Multiple Channels User Guide for HE863

1vv0300979 Rev.0 – 2011-12-01

Making machines talk.

APPLICABILITY TABLE

PRODUCT
HE863-EUD
HE863-EUG
HE863-EUR
HE863-NAD
HE863-NAG
HE863-NAR
HE863-AUD
HE863-AUG
HE863-AUR

SW Version
11.00.XY2

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Contents

1. Introduction

1.1. Scope

This document deals with an overview of serial interface on Telit production and helps SW application developers to the serial driver layer of the host to control Telit productions, efficiently.

1.2. Audience

This document is intended for SW application developers who are about to implement their serial driver layer with Telit production described in this documents.

1.3. Contact Information, Support

For general contact, technical support, to report documentation errors and to order manuals, contact Telit's Technical Support Center (TTSC) at:

TS-EMEA@telit.com
TS-NORTHAMERICA@telit.com
TS-LATINAMERICA@telit.com
TS-APAC@telit.com

Alternatively, use:

http://www.telit.com/en/products/technical-support-center/contact.php

For detailed information about where you can buy the Telit modules or for recommendations on accessories and components visit:

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Our aim is to make this guide as helpful as possible. Keep us informed of your comments and suggestions for improvements.

Telit appreciates feedback from the users of our information.

1.4. Document Organization

This document contains the following chapters:

"Chapter 1: "Introduction" provides a scope for this document, target audience, contact and support information, and text conventions.

"Chapter 2: "Multiple Channels Architecture" gives an overview and the characteristic of the serial interface on Telit products.

"Chapter 3: "UART Interface" describes the detailed information and the characteristic of UART interface on Telit products

"Chapter 4: "USB Interface" describes the detailed information and the characteristic of USB interface on Telit products

"Chapter 5: "CMUX Interface" describes the MUX protocol implemented on Telit products, the characteristic of each CMUX channels and how to use "Telit serial port mux" tool on Window-OS

1.5. Text Conventions

Danger – This information MUST be followed or catastrophic equipment failure or bodily injury may occur.

Caution or Warning – Alerts the user to important points about integrating the module, if these points are not followed, the module and end user equipment may fail or malfunction

Tip or Information – Provides advice and suggestions that may be useful when integrating the module

All dates are in ISO 8601 format, i.e. YYYY-MM-DD.

1.6. Related Documents

- HE863-Family AT commands Reference Guide Rev.4
- UC864-E/G/WD/WDU AT Commands Reference Guide Rev.6
- CC864-DUAL AT Commands Reference Guide Rev.2
- 3GPP TS 27.007

- 3GPP TS 27.010
- V.250 ITU-T
- USB Class Definitions for Communication Devices version 1.1

2. Multiple Channels Architecture

HE863 products allow DTE to transmit and receive PSD, CSD, GPS, SMS and so on via the multiple channels composed of UART and USB, or CMUX

