

CMUX User Guide

30268ST10299A Rev. 5 – 2011-03-01



APPLICABILITY TABLE

PRODUCT
GT863-PY
GT864-QUAD
GT864-PY
GM862-GPS
GC864-QUAD
GC864-DUAL
GC864-QUAD V2
GC864-DUAL V2
GE863-QUAD
GE863-GPS
GE863-SIM
GE863-PRO ³
GE864-QUAD
GE864-QUAD V2
GE864-DUAL V2
GE864-QUAD Automotive V2
GE864-QUAD Atex
GE865-QUAD
GL865-DUAL
GL865-QUAD

From SW Version:

7.02.04 / 7.03xx0



Contents

1. Introduction	5
1.1. Scope	5
1.2. Contact Information, Support	5
1.3. Text Conventions	6
1.4. Related Documents	6
1.5. Document History	6
2. Technical characteristics	7
2.1. Product architecture	7
2.2. Implementation feature.....	9
3. Serial Multiplexer Protocol	10
3.1. CMUX Frame Structure	10
3.2. UIH Control Channel Frame Coding	14
3.3. UIH Data Channel Frame Coding	19
3.4. CMUX establishment scenario.....	20
3.5. CMUX establishment scenario typical log	21
3.6. Lookup table for FCS calculation	22
4. INTEGRATOR HINTS	24
4.1. Basic requirement.....	24
4.2. Restriction	24
4.3. Exception to independent profile setting	26
4.4. Suggestion.....	27
5. Telit serial port PC interface for CMUX	28
5.1. Interface Specification.....	28
5.2. Scenario	28
5.3. Graphical Interface.....	29
5.4. Application Setup.....	31
6. AT Commands	32



DISCLAIMER

The information contained in this document is the proprietary information of Telit Communications S.p.A. and its affiliates ("TELIT").

The contents are confidential and any disclosure to persons other than the officers, employees, agents or subcontractors of the owner or licensee of this document, without the prior written consent of Telit, is strictly prohibited.

Telit makes every effort to ensure the quality of the information it makes available. Notwithstanding the foregoing, Telit does not make any warranty as to the information contained herein, and does not accept any liability for any injury, loss or damage of any kind incurred by use of or reliance upon the information.

Telit disclaims any and all responsibility for the application of the devices characterized in this document, and notes that the application of the device must comply with the safety standards of the applicable country, and where applicable, with the relevant wiring rules.

Telit reserves the right to make modifications, additions and deletions to this document due to typographical errors, inaccurate information, or improvements to programs and/or equipment at any time and without notice.

Such changes will, nevertheless be incorporated into new editions of this document.

Copyright: Transmittal, reproduction, dissemination and/or editing of this document as well as utilization of its contents and communication thereof to others without express authorization are prohibited. Offenders will be held liable for payment of damages. All rights are reserved.

Copyright © Telit Communications S.p.A. 2011.



1. Introduction

The information presented in this document is believed to be accurate and reliable. However, no responsibility is assumed by Telit Communications S.p.A. for its use, nor any infringement of patents or other rights of third parties which may result from its use. No license is granted by implication or otherwise under any patent rights of Telit Communications S.p.A. other than for circuitry embodied in Telit products. This document is subject to change without notice.

1.1. Scope

The scope of this document is to describe a multiplexing protocol implemented on the Telit module. The multiplexing protocol can be used to send any data, SMS, fax, TCP data.



NOTE:

CMUX can be activated only with the interface SELINT 2; this means that for the modules which start as default in SELINT 0 or SELINT 1¹, before activating CMUX, interface should be changed to SELINT 2.

1.2. 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:

<http://www.telit.com>

To register for product news and announcements or for product questions contact Telit's Technical Support Center (TTSC).

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

¹ please consult AT Commands Reference Guide 80000ST10025a for more information



Telit appreciates feedback from the users of our information.

1.3. 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.

