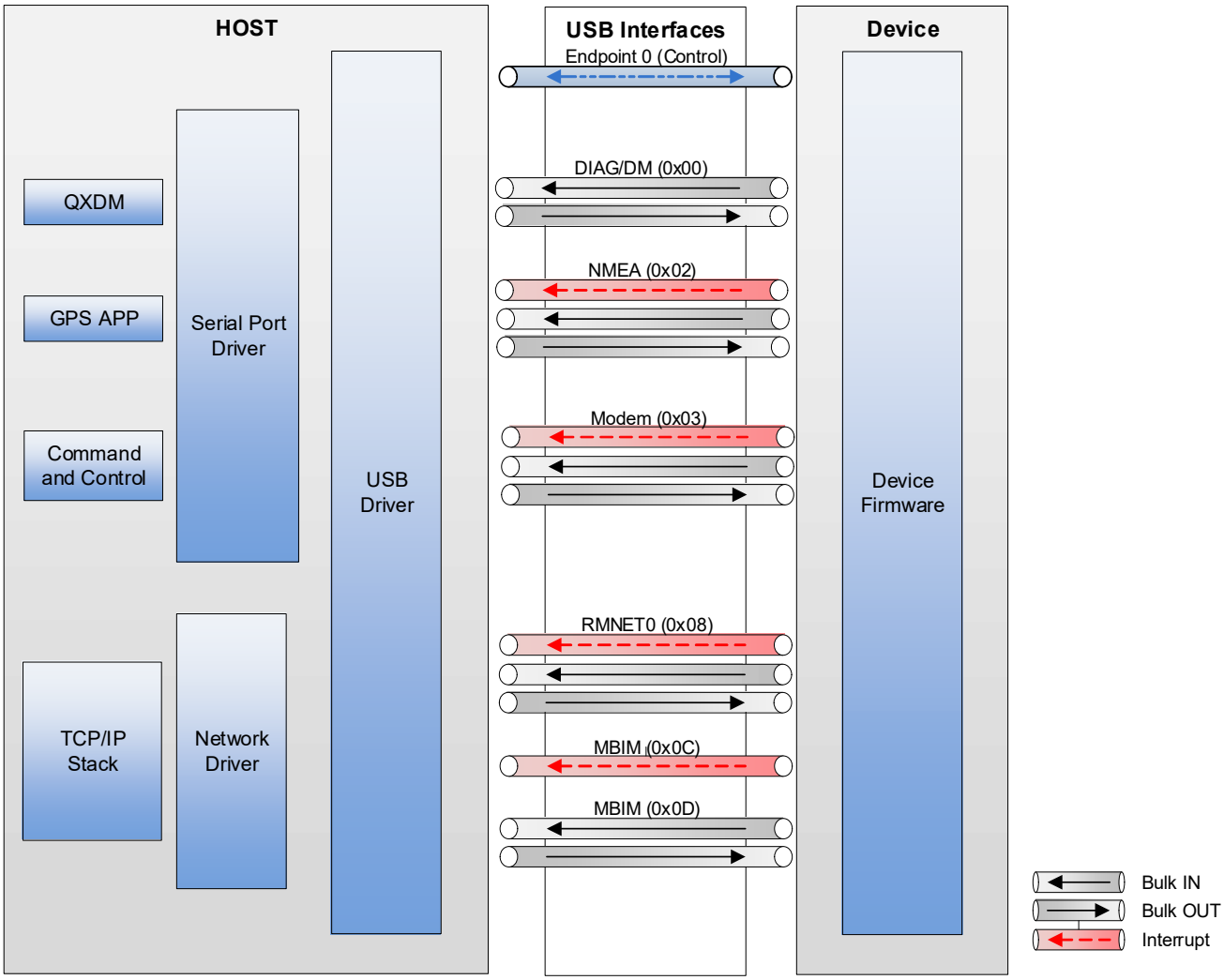

Figure 2-1: USB Interfaces with Endpoint Details—Legacy Configuration

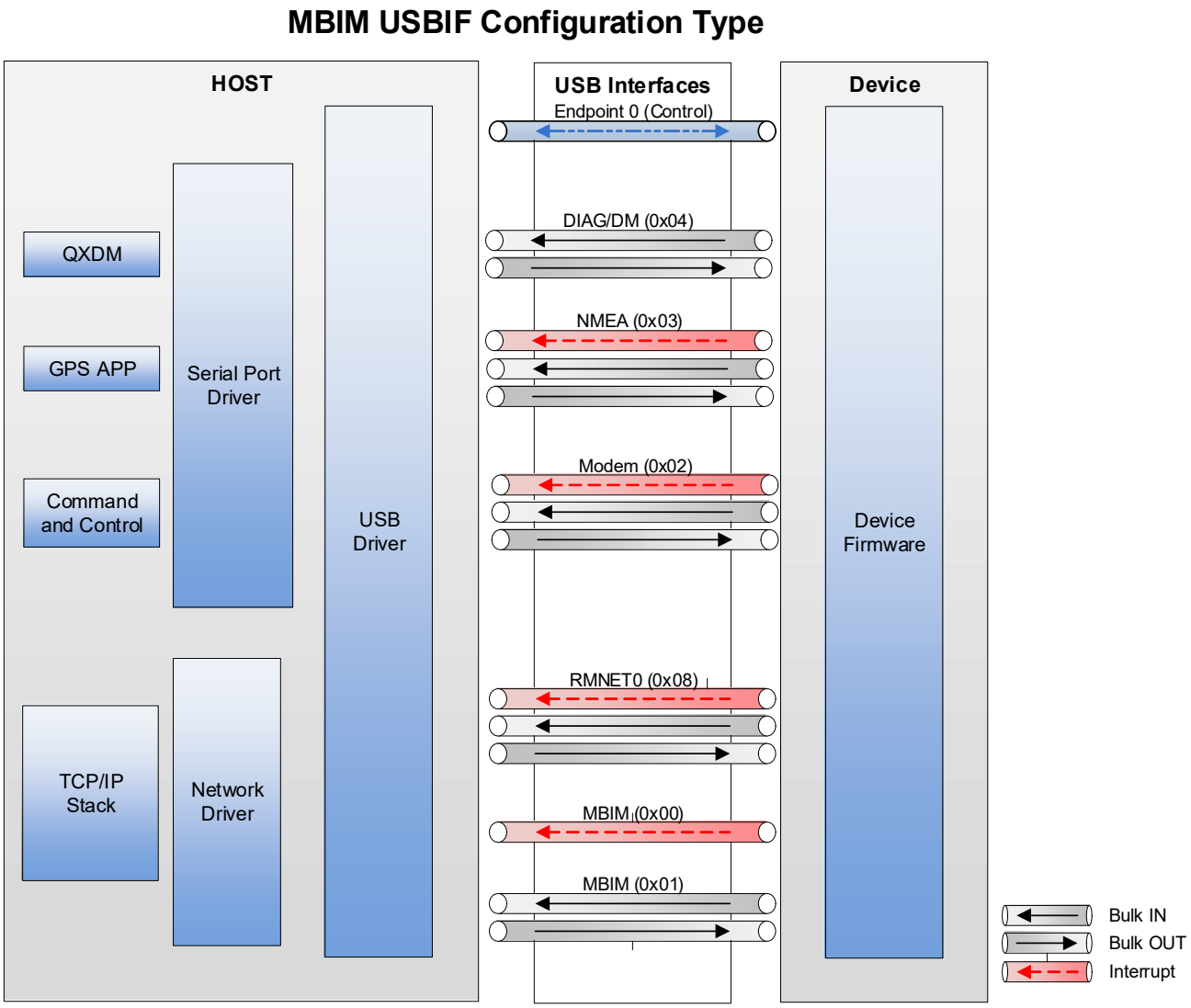

Figure 2-2: USB Interfaces with Endpoint Details—MBIM USBIF Configuration

Descriptors

The following tables present the Device, Configuration, and Endpoint descriptors for the full suite of available USB interfaces supported by EM75xx/EM74x1/MC74x1 modules. The available USB interfaces (as identified in Table 2-1 on page 9) are presented in the order that they typically enumerate and have endpoint addresses assigned:

- Legacy Configuration:
  - DIAG/DM (Interface 0x00)
  - NMEA (Interface 0x02)
  - Modem (Interface 0x03)
  - RMNET0 (Interface 0x08)
  - MBIM (Interfaces 0x0B, 0x0C)
- MBIM USBIF Configuration:
  - MBIM (Interfaces 0x00, 0x01)

- Modem (Interface 0x02)
- NMEA (Interface 0x03
- DIAG/DM (Interface 0x04)
- RMNET0 (Interface 0x08)

Table 2-2: USB descriptors—Legacy Configuration (RMNET Enabled)

Descriptor	Field identifier	Value	Description/Notes
Device Descriptor	bLength	0x12	
	bDescriptorType	0x01	
	bcdUSB	0x0200	USB spec version 2
	bDeviceClass	0x00	
	bDeviceSubClass	0x02	
	bDeviceProtocol	0x00	
	bMaxPacketSize0	0x40	Max packet size for endpoint 0=64 bytes
	idVendor	0x1199	VID (Sierra Wireless Inc.)
	idProduct	0X9091	PID (EM7511, EM7565, EM7411, EM7421, EM7431, MC7411, MC7421, MC7431)
	bcdDevice	0x0006	Module variant
	iManufacturer	0x01	"Sierra Wireless, Incorporated"
	iProduct	0x02	Product name e.g. “EM7565”, "EM7411", "MC7421" etc.
	iSerialNumber	0x00	*Note: Value contained in USBSERIALENABLE customization (accesible via !CUSTOM AT command).*
	bNumConfigurations	0x01	1 configuration
Configuration Descriptor (Index 0x00)	bLength	0x09	
	bDescriptorType	0x02	
	wTotalLength	0x00A0	*Note: Length varies depending on number of interfaces and endpoints.*
	bNumInterfaces	0x04	*Note: Number of interfaces varies depending on provisioning, and use of !USBCOMP to enable/disable interfaces.*
	bConfigurationValue	0x01	
	iConfiguration	0x00	
	bmAttributes	0xA0	Bus powered—remote wakeup (Default) (or 0x80 if remote wakeup is disabled)
	MaxPower	0xFA	500 mA