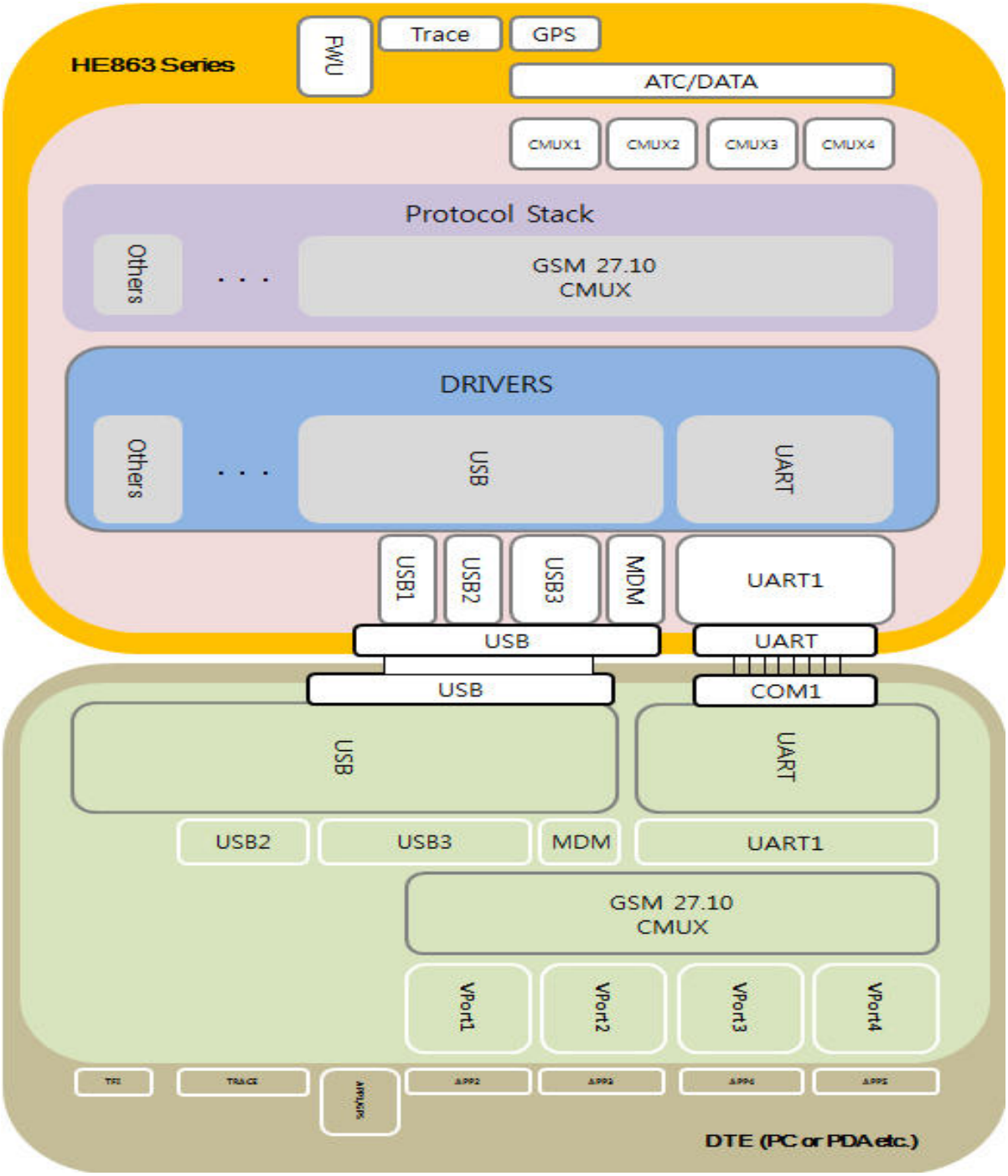

Figure-1 The architecture of multiple channels on HE863

2.1. Multiple Channels Hierarchy

This paragraph deals with the feature of multiple channels designed on HE863. TE should implement their system in conformance with HE863's channel feature.
HE863 offer multiple channels with the following hierarchy to TE

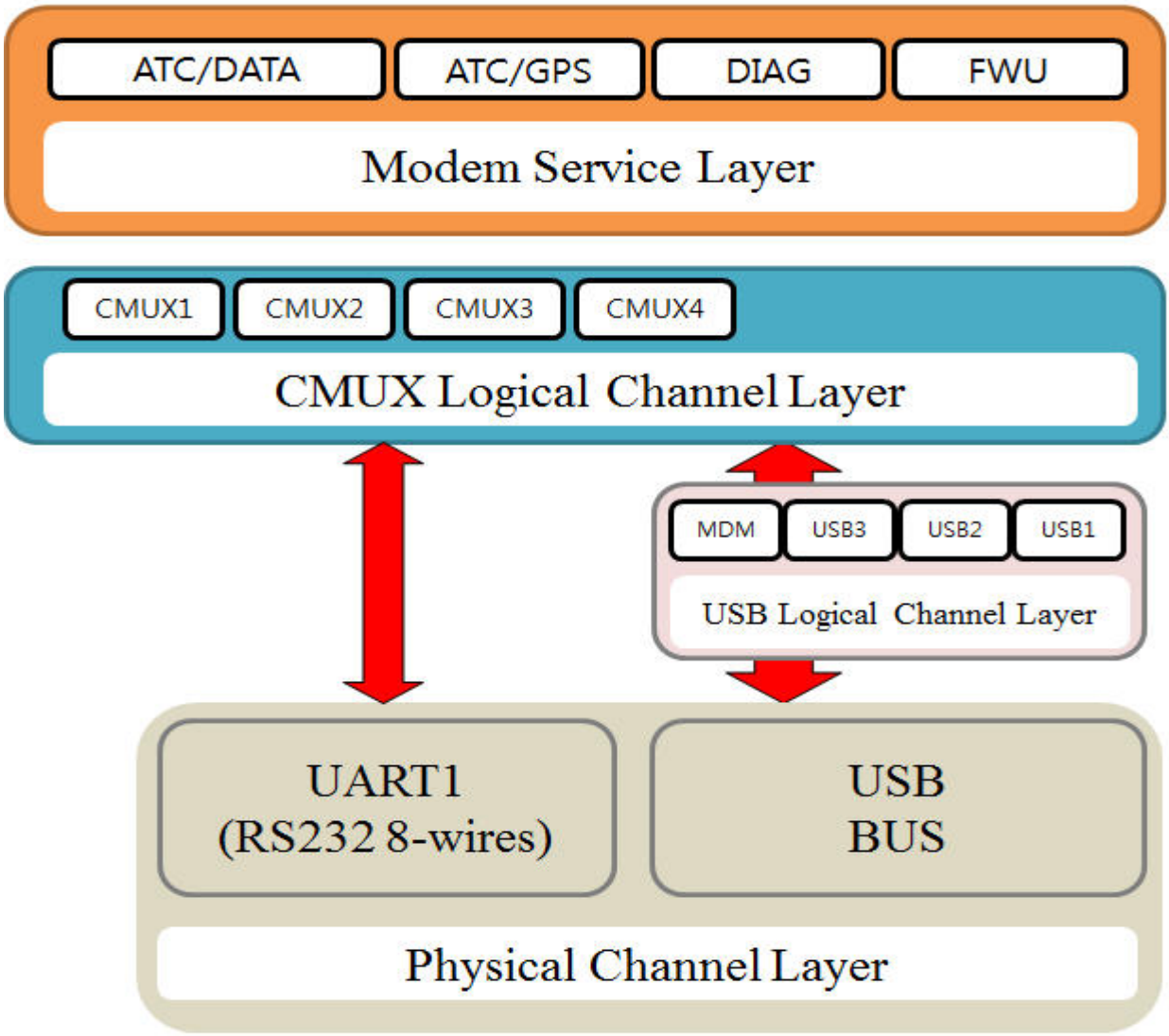

Figure-2 shows the hierarchy of multiple channels on HE863. Basically, HE863 have the characteristic behavior as follows

- USB support 3-interfaces
- CMUX support 4-interfaces
- CMUX is available on MDM, USB3, and UART1
- ATI service could be available via multiple channels at the same time

- In case of GPS products (HE863-EUG, HE863-NAG, HE863-AUG), GPS NMEA data is available on USB3 port.
- FWU(Firmware Upgrade) is available on USB

Table-1 illustrates the available service on each channel.