1.4. Related Documents

The following is a list of applicable documents downloadable from the Download Zone section of Telit’s website <http://www.telit.com>

- Digital Cellular Telecommunications Systems (Phase 2+); Terminal Equipment to Mobile Station (TE-MS) “Multiplexer Protocol”; ETSI TS 101 369 V7.1.0 (1999-11), GSM 07.10 Version 7.1.0, Release 199

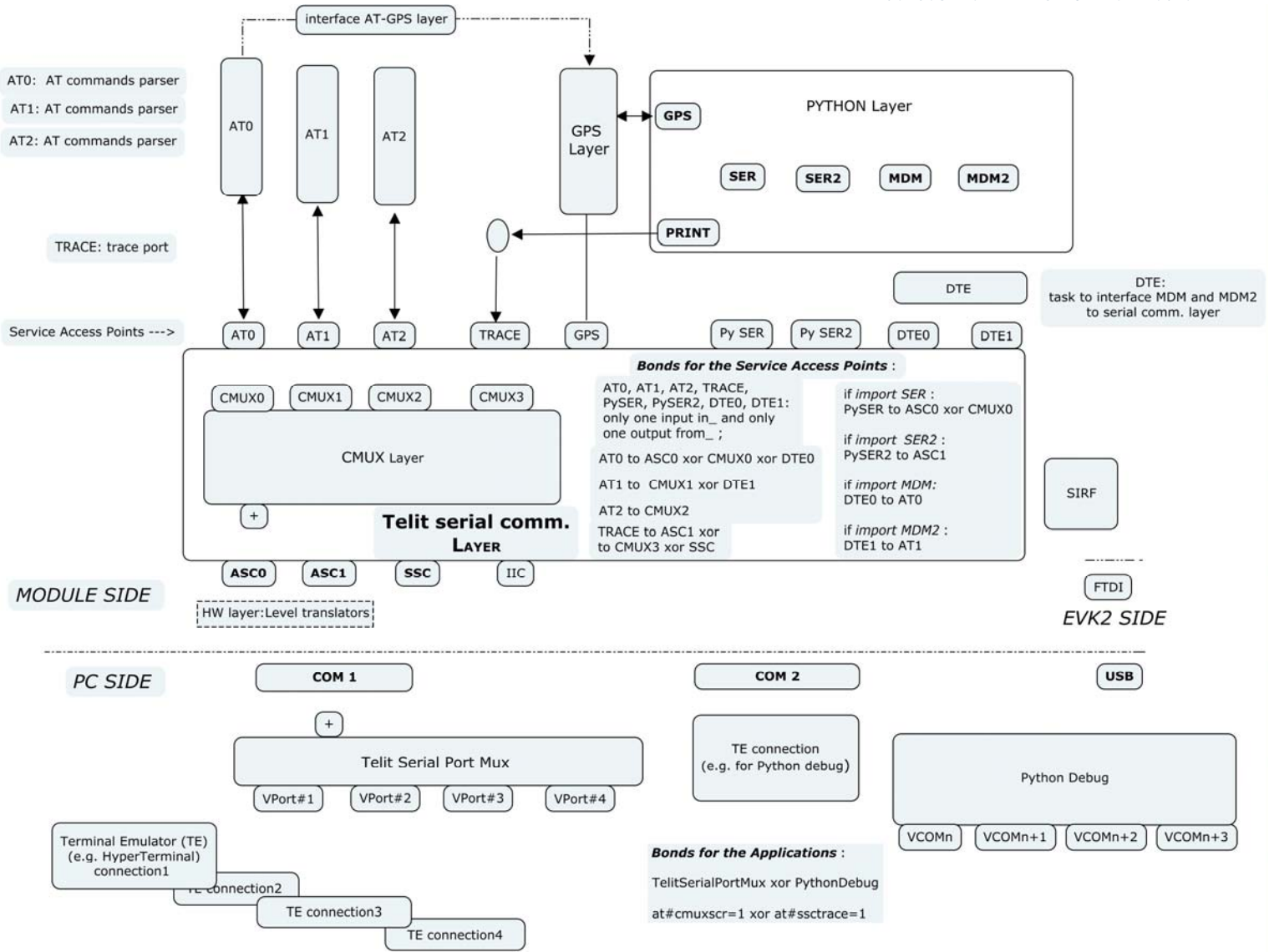
1.5. Document History

Revision	Date	Changes
ISSUE #0	2006-10-13	Initial release
ISSUE #1	2007-09-07	Added products into the applicability table
ISSUE #2	2008-02-01	6.1 How to begin: updated general overview of the document 4.1 CMUX Frame Structure: updated Added PSC (Power Saving Control) paragraph 4.2 General review of document
ISSUE #3	2009-01-19	Update P/N list and applicability table
ISSUE#4	2010-11-25	Cleared bit positions uncertainty about commands format.
ISSUE#5	2011-03-01	New Layout (added chapter 1) Updated Applicability table



CMUX User Guide

30268ST10299A Rev. 5 – 2011-03-01



Telit serial communications and AT interface layer



2.2. Implementation feature

Some of the most important characteristics of CMUX are described below.