Interface Descriptor (Interface # 0x00) DIAG/DM	bLength	0x09	
	bDescriptorType	0x04	
	bInterfaceNumber	0x00	
	bAlternateSetting	0x00	
	bNumEndpoints	0x02	
	bInterfaceClass	0xFF	Vendor-specific device class
	bInterfaceSubClass	0xFF	Vendor-specific device class
	bInterfaceProtocol	0xFF	Vendor-specific
	iInterface	0x00	

Table 2-2: USB descriptors—Legacy Configuration (RMNET Enabled) (Continued)

Descriptor	Field identifier	Value	Description/Notes
Endpoint Descriptor (Endpoint address 0x81)	bLength	0x07	
	bDescriptorType	0x05	
	bEndpointAddress	0x81	Endpoint ID (1); Direction (IN) *Note: Dynamically allocated. Actual endpoint addresses will vary depending on enabled/disabled interfaces.*
	bmAttributes	0x02	Transfer type: Bulk
	wMaxPacketSize	0x0200	Max 512 bytes; Must be high speed device
	bInterval	0x00	
Endpoint Descriptor (Endpoint address 0x01)	bLength	0x07	
	bDescriptorType	0x05	
	bEndpointAddress	0x01	Endpoint ID (1); Direction (OUT) *Note: Dynamically allocated. Actual endpoint addresses will vary depending on enabled/disabled interfaces.*
	bmAttributes	0x02	Transfer type: Bulk
	wMaxPacketSize	0x0200	Max 512 bytes; Must be high speed device
	bInterval	0x00	
Interface Descriptor (Interface # 0x02) NMEA	bLength	0x09	
	bDescriptorType	0x04	
	bInterfaceNumber	0x02	
	bAlternateSetting	0x00	
	bNumEndpoints	0x03	
	bInterfaceClass	0xFF	Vendor-specific device class
	bInterfaceSubClass	0x00	
	bInterfaceProtocol	0x00	
	iInterface	0x00	
Endpoint Descriptor (Endpoint address 0x83)	bLength	0x07	
	bDescriptorType	0x05	
	bEndpointAddress	0x83	Endpoint ID (3); Direction (IN) *Note: Dynamically allocated. Actual endpoint addresses will vary depending on enabled/disabled interfaces.*
	bmAttributes	0x03	Transfer type: Interrupt
	wMaxPacketSize	0x000A	1 transaction per microframe, max 10 bytes
	bInterval	0x09	
Endpoint Descriptor (Endpoint address 0x82)	bLength	0x07	
	bDescriptorType	0x05	
	bEndpointAddress	0x82	Endpoint ID (2); Direction (IN) *Note: Dynamically allocated. Actual endpoint addresses will vary depending on enabled/disabled interfaces.*
	bmAttributes	0x02	Transfer type: Bulk
	wMaxPacketSize	0x0200	Max 512 bytes; Must be high speed device
	bInterval	0x00	