Channel	ATC	DATA	GPS	TRACE
UART1	√	√		
CMUX1	√	√		
CMUX2	√□	√□	□	□
CMUX3	√□	√□	□	□
CMUX4	√□	√□	□	□
MDM	√□	√□	□	□
USB1	□	□	□	√□
USB2	□	□	□	√□
USB3	□	√□	√□	□

Table-1 the available service on each channel

NOTE:

In case of GPS production (HE863-EUG, HE863-NAG, HE863-AUG), if GPS enabled ($GPSP=1) USB3 is used as GPS service port

WARNING:

Data service on CMUX or UART1 channels result in the lower data-throughput because of the maximum baud rate (6 Mbps) lower than network (HSDPA 7.2 Mbps) throughput

3. UART Interface

This paragraph deals with the capability and available service for each UART.
HE863 allows TE to use one UART, which is used for specific service according to their capability.

	TD (C103)	RD (C104)	RTS (C105)	CTS (C106)	DSR (C107)	DTR (C108)	RI (C125)	DCD (C109)	Available Service
UART1	√	√	√	√	√	√	√	√	DATA (Low Speed), ATC (AT Command)

Table-4 the capability and service for each UART

UART1 fully supports RS-232C 8-wires, and it can be used for DATA service as well as ATC service which allow TE to send/receive AT Commands related to SMS/Voice, Call/Phonebook/Phone status and so on. If CMUX is activated on UART1, It's possible to use several services such as DATA and ATI through virtual channel provided by CMUX, at the same time.
More detailed information for CMUX, refer to "5 CMUX Interface".

4. USB Interface

This paragraph deals with the capability and an available service for each USB interface.
HE863 allows DTE to use two composite of USB interface according to the type of products.

- HE863 USB Composite Device
  - MDM / USB1 / USB2 / USB3

HE863 USB Composite Device provides TE with 4 USB interfaces.

HE863 products provide ACM functionality (RS-232C-RI/DSR/DTR/DCD serial emulation) only on MDM
Below table illustrates the information and available service for each USB interfaces

Port	Vendor ID	Product ID	Interface Number	Transfer type	Number of Endpoint	ACM Serial Emulation	Available Service
MDM	0x1BC7	0x0020	0x00	Interrupt	1	√	DATA (high speed) /ATC
			0x01	Bulk(512)	2		DATA (high speed) ATC
USB1			0x02	Interrupt	1	√	TRACE
			0x03	Bulk(512)	2		TRACE
USB2			0x04	Interrupt	1	√	TRACE
			0x05	Bulk(512)	2		TRACE
USB3			0x06	Interrupt	1	√	DATA (high speed) /ATC
			0x07	Bulk(512)	2	□	DATA (high speed) /ATC

Table-5 the information and service for HE863 USB

All interfaces support ACM functionality, which allow TE use this interface as the high speed DATA port such as PSD service under 2G/3G network as well as ATI service. And HE863 products offer two TRACE channel (USB1 and USB2).
NMEA interface is offered to the product support GPS functionality (HE863-EUG, HE863-NAG, and HE863-AUG)

5. CMUX Interface

This paragraph describes how to use CMUX on HE863. CMUX can be activated on MDM, USB3 and UART1.
This is useful to TE has only one physical channel like as UART1 and want to get the benefit provided by multiple channels. It allows TE to transmit and receive DATA (PPP/Internal TCP/IP/CSD) service and ATC service such as Call Control/SMS/Phonebook and so on through CMUX(3GPP 27.010) channels, simultaneously.

5.1. Implementation feature

The most important characteristics of CMUX are described below.

- 3GPP 27.010 Basic options.
- Support 4 DLCI channels on MDM, USB3, and UART1.
- Each CMUX channel has its own profile
- Every CMUX channel has its own independent flow control
- Other CMUX channels have lower performance than usual case, while High Speed Data service such as HDPA performed on one CMUX channel

5.2. CMUX Protocol

5.2.1. CMUX Frame Structure

All information transmitted between MS and TE with the frame based on the following Structure:

Flag	Address	Control	Length Indicator	Information	FCS	Flag
1 octet	1 octet	1 octet	1 or 2 octets	Unspecified length but integral number of octets	1 octet	1 octet

Flag Octet

Each frame begins and ends with a flag octet defined as
Binary: 11111001 or
Hexadecimal: 0xF9

Address Octet
The form of address octet is as follows:

0	1	2	3	4	5	6	7
EA	C/R	D L C I					

EA: Extension Bit
Should always have the value 1 as the basic option of the protocol

C/R: Command Response
The C/R (command/response) bit identifies the frame as either a command or a response. In conformance with the standard HDLC rules, a command frame contains the address of the data link connection entity to which it is transmitted while a response frame contains the address of the data link connection entity transmitting the frame.

Command/response	Direction			C/R value
Command	TE	→	MS	1
	MS	→	TE	0
Response	TE	→	MS	0
	MS	→	TE	1

Example:

Let's suppose that TE is the one that takes the initiative to initialize the multiplexer (i.e. sends the SABM command at DLCI 0) and that the MS accepts the initialization of the multiplexer (i.e. sends the UA response at DCLI 0).

DLCI: Data Link Connection Identifier
DLCI value identifies the Virtual Port inside MS with the following assignment

DLCI	Virtual Port Type
0	Reserved to Control Channel
1	Virtual Port#1
2	Virtual Port#2
3	Virtual Port#3
4	Virtual Port#4

Control Field
The content of the control field defines the type of frame as in the following table:

Frame Type	0	1	2	3	4	5	6	7
SABM(Set Asynchronous Balanced Mode)	1	1	1	1	P/F	1	0	0
UA(Unnumbered Acknowledgement)	1	1	0	0	P/F	1	1	0
DM(Disconnected Mode)	1	1	1	1	P/F	0	0	0
DISC(Disconnect)	1	1	0	0	P/F	0	1	0
UIH(Unnumbered Information with Header check)	1	1	1	1	P/F	1	1	1

P/F stands for Poll/Final bit:
Command: P=1
Response: F=1

SABM (Set Asynchronous Balanced Mode)
The SABM command is used by TE to start the HDLC Connection and MS will answer to this command with an UA Frame.