- 7.10 CMUX Basic Option used
- CMUX implementation support four full DLCI (Serial Port)
- Every CMUX instance has its own user profile storage in NVM
- Independent setting of unsolicited message.
- In case of GPS product one serial port can be dedicated to NMEA output.
- Every CMUX instance has its own independent flow control.



3. Serial Multiplexer Protocol

3.1. CMUX Frame Structure

All information transmitted between the module and the application are based on frame that has the following frame Structure:

Flag	Address	Control	Length Indicator	Information	FCS	Flag
1 octet	1 octet	1 octet	1or2 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 the following:

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	Application → Module	1
	Module → Application	0
Response	Application → Module	0
	Module → Application	1



Example:

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

DLCI: Data Link Connection Identifier

DLCI value identifies the Virtual Port inside the Module 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	Reserved for Python debug

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:

Commands: P=1

Response: F=1

SABM (Set Asynchronous Balanced Mode)

The SABM command is used by the application to start the HDLC Connection and module will answer to this command with an UA Frame.

UA (Unnumbered Acknowledgement)

The UA response is sent by the module as an acknowledgement that a SABM or DISC command was accepted.



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.²

See specific chapter with code examples for more implementation details.

² refer to the ETSI Specification 07.10



3.2. 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:

1. Multiplexer close down (CLD)

The multiplexer close down command is used to reset the link into normal AT command mode without multiplexing. Least Significant bit is on left side of the octet:

LSb		MSb LSb						MSb							
Type ³		Len													
E/A	C/R	0	0	0	0	1	1	E/A	0	0	0	0	0	0	0

³ Type value is based on the GSM 07.10





NOTE:

During the power saving mode module will not able to receive any character on the serial interface. For further detail how to exit from power saving refer to SW User Guide document.

Chapter 5.4.7 of FSM 07.10 are not applicable to Telit Module.