Table 2-2: USB descriptors—Legacy Configuration (RMNET Enabled) (Continued)

Descriptor	Field identifier	Value	Description/Notes
Endpoint Descriptor (Endpoint address 0x02)	bLength	0x07	
	bDescriptorType	0x05	
	bEndpointAddress	0x02	Endpoint ID (2); Direction (OUT) *Note: Dynamically allocated. Actual endpoint addresses will vary depending on enabled/disabled interfaces.*
	bmAttributes	0x02	Transfer type: Bulk
	wMaxPacketSize	0x0200	Max 512 bytes; Must be high speed device
	bInterval	0x00	
Interface Descriptor (Interface # 0x03) Modem	bLength	0x09	
	bDescriptorType	0x04	
	bInterfaceNumber	0x03	
	bAlternateSetting	0x00	
	bNumEndpoints	0x03	
	bInterfaceClass	0xFF	Vendor-specific device class
	bInterfaceSubClass	0x00	
	bInterfaceProtocol	0x00	
	iInterface	0x00	
Endpoint Descriptor (Endpoint address 0x85)	bLength	0x07	
	bDescriptorType	0x05	
	bEndpointAddress	0x85	Endpoint ID (5); Direction (IN) *Note: Dynamically allocated. Actual endpoint addresses will vary depending on enabled/disabled interfaces.*
	bmAttributes	0x03	Transfer type: Interrupt
	wMaxPacketSize	0x000A	1 transaction per microframe, max 10 bytes
	bInterval	0x09	
Endpoint Descriptor (Endpoint address 0x84)	bLength	0x07	
	bDescriptorType	0x05	
	bEndpointAddress	0x84	Endpoint ID (4); Direction (IN) *Note: Dynamically allocated. Actual endpoint addresses will vary depending on enabled/disabled interfaces.*
	bmAttributes	0x02	Transfer type: Bulk
	wMaxPacketSize	0x0200	Max 512 bytes; Must be high speed device
	bInterval	0x00	
Endpoint Descriptor (Endpoint address 0x03)	bLength	0x07	
	bDescriptorType	0x05	
	bEndpointAddress	0x03	Endpoint ID (3); Direction (OUT) *Note: Dynamically allocated. Actual endpoint addresses will vary depending on enabled/disabled interfaces.*
	bmAttributes	0x02	Transfer type: Bulk
	wMaxPacketSize	0x0200	Max 512 bytes; Must be high speed device
	bInterval	0x00	

Table 2-2: USB descriptors—Legacy Configuration (RMNET Enabled) (Continued)

Descriptor	Field identifier	Value	Description/Notes
Interface Descriptor (Interface # 0x08) RMNET0	bLength	0x09	
	bDescriptorType	0x04	
	bInterfaceNumber	0x08	
	bAlternateSetting	0x00	
	bNumEndpoints	0x03	
	bInterfaceClass	0xFF	Vendor-specific device class
	bInterfaceSubClass	0xFF	
	bInterfaceProtocol	0xFF	
	iInterface	0x07	"rmnet-qmap-1"
Endpoint Descriptor (Endpoint address 0x86)	bLength	0x07	
	bDescriptorType	0x05	
	bEndpointAddress	0x86	Endpoint ID (6); Direction (IN) *Note: Dynamically allocated. Actual endpoint addresses will vary depending on enabled/disabled interfaces.*
	bmAttributes	0x03	Transfer type: Interrupt
	wMaxPacketSize	0x0008	1 transaction per microframe, max 10 bytes
	bInterval	0x09	
Endpoint Descriptor (Endpoint address 0x8E)	bLength	0x07	
	bDescriptorType	0x05	
	bEndpointAddress	0x8E	Endpoint ID (E); Direction (IN) *Note: Dynamically allocated. Actual endpoint addresses will vary depending on enabled/disabled interfaces.*
	bmAttributes	0x02	Transfer type: Bulk
	wMaxPacketSize	0x0200	Max 512 bytes; Must be high speed device
	bInterval	0x00	
Endpoint Descriptor (Endpoint address 0x0F)	bLength	0x07	
	bDescriptorType	0x05	
	bEndpointAddress	0x0F	Endpoint ID (F); Direction (OUT) *Note: Dynamically allocated. Actual endpoint addresses will vary depending on enabled/disabled interfaces.*
	bmAttributes	0x02	Transfer type: Bulk
	wMaxPacketSize	0x0200	Max 512 bytes; Must be high speed device
	bInterval	0x00	

Table 2-3: USB descriptors—Legacy Configuration (MBIM Enabled)