UA (Unnumbered Acknowledgement)
The UA response is sent by MS as an acknowledgement that a SABM or DISC command was accepted.

DM (Disconnected Mode)
In case module rejects SABM or DISC command it will send DM response, this happens if for example a SABM is sent for a DLCI not supported. Or if a DISC is sent to a DLCI Address already closed.

DISC (Disconnect)
The DISC is used to close a previously established connection. If TE sends a disc for the DLCI 0(the control channel), all the established channels will be closed. MS will answer to this command with an UA Frame.

UIH (Unnumbered Information)
Please refer to the following chapters for the detailed information about UIH

Length Indicator
This Octet specifies the length of the information field

0	1	2	3	4	5	6	7
EA	L1	L2	L3	L4	L5	L6	L7

E/A Bit should be 1 in case 7 bits are enough for the length (len <= 127) otherwise length should be coded with two octets as described below:

Octet 1

0	1	2	3	4	5	6	7
0	L1	L2	L3	L4	L5	L6	L7

Octet 2

0	1	2	3	4	5	6	7
1	L9	L10	L11	L12	L13	L14	L15

NOTE:

Since the maximum frame length used by Telit implementation is 128, Octet 2 never used.

Codification of the octet (Octet 1=0 and Octet 2=1) derives from 3GPP 27.010

Information Data
The information field is the payload of the frame and carries the user data. The field exists only for frame type that contains UIH Control Field. The P/F bit should be set to value 0 when this field is sent.

FCS (Frame Checking Sequence)
The FCS is calculated over the entire frame, but excluding the flags. Only in case of UIH frame the FCS will not be calculated over the information field.
The FCS is the ones complement of the sum (modulo 2) of
The remainder of $X^k (x^7 + x^6 + x^5 + x^4 + x^3 + x^2 + x^1 + 1)$ divided (modulo 2) by the generator polynomial $x^8 + x^2+x+1$, where k is the number of bits in the frame
See specific chapter with code examples for more implementation details.

5.2.2. UIH Control Channel Frame Coding

DLCI shall always have the value 0

Type	Length Indicator	Value
1 octet	1or2 octets	N Octet

Type Octet:

0	1	2	3	4	5	6	7
EA	C/R	T	Y	P	E		

EA: Extension Bit
Will always be 1.

C/R: Identifies if it is a Command or Response

Length indicator

Specifies the length of the information field and it is code like in the CMUX Frame Structure paragraph.

Value
The number of octets is specified by the Length Indicator and depends on the type of the command. The available command types are listed below:

5.2.2.1. Multiplexer close down (CLD)

The multiplexer close down command is used to reset the link into normal AT command mode without multiplexing

Type	Len
3	0

5.2.2.2. Test Command (Test)

The test command is used to test the connection between MS and TE. The length byte describes the number of values bytes, which are used as a verification pattern. The opposite entity shall respond with exactly the same value bytes.

Type	Len	Value 1	Value 2	Value	Value N
4	N	Any Char	Any Char	Any Char	Any Char

5.2.2.3. Modem Status Command (MSC)

This command is used to send V.24 signal info. This signal is independent for each instance. If DCE receives a MSC command it will always answer with another MSC that will contain its V24 status.

Format without Break Indication

Type	Len	Value 1	Value 2
7	2	DLCI	V24 Octet

Format with Break Indication

Type	Len	Value 1	Value 2	Value 3
7	2	DLCI	V24 Octet	Break Octet

V24 Octet from TE to MS

0	1	2	3	4	5	6	7
0	FC	DSR	CTS	0	0	RING	DCD

V24 Octet from TE to MS

0	1	2	3	4	5	6	7
0	FC	DTR	RTS	0	0	0	0

FC : This bit is set to 1 when MS or TE is not able to accept any frames.
CTS: This bit is set to 1 when MS is able to receive data (ref. command &K,\Q and related)
RTS: This bit is set to 1 when TE is able to receive data (ref. command &K,\Q and related)
DSR: This bit is set to 1 when MS is ready to communicate (ref. command &S and related)
DTR: This bit is set to 1 when TE is ready to receive data (ref. command &D and related)
RING: This bit is set to 1 when MS receive an incoming call (ref. command \R, and related)
DCD: This bit is set to 1 when MS has an active data connection (ref. command &C, and related)

NOTE:

When a new instance is established the default setting are FC=1, RTS=0, DTR=0, this means that MS will not be able to send the data to TE until user change the default setting to FC=0, RTS=1, DTR=1. TE will send an MSC command to change this value before starting sending data

Break Octet

0	1	2	3	4	5	6	7
1	0	0	0	0	0	0	0

This octet will be sent each time a Break Signal is simulated.

5.2.2.4. Non Supported Command Response (NSC)

This response is sent in case a command type is not supported by the receiving entity.

Type	Len	Value 1
8	1	Command Not Supported

5.2.3. UIH Data Channel Frame Coding

DLCI can assume values: 1, 2, 3 or 4

Length Indicator	User Data
1or2 octets	n Octet

Length indicator

Specifies the length of the information field and it is code like in the CMUX Frame Structure paragraph.

User Data
The Number of data is defined by the Length Indicator

5.2.4. CMUX Operation procedure

Figure-5 illustrates how to set up CMUX mode via physical line (UART) and shutdown this mode and restore to AT command mode, gracefully.