3.3. UIH Data Channel Frame Coding

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

Length Indicator	User Data
1 or 2 octets	n Octet

Length indicator

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

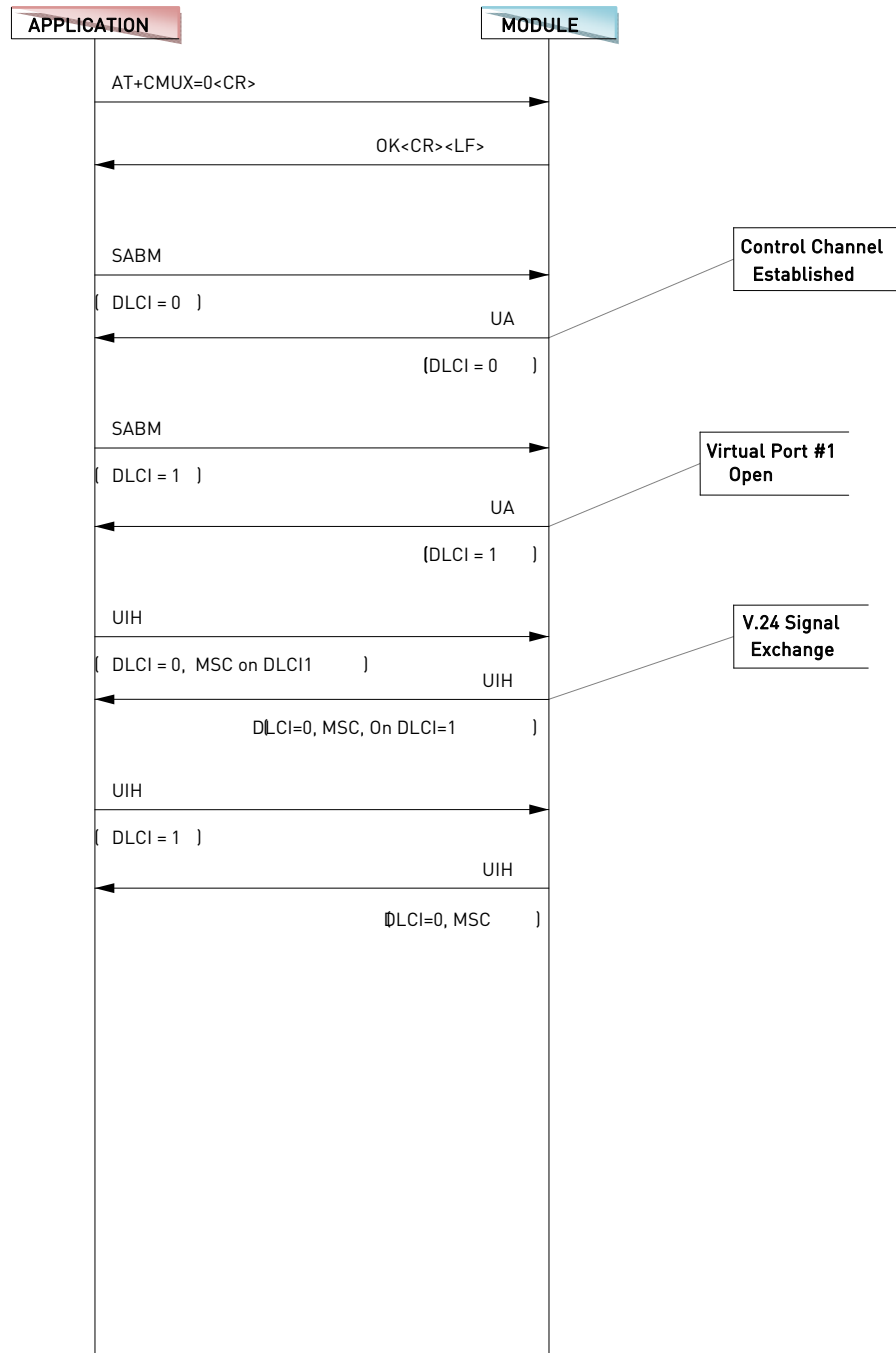
User Data

The Number of data is defined by the Length Indicator



3.4. CMUX establishment scenario

MSC CMU Establishment



3.5. CMUX establishment scenario typical log

Red - commands sent from Application to Module
 Green - commands sent form Module to Application
 Black - Comments

```
// ASCII Log
AT#SELINT=2      -Make sure that Interface selection is equal 2
OK
ATE0V1&K3&D2    -Disable Echo, Activate Hardware Flow Control, Program the DTR to disconnect
OK
AT+CMUX=0        -Start MUX protocol
OK
```



NOTE:

After Multiplexer is established the AT Instance 1 is removed from the Physical Serial port and mapped to Virtual COM1. The settings ATE0V1&K3&D2 will be available on Virtual port #1.

```
// Hexadecimal Log

F9 03 3F 01 1C F9      -DLCI = 0,   SABM CMD,   POLL BIT SET
F9 03 73 01 D7 F9      -DLCI = 0,   UA RESPONSE, FINAL BIT SET
CMUX Protocol Established

F9 07 3F 01 DE F9      -DLCI = 1,   SABM CMD,   POLL BIT SET
F9 07 73 01 15 F9      -DLCI = 1,   UA RESPONSE, FINAL BIT SET
Virtual Port #1 Opened

F9 03 EF 09 E3 05 07 0C FB F9  -DLCI = 0, UIH Frame, MSC Cmd   for DLCI 1
Application Set FC=0, RTS=1, DTR=1 for Virtual Com 1

F9 03 EF 09 E1 05 07 0C FB F9  -DLCI = 0, UIH Frame, MSC Cmd   for DLCI 1
Module Set FC=0, RTS=1, DTR=1, RING=0, DCD=0 for Virtual Com 1
Ready to send AT Command on Instance #1

F9 07 EF 11 41 54 2B 43 47 4D 52 0D 2B F9  -Send Command AT+CGMR
F9 05 EF 27 0D 0A 30 37 2E 30 32 2E 35 30 34 0D 0A 0D 0A 4F 4B 0D 0A 8° F9
-Answer from module is <CR><LF>07.02.504<CR><LF><CR><LF><OK>

F9 03 EF 05 41 00 F2 F9      - Send PSC = 0 Command
```



To wake up the module or the Application Toggle refer to the AT command AT+CFUN=0.