Descriptor	Field identifier	Value	Description/Notes
Device Descriptor	bLength	0x12	
	bDescriptorType	0x01	
	bcdUSB	0x0200	USB spec version 2
	bDeviceClass	0xEF	
	bDeviceSubClass	0x02	
	bDeviceProtocol	0x01	
	bMaxPacketSize0	0x40	Max packet size for endpoint 0=64 bytes
	idVendor	0x1199	VID (Sierra Wireless Inc.)
	idProduct	0X9091	PID (EM7511, EM7565, EM7411, EM7421, EM7431, MC7411, MC7421, MC7431)
	bcdDevice	0x0006	Module variant
	iManufacturer	0x01	"Sierra Wireless, Incorporated"
	iProduct	0x02	Product name e.g. “EM7565”, "EM7411", "MC7421", etc.
	iSerialNumber	0x00	*Note: Value contained in USBSERIALENABLE customization (accesible via !CUSTOM AT command).*
	bNumConfigurations	0x01	1 configuration
Configuration Descriptor (Index 0x00)	bLength	0x09	
	bDescriptorType	0x02	
	wTotalLength	0x00D8	*Note: Length varies depending on number of interfaces and endpoints.*
	bNumInterfaces	0x05	*Note: Number of interfaces varies depending on provisioning, and use of !USBCOMP to enable/disable interfaces.*
	bConfigurationValue	0x01	
	iConfiguration	0x00	
	bmAttributes	0xA0	Bus powered—remote wakeup (Default) (or 0x80 if remote wakeup is disabled)
	MaxPower	0xFA	500 mA
Interface Descriptor (Interface # 0x00) DIAG/DM	bLength	0x09	
	bDescriptorType	0x04	
	bInterfaceNumber	0x00	
	bAlternateSetting	0x00	
	bNumEndpoints	0x02	
	bInterfaceClass	0xFF	Vendor-specific device class
	bInterfaceSubClass	0xFF	Vendor-specific device class
	bInterfaceProtocol	0xFF	Vendor-specific
	iInterface	0x00	

Table 2-3: USB descriptors—Legacy Configuration (MBIM Enabled) (Continued)

Descriptor	Field identifier	Value	Description/Notes
Endpoint Descriptor (Endpoint address 0x81)	bLength	0x07	
	bDescriptorType	0x05	
	bEndpointAddress	0x81	Endpoint ID (1); Direction (IN) *Note: Dynamically allocated. Actual endpoint addresses will vary depending on enabled/disabled interfaces.*
	bmAttributes	0x02	Transfer type: Bulk
	wMaxPacketSize	0x0200	Max 512 bytes; Must be high speed device
	bInterval	0x00	
Endpoint Descriptor (Endpoint address 0x01)	bLength	0x07	
	bDescriptorType	0x05	
	bEndpointAddress	0x01	Endpoint ID (1); Direction (OUT) *Note: Dynamically allocated. Actual endpoint addresses will vary depending on enabled/disabled interfaces.*
	bmAttributes	0x02	Transfer type: Bulk
	wMaxPacketSize	0x0200	Max 512 bytes; Must be high speed device
	bInterval	0x00	
Interface Descriptor (Interface # 0x02) NMEA	bLength	0x09	
	bDescriptorType	0x04	
	bInterfaceNumber	0x02	
	bAlternateSetting	0x00	
	bNumEndpoints	0x03	
	bInterfaceClass	0xFF	Vendor-specific device class
	bInterfaceSubClass	0x00	
	bInterfaceProtocol	0x00	
	iInterface	0x00	
Endpoint Descriptor (Endpoint address 0x83)	bLength	0x07	
	bDescriptorType	0x05	
	bEndpointAddress	0x83	Endpoint ID (3); Direction (IN) *Note: Dynamically allocated. Actual endpoint addresses will vary depending on enabled/disabled interfaces.*
	bmAttributes	0x03	Transfer type: Interrupt
	wMaxPacketSize	0x000A	1 transaction per microframe, max 10 bytes
	bInterval	0x09	
Endpoint Descriptor (Endpoint address 0x82)	bLength	0x07	
	bDescriptorType	0x05	
	bEndpointAddress	0x82	Endpoint ID (2); Direction (IN) *Note: Dynamically allocated. Actual endpoint addresses will vary depending on enabled/disabled interfaces.*
	bmAttributes	0x02	Transfer type: Bulk
	wMaxPacketSize	0x0200	Max 512 bytes; Must be high speed device
	bInterval	0x00	

Table 2-3: USB descriptors—Legacy Configuration (MBIM Enabled) (Continued)

Descriptor	Field identifier	Value	Description/Notes
Endpoint Descriptor (Endpoint address 0x02)	bLength	0x07	
	bDescriptorType	0x05	
	bEndpointAddress	0x02	Endpoint ID (2); Direction (OUT) *Note: Dynamically allocated. Actual endpoint addresses will vary depending on enabled/disabled interfaces.*
	bmAttributes	0x02	Transfer type: Bulk
	wMaxPacketSize	0x0200	Max 512 bytes; Must be high speed device
	bInterval	0x00	
Interface Descriptor (Interface # 0x03) Modem	bLength	0x09	
	bDescriptorType	0x04	
	bInterfaceNumber	0x03	
	bAlternateSetting	0x00	
	bNumEndpoints	0x03	
	bInterfaceClass	0xFF	Vendor-specific device class
	bInterfaceSubClass	0x00	
	bInterfaceProtocol	0x00	
	iInterface	0x00	
Endpoint Descriptor (Endpoint address 0x85)	bLength	0x07	
	bDescriptorType	0x05	
	bEndpointAddress	0x85	Endpoint ID (5); Direction (IN) *Note: Dynamically allocated. Actual endpoint addresses will vary depending on enabled/disabled interfaces.*
	bmAttributes	0x03	Transfer type: Interrupt
	wMaxPacketSize	0x000A	1 transaction per microframe, max 10 bytes
	bInterval	0x09	
Endpoint Descriptor (Endpoint address 0x84)	bLength	0x07	
	bDescriptorType	0x05	
	bEndpointAddress	0x84	Endpoint ID (4); Direction (IN) *Note: Dynamically allocated. Actual endpoint addresses will vary depending on enabled/disabled interfaces.*
	bmAttributes	0x02	Transfer type: Bulk
	wMaxPacketSize	0x0200	Max 512 bytes; Must be high speed device
	bInterval	0x00	
Endpoint Descriptor (Endpoint address 0x03)	bLength	0x07	
	bDescriptorType	0x05	
	bEndpointAddress	0x03	Endpoint ID (3); Direction (OUT) *Note: Dynamically allocated. Actual endpoint addresses will vary depending on enabled/disabled interfaces.*
	bmAttributes	0x02	Transfer type: Bulk
	wMaxPacketSize	0x0200	Max 512 bytes; Must be high speed device
	bInterval	0x00	