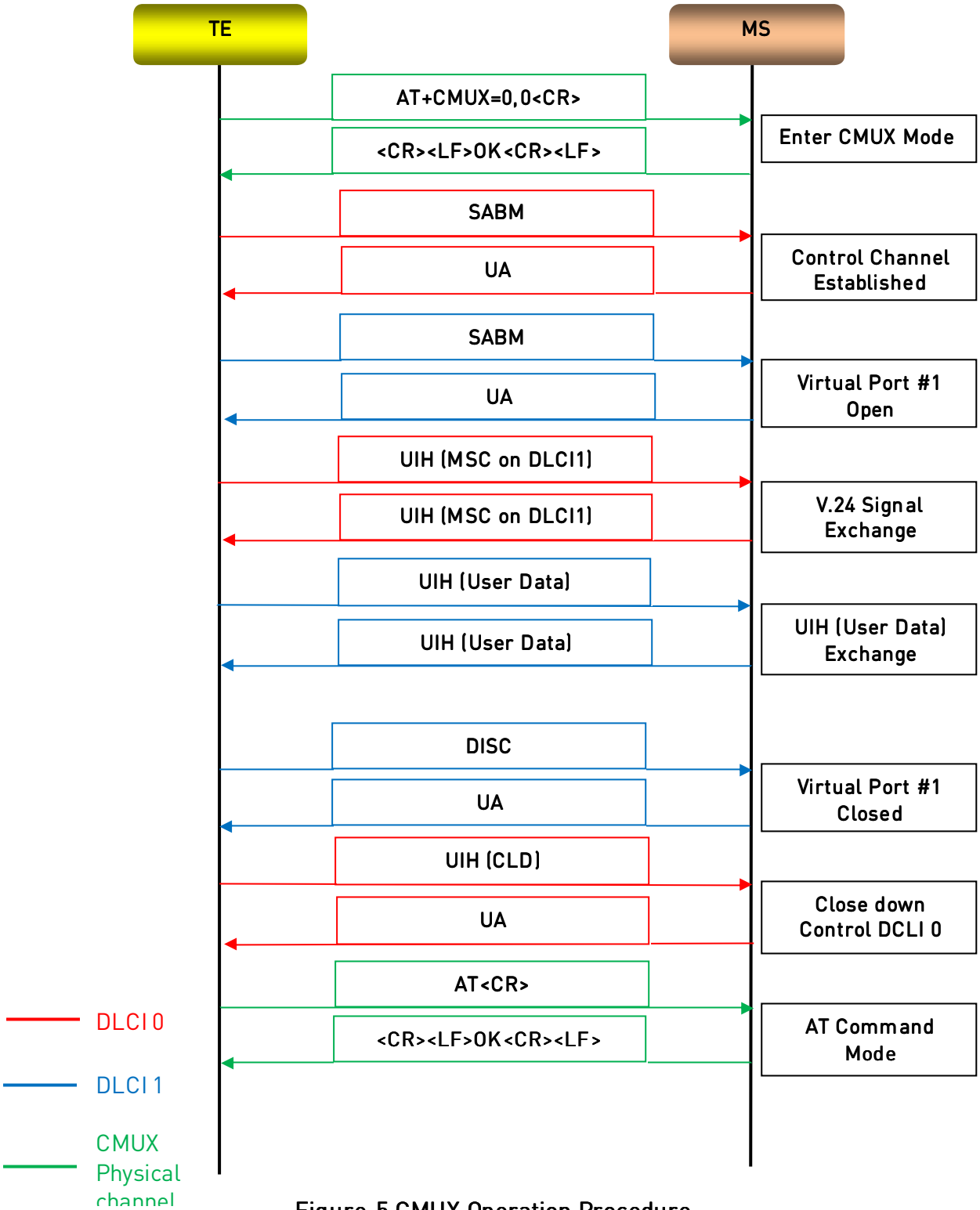

Figure-5 CMUX Operation Procedure

5.2.5. FCS calculation

The following part of the code is provided to make the calculation of FCS.

```
Static const unsigned char crctable[256] = { //reversed, 8-bit, poly=0x07
0x00, 0x91, 0xE3, 0x72, 0x07, 0x96, 0xE4, 0x75, 0x0E, 0x9F, 0xED, 0x7C, 0x09, 0x98, 0xEA, 0x7B,
0x1C, 0x8D, 0xFF, 0x6E, 0x1B, 0x8A, 0xF8, 0x69, 0x12, 0x83, 0xF1, 0x60, 0x15, 0x84, 0xF6, 0x67,
0x38, 0xA9, 0xDB, 0x4A, 0x3F, 0xAE, 0xDC, 0x4D, 0x36, 0xA7, 0xD5, 0x44, 0x31, 0xA0, 0xD2, 0x43,
0x24, 0xB5, 0xC7, 0x56, 0x23, 0xB2, 0xC0, 0x51, 0x2A, 0xBB, 0xC9, 0x58, 0x2D, 0xBC, 0xCE, 0x5F,
0x70, 0xE1, 0x93, 0x02, 0x77, 0xE6, 0x94, 0x05, 0x7E, 0xEF, 0x9D, 0x0C, 0x79, 0xE8, 0x9A, 0x0B,
0x6C, 0xFD, 0x8F, 0x1E, 0x6B, 0xFA, 0x88, 0x19, 0x62, 0xF3, 0x81, 0x10, 0x65, 0xF4, 0x86, 0x17,
0x48, 0xD9, 0xAB, 0x3A, 0x4F, 0xDE, 0xAC, 0x3D, 0x46, 0xD7, 0xA5, 0x34, 0x41, 0xD0, 0xA2, 0x33,
0x54, 0xC5, 0xB7, 0x26, 0x53, 0xC2, 0xB0, 0x21, 0x5A, 0xCB, 0xB9, 0x28, 0x5D, 0xCC, 0xBE, 0x2F,
0xE0, 0x71, 0x03, 0x92, 0xE7, 0x76, 0x04, 0x95, 0xEE, 0x7F, 0x0D, 0x9C, 0xE9, 0x78, 0x0A, 0x9B,
0xFC, 0x6D, 0x1F, 0x8E, 0xFB, 0x6A, 0x18, 0x89, 0xF2, 0x63, 0x11, 0x80, 0xF5, 0x64, 0x16, 0x87,
0xD8, 0x49, 0x3B, 0xAA, 0xDF, 0x4E, 0x3C, 0xAD, 0xD6, 0x47, 0x35, 0xA4, 0xD1, 0x40, 0x32, 0xA3,
0xC4, 0x55, 0x27, 0xB6, 0xC3, 0x52, 0x20, 0xB1, 0xCA, 0x5B, 0x29, 0xB8, 0xCD, 0x5C, 0x2E, 0xBF,
0x90, 0x01, 0x73, 0xE2, 0x97, 0x06, 0x74, 0xE5, 0x9E, 0x0F, 0x7D, 0xEC, 0x99, 0x08, 0x7A, 0xEB,
0x8C, 0x1D, 0x6F, 0xFE, 0x8B, 0x1A, 0x68, 0xF9, 0x82, 0x13, 0x61, 0xF0, 0x85, 0x14, 0x66, 0xF7,
0xA8, 0x39, 0x4B, 0xDA, 0xAF, 0x3E, 0x4C, 0xDD, 0xA6, 0x37, 0x45, 0xD4, 0xA1, 0x30, 0x42, 0xD3,
0xB4, 0x25, 0x57, 0xC6, 0xB3, 0x22, 0x50, 0xC1, 0xBA, 0x2B, 0x59, 0xC8, 0xBD, 0x2C, 0x5E, 0xCF
};

static UINT8 CalcFCS( UINT8 *buf, int len)
{
 UINT8 FCS=0xFF;
 if ((buf[1]& CMUX_PF_BIT_NEG) == CMUX_UIH_FRAME)
   len = 3;

 while (len--) FCS=crctable[FCS^*buf++];

 return (0xFF-FCS);
}

static int CheckFCS( UINT8 *buf, int len)
{
 UINT8 FCS=0xFF;
 UINT8 crc;