Table 2-3: USB descriptors—Legacy Configuration (MBIM Enabled) (Continued)

Descriptor	Field identifier	Value	Description/Notes
Interface Descriptor (Interface # 0x0C) MBIM	bLength	0x09	
	bDescriptorType	0x04	
	bInterfaceNumber	0x0C	
	bAlternateSetting	0x00	
	bNumEndpoints	0x01	
	bInterfaceClass	0x02	Communications (CDC Control) USB Device Interface Class
	bInterfaceSubClass	0x0E	
	bInterfaceProtocol	0x00	
	iInterface	0x00	
Endpoint Descriptor (Endpoint address 0x86)	bLength	0x07	
	bDescriptorType	0x05	
	bEndpointAddress	0x86	Endpoint ID (6); Direction (IN) *Note: Dynamically allocated. Actual endpoint addresses will vary depending on enabled/disabled interfaces.*
	bmAttributes	0x03	Transfer type: Interrupt
	wMaxPacketSize	0x0040	1 transaction per microframe, max 64 bytes
	wInterval	0x0009	
	~~bSyncAddress~~	~~0x00~~	NO SYNC ADDRESS SHOWN IN USB VIEWER
Interface Descriptor (Interface # 0x0D) MBIM	bLength	0x09	
	bDescriptorType	0x04	
	bInterfaceNumber	0x0D	
	bAlternateSetting	0x01	
	bNumEndpoints	0x02	
	bInterfaceClass	0x0A	Communications (CDC Control) USB Device Interface Class
	bInterfaceSubClass	0x00	
	bInterfaceProtocol	0x02	
	iInterface	0x00	
Endpoint Descriptor (Endpoint address 0x8E)	bLength	0x07	
	bDescriptorType	0x05	
	bEndpointAddress	0x8E	Endpoint ID (14); Direction (IN) *Note: Dynamically allocated. Actual endpoint addresses will vary depending on enabled/disabled interfaces.*
	bmAttributes	0x02	Transfer type: Bulk
	wMaxPacketSize	0x0200	max 512 bytes
	wInterval	0x0000	
	~~bSyncAddress~~	~~0x00~~	NO SYNC ADDRESS SHOWN IN USB VIEWER
Endpoint Descriptor (Endpoint address 0x0F)	bLength	0x07	
	bDescriptorType	0x05	
	bEndpointAddress	0x0F	Endpoint ID (15); Direction (OUT) *Note: Dynamically allocated. Actual endpoint addresses will vary depending on enabled/disabled interfaces.*
	bmAttributes	0x02	Transfer type: Bulk
	wMaxPacketSize	0x0200	max 512 bytes
	wInterval	0x0000	
	~~bSyncAddress~~	~~0x00~~	NO SYNC ADDRESS SHOWN IN USB VIEWER

Table 2-4: USB descriptors—MBIM USB-IF Configuration (RMNET enabled)

Descriptor	Field identifier	Value	Description / Notes
Device Descriptor	bLength	0x12	
	bDescriptorType	0x01	
	bcdUSB	0x0200	USB spec version 2
	bDeviceClass	0x00	
	bDeviceSubClass	0x00	
	bDeviceProtocol	0x00	
	bMaxPacketSize0	0x40	Max packet size for endpoint 0=64 bytes
	idVendor	0x1199	VID (Sierra Wireless Inc.)
	idProduct	0x90B1	PID (EM7511, EM7565, EM7411, EM7421, EM7431, MC7411, MC7421, MC7431)
	bcdDevice	0x0006	Module variant
	iManufacturer	0x01	"Sierra Wireless, Incorporated"
	iProduct	0x02	Product name e.g. “EM7565”, "EM7411", "MC7421", etc.
	iSerialNumber	0x00	*Note: Value contained in USBSERIALENABLE customization (accesible via !CUSTOM AT command).*
	bNumConfigurations	0x01	1 configuration
Configuration Descriptor (Index 0x00)	bLength	0x09	
	bDescriptorType	0x02	
	wTotalLength	0x00A0	*Note: Length varies depending on number of interfaces and endpoints.*
	bNumInterfaces	0x04	*Note: Number of interfaces varies depending on provisioning, and use of !USBCOMP to enable/disable interfaces.*
	bConfigurationValue	0x01	
	iConfiguration	0x00	
	bmAttributes	0xA0	Bus powered—remote wakeup (Default) (or 0x80 if remote wakeup is disabled)
	MaxPower	0xFA	500 mA
Interface Descriptor (Interface # 0x02) Modem	bLength	0x09	
	bDescriptorType	0x04	
	bInterfaceNumber	0x02	
	bAlternateSetting	0x00	
	bNumEndpoints	0x03	
	bInterfaceClass	0xFF	Vendor-specific device class
	bInterfaceSubClass	0x00	
	bInterfaceProtocol	0x00	
	iInterface	0x00	

Table 2-4: USB descriptors — MBIM USB-IF Configuration (RMNET enabled) (Continued)