 if ((buf[1]& CMUX_PF_BIT_NEG) == CMUX_UIH_FRAME)
 {
   crc=buf[len-1];
   if (buf[2]&0x1)
```

```
    len = 3;
   else
    len = 4;
   while (len--)
   {
    FCS=crctable[FCS^*buf++];
   }
   FCS=crctable[FCS^crc];
 }
 else
   while (len--)
   {
    FCS=crctable[FCS^*buf++];
   }
 /*0xCF is the reversed order of 11110011.*/
 return (FCS==0xCF);
}
```

5.3. Integrator Hints

5.3.1. Basic requirement

The customer/integrator observes the following requirement in order to design its own multiplexer application.

- Support the basic option according to 3GPP 27.010
- Character framing must be configured for 8 data bits, no parity and 1 stop bit.
- Use hardware flow control with multiplexer mode and set before entering in multiplexer mode with command AT&K3
- DTR Lines should be set correctly (pull-up), since a transition of the DTR cause closing of multiplexer.

5.3.2. Restriction

If HE863 is operating in multiplexer mode, the following restrictions will be applied:

- Software flow control XON/XOFF flow control is not supported in multiplexer mode.
- The escape sequences `+++` will not be detected by MS, It is responsibility of the application to use the break octet of the MSC (Modem Status Command) instead. Break octet of the MSC produce the same effect as `+++` escape sequence

5.4. Telit Serial Port Mux

5.4.1. Interface Specification

Telit has developed a tool called Telit Serial Port MUX in order to make easier application of the CMUX mode. It is a PC interface able to manage data coming/to or being sent from/to CMUX. This target has been achieved by creating up to four serial virtual ports on the PC and using a specific communication protocol to manage the communication between the real serial COM that changes data with CMUX and each of the virtual port

5.4.2. Scenario

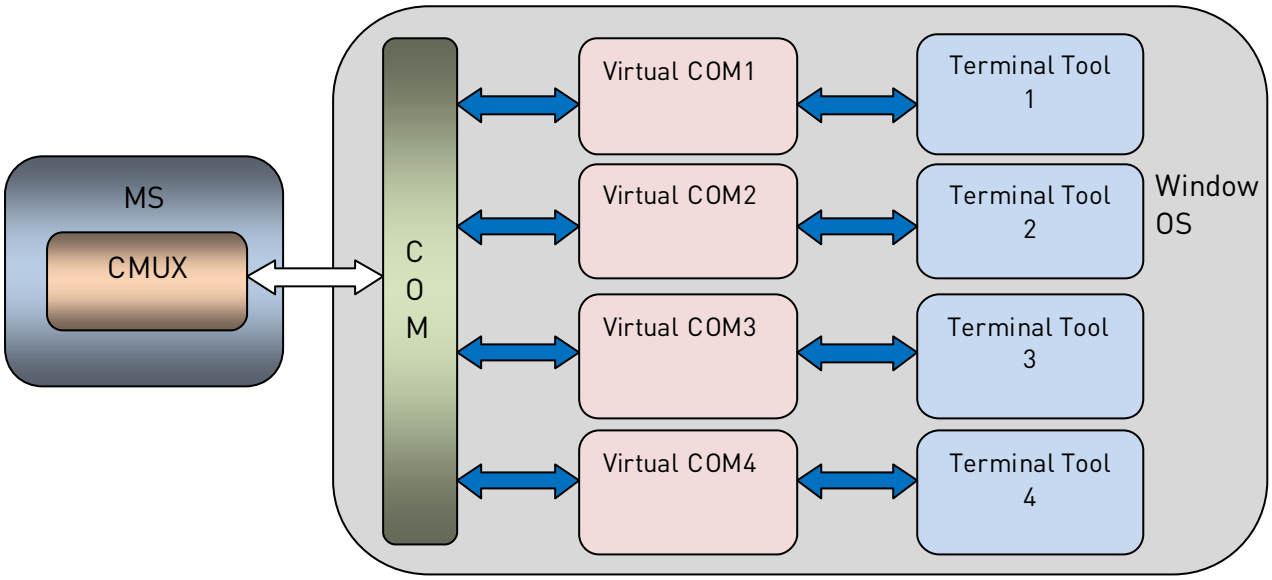

Figure-6 Virtual Port configuration on Window OS

As you can see, it's possible to run 3 different applications using the CMUX channels. For example 3- HyperTerminal can send AT commands at the same via the CMUX channels