Descriptor	Field identifier	Value	Description/Notes
Endpoint Descriptor (Endpoint address 0x82)	bLength	0x07	
	bDescriptorType	0x05	
	bEndpointAddress	0x82	Endpoint ID (2); Direction (IN) *Note: Dynamically allocated. Actual endpoint addresses will vary depending on enabled/disabled interfaces.*
	bmAttributes	0x03	Transfer type: Interrupt
	wMaxPacketSize	0x000A	1 transaction per microframe, max 10 bytes
	bInterval	0x09	
Endpoint Descriptor (Endpoint address 0x81)	bLength	0x07	
	bDescriptorType	0x05	
	bEndpointAddress	0x81	Endpoint ID (1); Direction (IN) *Note: Dynamically allocated. Actual endpoint addresses will vary depending on enabled/disabled interfaces.*
	bmAttributes	0x02	Transfer type: Bulk
	wMaxPacketSize	0x0200	Max 512 bytes; Must be high speed device
	bInterval	0x00	
Endpoint Descriptor (Endpoint address 0x01)	bLength	0x07	
	bDescriptorType	0x05	
	bEndpointAddress	0x01	Endpoint ID (1); Direction (OUT) *Note: Dynamically allocated. Actual endpoint addresses will vary depending on enabled/disabled interfaces.*
	bmAttributes	0x02	Transfer type: Bulk
	wMaxPacketSize	0x0200	Max 512 bytes; Must be high speed device
	bInterval	0x00	
Interface Descriptor (Interface # 0x03) NMEA	bLength	0x09	
	bDescriptorType	0x04	
	bInterfaceNumber	0x03	
	bAlternateSetting	0x00	
	bNumEndpoints	0x03	
	bInterfaceClass	0xFF	Vendor-specific device class
	bInterfaceSubClass	0x00	
	bInterfaceProtocol	0x00	
	iInterface	0x00	
Endpoint Descriptor (Endpoint address 0x84)	bLength	0x07	
	bDescriptorType	0x05	
	bEndpointAddress	0x84	Endpoint ID (4); Direction (IN) *Note: Dynamically allocated. Actual endpoint addresses will vary depending on enabled/disabled interfaces.*
	bmAttributes	0x03	Transfer type: Interrupt
	wMaxPacketSize	0x000A	1 transaction per microframe, max 10 bytes
	bInterval	0x09	

Table 2-4: USB descriptors — MBIM USB-IF Configuration (RMNET enabled) (Continued)

Descriptor	Field identifier	Value	Description / Notes
Endpoint Descriptor (Endpoint address 0x83)	bLength	0x07	
	bDescriptorType	0x05	
	bEndpointAddress	0x83	Endpoint ID (3); Direction (IN) *Note: Dynamically allocated. Actual endpoint addresses will vary depending on enabled/disabled interfaces.*
	bmAttributes	0x02	Transfer type: Bulk
	wMaxPacketSize	0x0200	Max 512 bytes; Must be high speed device
	bInterval	0x00	
Endpoint Descriptor (Endpoint address 0x02)	bLength	0x07	
	bDescriptorType	0x05	
	bEndpointAddress	0x02	Endpoint ID (2); Direction (OUT) *Note: Dynamically allocated. Actual endpoint addresses will vary depending on enabled/disabled interfaces.*
	bmAttributes	0x02	Transfer type: Bulk
	wMaxPacketSize	0x0200	Max 512 bytes; Must be high speed device
	bInterval	0x00	
Interface Descriptor (Interface # 0x04) DIAG / DM	bLength	0x09	
	bDescriptorType	0x04	
	bInterfaceNumber	0x04	
	bAlternateSetting	0x00	
	bNumEndpoints	0x02	
	bInterfaceClass	0xFF	Vendor-specific device class
	bInterfaceSubClass	0xFF	Vendor-specific device class
	bInterfaceProtocol	0xFF	Vendor-specific
	iInterface	0x00	
Endpoint Descriptor (Endpoint address 0x85)	bLength	0x07	
	bDescriptorType	0x05	
	bEndpointAddress	0x85	Endpoint ID (5); Direction (IN) *Note: Dynamically allocated. Actual endpoint addresses will vary depending on enabled/disabled interfaces.*
	bmAttributes	0x02	Transfer type: Bulk
	wMaxPacketSize	0x0200	Max 512 bytes; Must be high speed device
	bInterval	0x00	
Endpoint Descriptor (Endpoint address 0x03)	bLength	0x07	
	bDescriptorType	0x05	
	bEndpointAddress	0x03	Endpoint ID (3); Direction (OUT) *Note: Dynamically allocated. Actual endpoint addresses will vary depending on enabled/disabled interfaces.*
	bmAttributes	0x02	Transfer type: Bulk
	wMaxPacketSize	0x0200	Max 512 bytes; Must be high speed device
	bInterval	0x00	

Table 2-4: USB descriptors — MBIM USB-IF Configuration (RMNET enabled) (Continued)

Descriptor	Field identifier	Value	Description/Notes
Interface Descriptor (Interface # 0x08) RMNET0	bLength	0x09	
	bDescriptorType	0x04	
	bInterfaceNumber	0x08	
	bAlternateSetting	0x00	
	bNumEndpoints	0x03	
	bInterfaceClass	0xFF	Vendor-specific device class
	bInterfaceSubClass	0xFF	
	bInterfaceProtocol	0xFF	
	iInterface	0x07	"rmnet-qmap-1"
Endpoint Descriptor (Endpoint address 0x86)	bLength	0x07	
	bDescriptorType	0x05	
	bEndpointAddress	0x86	Endpoint ID (6); Direction (IN) *Note: Dynamically allocated. Actual endpoint addresses will vary depending on enabled/disabled interfaces.*
	bmAttributes	0x03	Transfer type: Interrupt
	wMaxPacketSize	0x0008	1 transaction per microframe, max 10 bytes
	bInterval	0x09	
Endpoint Descriptor (Endpoint address 0x8E)	bLength	0x07	
	bDescriptorType	0x05	
	bEndpointAddress	0x8E	Endpoint ID (E); Direction (IN) *Note: Dynamically allocated. Actual endpoint addresses will vary depending on enabled/disabled interfaces.*
	bmAttributes	0x02	Transfer type: Bulk
	wMaxPacketSize	0x0200	Max 512 bytes; Must be high speed device
	bInterval	0x00	
Endpoint Descriptor (Endpoint address 0x0F)	bLength	0x07	
	bDescriptorType	0x05	
	bEndpointAddress	0x0F	Endpoint ID (F); Direction (OUT) *Note: Dynamically allocated. Actual endpoint addresses will vary depending on enabled/disabled interfaces.*
	bmAttributes	0x02	Transfer type: Bulk
	wMaxPacketSize	0x0200	Max 512 bytes; Must be high speed device
	bInterval	0x00	

Table 2-5: USB descriptors—MBIM USB-IF Configuration (MBIM enabled)