5.4.3. Graphical Interface

Telit Serial Port Mux application on your PC after installation looks as in the following figure:

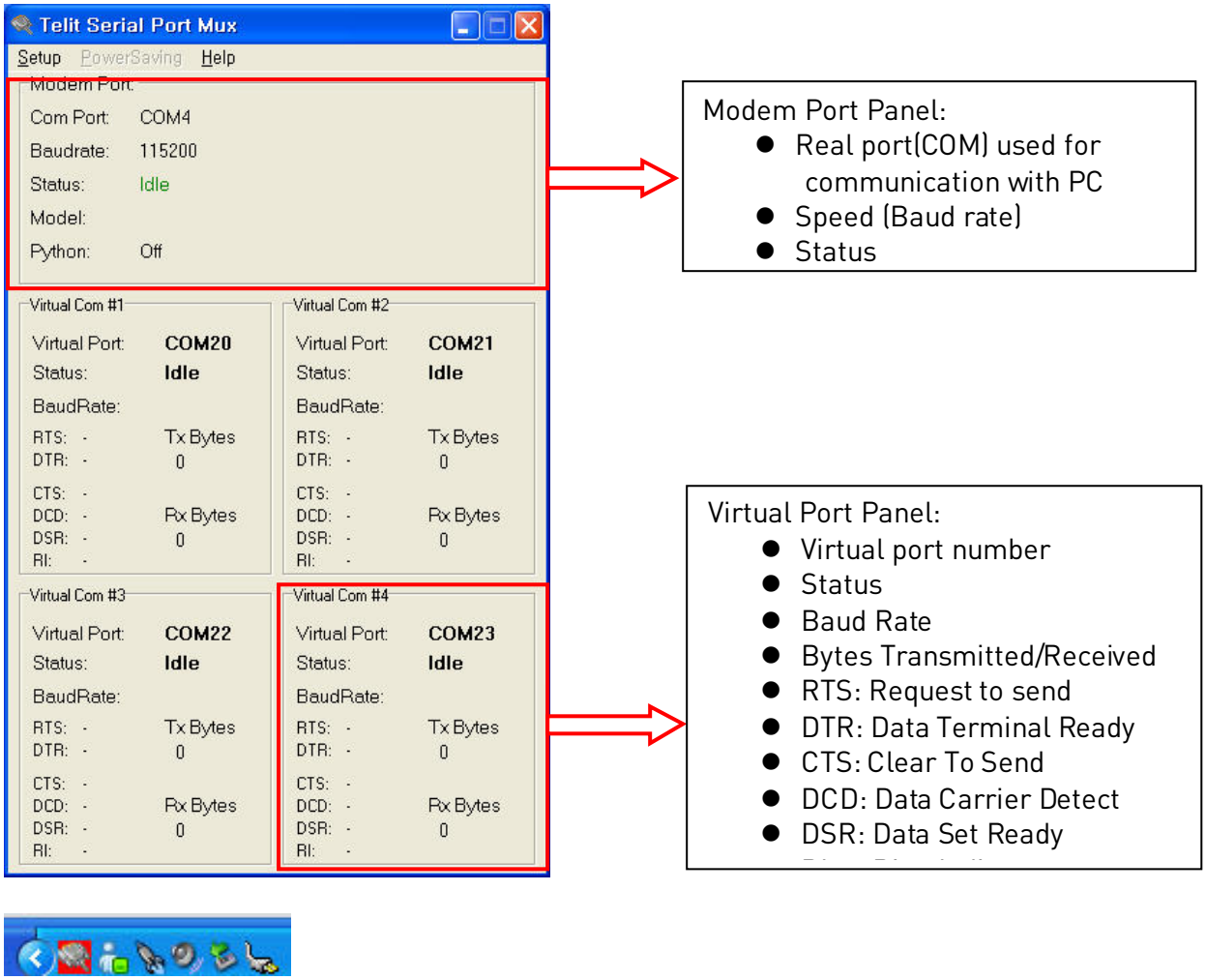

Figure-7 Telit Serial Port Mux Graphical Interface

Modem Port Panels: contains information about the modem connected to your PC, such as:

1. Which COM on your PC will be used to transfer data(this can be set during the initial setup or in the Setup voice of the application menu)
2. COM Speed selected.
3. Connection Status: it can be "idle" or "error" when CMUX is disconnected, "connecting" when PC is trying to connect to CMUX and "connected" when CMUX is connected, successfully
4. Indication about the model of the modem connected.

Virtual Port Panel: here you can find all the information about the connection using a Virtual COM installed on your PC:

1. Virtual COM number
2. Virtual Port Status: it can be "idle", "Error", "Opened".

3. Baud Rate
4. Number of bytes received and transmitted(RX Bytes, TX Bytes)
5. All the common serial port signal like RTS,DTR,CTS,DCD,DSR and RI

Tray Icon: indicates the status of the Serial Port Mux

1.  CMUX connected: the Tray Icon is blinking

2.  CMUX disconnected or connecting

3.  CMUX error.

5.4.4. Application Setup

In order to select the number of Virtual ports that are going to be created, real COM ports that are going to be used and their speed you should go to the Setup menu. These setups can be done during the tool installation and also when the tool is running

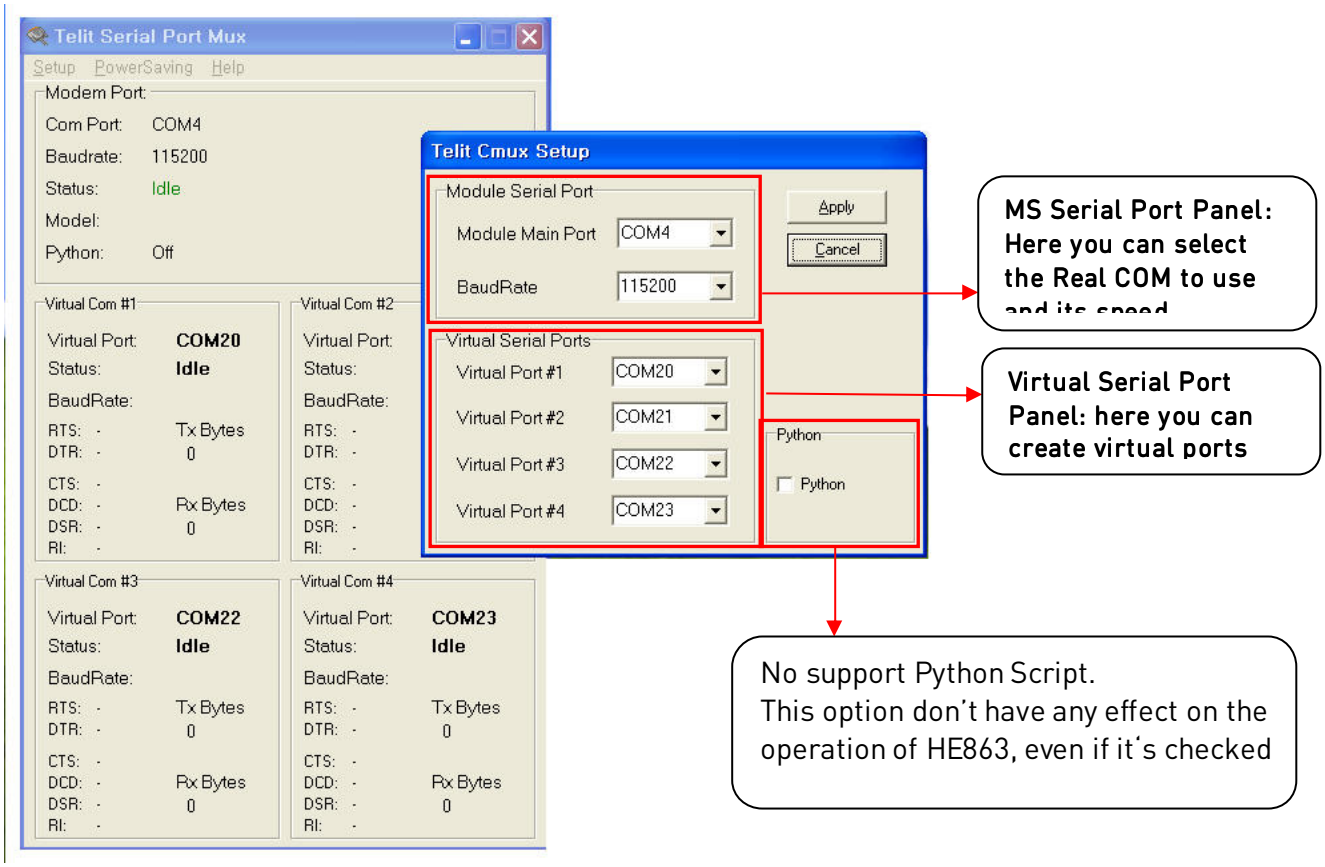

Figure-8 Telit Serial Port Mux Setup

Virtual Ports created can also be visualized in the Device Manager.

6. List of acronyms

Abbreviation	Description
ABM	Asynchronous Balanced Mode
ACM	Abstract Control Model
ATC	AT Command
CSD	Circuit Switch Data
CTS	Clear To Send (Circuit 106)
DCD	Data Carrier Detect (Circuit 109)
DCE	Data Communications Equipment
DCLI	Data Link Connection Identification
DM	Disconnected Mode
DSR	Data Service Ready (Circuit 107)
DTE	Data Terminal Equipment
DTR	Data Terminal Ready (Circuit 108/2)
FCS	Frame Check Sequence
FWU	Firmware Upgrade
GPRS	General Packet Radio Service
GPS	Global Positioning System
NMEA	National Marine Electronics Association
MS	Mobile Station
MSC	Modem Status Command
PSD	Packet Switch Data
RD	Received Data (Circuit 104)
RI	Ring Indicator (Circuit 125)
RS-232C	Recommended Standard 232C
RTS	Request To Send (Circuit 105)
SABM	Set Asynchronous Balanced Mode
SMS	Short Message Service
TD	Transmitted Data (Circuit 103)
TE	Terminal Equipment
TFI	Telit Firmware Installer
UART1	Universal Asynchronous Receiver Transmitter 1
UART2	Universal Asynchronous Receiver Transmitter 2
UIH	Unnumbered Information with header Check
URC	Unsolicited Result Code
USB	Universal Serial Bus
USB AUX	Telit USB Auxiliary Port
USB DIAG	Telit Diagnostics Interface
USB MDM	Telit HSDPA /CDMA Wireless Modem
USB NMEA	Telit Nmea Port

6.1. Document History

Revision	Date	Changes
0	2011-12-01	First issue