Descriptor	Field identifier	Value	Description/Notes
Device Descriptor	bLength	0x12	
	bDescriptorType	0x01	
	bcdUSB	0x0200	USB spec version 2
	bDeviceClass	0xEF	
	bDeviceSubClass	0x02	
	bDeviceProtocol	0x01	
	bMaxPacketSize0	0x40	Max packet size for endpoint 0=64 bytes
	idVendor	0x1199	VID (Sierra Wireless Inc.)
	idProduct	0x90B1	PID (EM7511, EM7565, EM7411, EM7421, EM7431, MC7411, MC7421, MC7431)
	bcdDevice	0x0006	Module variant
	iManufacturer	0x01	"Sierra Wireless, Incorporated"
	iProduct	0x02	Product name e.g. “EM7565”, "EM7411", "MC7421", etc.
	iSerialNumber	0x00	*Note: Value contained in USBSERIALENABLE customization (accesible via !CUSTOM AT command).*
	bNumConfigurations	0x01	1 configuration
Configuration Descriptor (Index 0x00)	bLength	0x09	
	bDescriptorType	0x02	
	wTotalLength	0x00D8	*Note: Length varies depending on number of interfaces and endpoints.*
	bNumInterfaces	0x05	*Note: Number of interfaces varies depending on provisioning, and use of !USBCOMP to enable/disable interfaces.*
	bConfigurationValue	0x01	
	iConfiguration	0x00	
	bmAttributes	0xA0	Bus powered—remote wakeup (Default) (or 0x80 if remote wakeup is disabled)
	MaxPower	0xFA	500 mA
Interface Descriptor (Interface # 0x00) MBIM	bLength	0x09	
	bDescriptorType	0x04	
	bInterfaceNumber	0x00	
	bAlternateSetting	0x00	
	bNumEndpoints	0x01	
	bInterfaceClass	0x02	Communications (CDC Control) USB Device Interface Class
	bInterfaceSubClass	0x0E	
	bInterfaceProtocol	0x00	
	iInterface	0x00	
Endpoint Descriptor (Endpoint address 0x81)	bLength	0x07	
	bDescriptorType	0x05	
	bEndpointAddress	0x81	Endpoint ID (1); Direction (IN) *Note: Dynamically allocated. Actual endpoint addresses will vary depending on enabled/disabled interfaces.*
	bmAttributes	0x03	Transfer type: Interrupt
	wMaxPacketSize	0x0040	1 transaction per microframe, max 64 bytes
	wInterval	0x0009	
	~~bSyncAddress~~	~~0x00~~	NO SYNC ADDRESS SHOWN IN USB VIEWER

Table 2-5: USB descriptors — MBIM USB-IF Configuration (MBIM enabled) (Continued)

Descriptor	Field identifier	Value	Description/Notes
Interface Descriptor (Interface # 0x01) MBIM	bLength	0x09	
	bDescriptorType	0x04	
	bInterfaceNumber	0x01	
	bAlternateSetting	0x01	
	bNumEndpoints	0x02	
	bInterfaceClass	0x0A	Communications (CDC Control) USB Device Interface Class
	bInterfaceSubClass	0x00	
	bInterfaceProtocol	0x02	
	iInterface	0x00	
Endpoint Descriptor (Endpoint address 0x8E)	bLength	0x07	
	bDescriptorType	0x05	
	bEndpointAddress	0x8E	Endpoint ID (14); Direction (IN) *Note: Dynamically allocated. Actual endpoint addresses will vary depending on enabled/disabled interfaces.*
	bmAttributes	0x02	Transfer type: Bulk
	wMaxPacketSize	0x0200	max 512 bytes
	wInterval	0x0000	
	~~bSyncAddress~~	~~0x00~~	NO SYNC ADDRESS SHOWN IN USB VIEWER
Endpoint Descriptor (Endpoint address 0x0F)	bLength	0x07	
	bDescriptorType	0x05	
	bEndpointAddress	0x0F	Endpoint ID (15); Direction (OUT) *Note: Dynamically allocated. Actual endpoint addresses will vary depending on enabled/disabled interfaces.*
	bmAttributes	0x02	Transfer type: Bulk
	wMaxPacketSize	0x0200	max 512 bytes
	wInterval	0x0000	
	~~bSyncAddress~~	~~0x00~~	NO SYNC ADDRESS SHOWN IN USB VIEWER
Interface Descriptor (Interface # 0x02) Modem	bLength	0x09	
	bDescriptorType	0x04	
	bInterfaceNumber	0x02	
	bAlternateSetting	0x00	
	bNumEndpoints	0x03	
	bInterfaceClass	0xFF	Vendor-specific device class
	bInterfaceSubClass	0x00	
	bInterfaceProtocol	0x00	
	iInterface	0x00	
Endpoint Descriptor (Endpoint address 0x83)	bLength	0x07	
	bDescriptorType	0x05	
	bEndpointAddress	0x83	Endpoint ID (3); Direction (IN) *Note: Dynamically allocated. Actual endpoint addresses will vary depending on enabled/disabled interfaces.*
	bmAttributes	0x03	Transfer type: Interrupt
	wMaxPacketSize	0x000A	1 transaction per microframe, max 10 bytes
	bInterval	0x09	

Table 2-5: USB descriptors — MBIM USB-IF Configuration (MBIM enabled) (Continued)

Descriptor	Field identifier	Value	Description / Notes
Endpoint Descriptor (Endpoint address 0x82)	bLength	0x07	
	bDescriptorType	0x05	
	bEndpointAddress	0x82	Endpoint ID (2); Direction (IN) *Note: Dynamically allocated. Actual endpoint addresses will vary depending on enabled/disabled interfaces.*
	bmAttributes	0x02	Transfer type: Bulk
	wMaxPacketSize	0x0200	Max 512 bytes; Must be high speed device
	bInterval	0x00	
Endpoint Descriptor (Endpoint address 0x01)	bLength	0x07	
	bDescriptorType	0x05	
	bEndpointAddress	0x01	Endpoint ID (1); Direction (OUT) *Note: Dynamically allocated. Actual endpoint addresses will vary depending on enabled/disabled interfaces.*
	bmAttributes	0x02	Transfer type: Bulk
	wMaxPacketSize	0x0200	Max 512 bytes; Must be high speed device
	bInterval	0x00	
Interface Descriptor (Interface # 0x03) NMEA	bLength	0x09	
	bDescriptorType	0x04	
	bInterfaceNumber	0x03	
	bAlternateSetting	0x00	
	bNumEndpoints	0x03	
	bInterfaceClass	0xFF	Vendor-specific device class
	bInterfaceSubClass	0x00	
	bInterfaceProtocol	0x00	
	iInterface	0x00	
Endpoint Descriptor (Endpoint address 0x85)	bLength	0x07	
	bDescriptorType	0x05	
	bEndpointAddress	0x85	Endpoint ID (5); Direction (IN) *Note: Dynamically allocated. Actual endpoint addresses will vary depending on enabled/disabled interfaces.*
	bmAttributes	0x03	Transfer type: Interrupt
	wMaxPacketSize	0x000A	1 transaction per microframe, max 10 bytes
	bInterval	0x09	
Endpoint Descriptor (Endpoint address 0x84)	bLength	0x07	
	bDescriptorType	0x05	
	bEndpointAddress	0x84	Endpoint ID (4); Direction (IN) *Note: Dynamically allocated. Actual endpoint addresses will vary depending on enabled/disabled interfaces.*
	bmAttributes	0x02	Transfer type: Bulk
	wMaxPacketSize	0x0200	Max 512 bytes; Must be high speed device
	bInterval	0x00	

Table 2-5: USB descriptors—MBIM USB-IF Configuration (MBIM enabled) (Continued)

Descriptor	Field identifier	Value	Description/Notes
Endpoint Descriptor (Endpoint address 0x02)	bLength	0x07	
	bDescriptorType	0x05	
	bEndpointAddress	0x02	Endpoint ID (2); Direction (OUT) *Note: Dynamically allocated. Actual endpoint addresses will vary depending on enabled/disabled interfaces.*
	bmAttributes	0x02	Transfer type: Bulk
	wMaxPacketSize	0x0200	Max 512 bytes; Must be high speed device
	bInterval	0x00	
Interface Descriptor (Interface # 0x04) DIAG/DM	bLength	0x09	
	bDescriptorType	0x04	
	bInterfaceNumber	0x04	
	bAlternateSetting	0x00	
	bNumEndpoints	0x02	
	bInterfaceClass	0xFF	Vendor-specific device class
	bInterfaceSubClass	0xFF	Vendor-specific device class
	bInterfaceProtocol	0xFF	Vendor-specific
	iInterface	0x00	
Endpoint Descriptor (Endpoint address 0x86)	bLength	0x07	
	bDescriptorType	0x05	
	bEndpointAddress	0x86	Endpoint ID (6); Direction (IN) *Note: Dynamically allocated. Actual endpoint addresses will vary depending on enabled/disabled interfaces.*
	bmAttributes	0x02	Transfer type: Bulk
	wMaxPacketSize	0x0200	Max 512 bytes; Must be high speed device
	bInterval	0x00	
Endpoint Descriptor (Endpoint address 0x03)	bLength	0x07	
	bDescriptorType	0x05	
	bEndpointAddress	0x03	Endpoint ID (3); Direction (OUT) *Note: Dynamically allocated. Actual endpoint addresses will vary depending on enabled/disabled interfaces.*
	bmAttributes	0x02	Transfer type: Bulk
	wMaxPacketSize	0x0200	Max 512 bytes; Must be high speed device
	bInterval	0x00	

USB Enumeration Examples

As noted earlier, endpoint addresses are dynamically allocated as each USB interface enumerates.

The following table shows the endpoint allocations for a module using Legacy configuration that has DIAG, NMEA, Modem, and MBIM USB interfaces enabled, and for a module that does not have NMEA enabled.

Table 2-6: Endpoint Allocation Examples

Direction: IN				Direction: OUT		
Endpoint Address	Interfaces (0x##)			Endpoint Address	Interfaces (0x##)	
	0x00 (DIAG) 0x02 (NMEA) 0x03 (Modem) 0x0C/0x0D (MBIM)	0x00 (DIAG) 0x03 (Modem) 0x0C/0x0D (MBIM)			0x00 (DIAG) 0x02 (NMEA) 0x03 (Modem) 0x0C/0x0D (MBIM)	0x00 (DIAG) 0x03 (Modem) 0x0C/0x0D (MBIM)
x81	DIAG Interrupt	DIAG Interrupt		x01	DIAG Bulk	DIAG Bulk
x82	NMEA Bulk	Modem Bulk		x02	NMEA Bulk	Modem Bulk
x83	NMEA Interrupt	Modem Interrupt		x03	Modem Bulk	
x84	Modem Bulk	MBIM Interrupt		x04		
x85	Modem Interrupt			x05		
x86	MBIM Interrupt			x06		
x8E	MBIM Bulk	MBIM Bulk		x0E		
x8F				x0F	MBIM Bulk	MBIM Bulk

3: References

Sierra Wireless Documents

The Sierra Wireless document listed below is available from source.sierrawireless.com.

[1] AirPrime EM75xx and EM/MC74x1 AT Command Reference (Doc# 41111748)

Industry/Other Documents

Related and supporting documents include:

[2] Terminal Equipment to User Equipment (TE-UE) multiplexer protocol (Release 6)
Website: www.3gpp.org

[3] Universal Serial Bus Class Definitions for Communication Devices, Version 1.1
Website: www.usb.org

[4] Universal Serial Bus Specification, Rev 3.0
Website: www.usb.org

[5] Universal Serial Bus Communications Class Subclass Specification for Mobile Broadband Interface Model
Website: www.usb.org

A: Acronyms

Table A-1: Acronyms and Definitions

Acronym or term	Definition
USB	Universal Serial Bus
ACM	Abstract Control Model
VID	Vendor ID (assigned by usb.org to Sierra Wireless)
PID	Product ID (assigned by Sierra Wireless)
MBIM	Mobile Broadband Interface Model
NMEA	National Marine Electronics Association
DIAG	Diagnostic interface (a.k.a. DM)
DM	Diagnostic Interface (a.k.a DIAG)
QMI	Qualcomm MSM Interface