3.6. Lookup table for FCS calculation

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

```
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;

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

    return (0xFF-FCS);
}

static int CheckFCS( UINT8 *buf, int len)
```



4. Integrator hints

4.1. Basic requirement

The customer/integrator in order to design its own multiplexer application must follow these basic requirements:

- The GSM engine supports the basic option and UIH Framing according to GSM 07.10;
- Character framing must be configured for 8 data bits, no parity and 1 stop bit;
- It is recommended to use the hardware flow control with multiplexer mode and it should be set before you enter in Multiplexer mode with command AT&K3;
- DTR Lines should be set correctly (pull-up), since a transition of the DTR causes closing of multiplexer.

4.2. Restriction

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

- Software flow control XON/XOFF flow control is not supported in multiplexer mode.
- Call control: a voice call can be initiated, answered and closed on any channel
- Call control: Data or Fax call can be initiated and answered on any channel but closed only on the channel where the call was started/answered
- Phonebook access: if you wish to write the same phonebook entry on two or more different channels at the same time, please note that only the last entry will be stored;
- When in Multiplexed mode, the escape sequence '+++ ' will not be detected by the module. 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.
- The commands reported in the table below are ignored in case of Multiplexer mode. To be more precise it is possible to read/write values but they will have no effect on the behavior of the module



AT+IPR	
AT+IFC	
AT+ICF	
ATS2; ATS12; '+++'	Escape sequence is not handled by the Module but shall be handled by the applicator that will send a BREAK signal to the module using the MSC command
ATS25	Module will recognize DTR off as soon as the MSC command is received
AT+CMUX	
AT#SELINT	
AT&F, ATZ, AT#Z	Default value of previous ignored command are reset but not applied

- Due to some restriction in the GSM/GPRS standard or limitation of the software some AT commands will not be executed in parallel by the module. If one of the following commands are requested to be executed on one AT Instance while one of this command is running on another instance, the latest execution is suspend until the first request is completed
 - ATA <Until CONNECT is not displayed>
 - ATD <Until CONNECT is not displayed>
 - ATO
 - ATH
 - AT#CAMEN
 - AT#TPHOTO
 - AT+CGATT <Set command>
 - AT+CGACT
 - AT+COPS <Set Command or Test Command>
 - AT+CREG <Set Command>
 - AT#SEMAIL <Blocked after Ctrl-z is sent>
 - AT#EMAILD <Blocked after Ctrl-z is sent>
 - AT#SKTOP <Until CONNECT is not displayed>
 - AT#SKTD <Until CONNECT is not displayed>
 - AT#QDNS
 - AT+CAMM
 - All FTP Command
 - All CSURV Command
 - All Supplementary Service Command
 - All Phone Book related command





NOTE:

This limitation is appears only when two or more of the commands listed above are combined. For a simple example commands AT#MONI, +CGMR, AT+COPS? Will always be executed without suspension since only one of the commands listed above is running.

For Further restriction on behavior of other command please refer to the specific documentation such as AT Commands Reference Guide, Easy GPRS User Guide, SIM Access Profile User Guide.

4.3. Exception to independent profile setting

Every instance has its own user profile stored in NVM, with the exception of the following AT commands that will modify the global operation of the system, independently from the CMUX instance that is using them.

- AT#HFMICG
- AT#HSMICG
- AT+CMUT
- AT#STM
- AT#SHFEC
- AT#CAP
- AT+CLVL
- AT#SRS
- AT+CRSL
- AT#SRP
- AT#NITZ
- AT+CALM
- AT#SHFSD
- AT#DAC
- AT+CFUN
- AT+COPS
- AT#CODEC
- AT#DVI
- AT#E2SMSRI
- AT#E2SLRI
- AT+CSCB

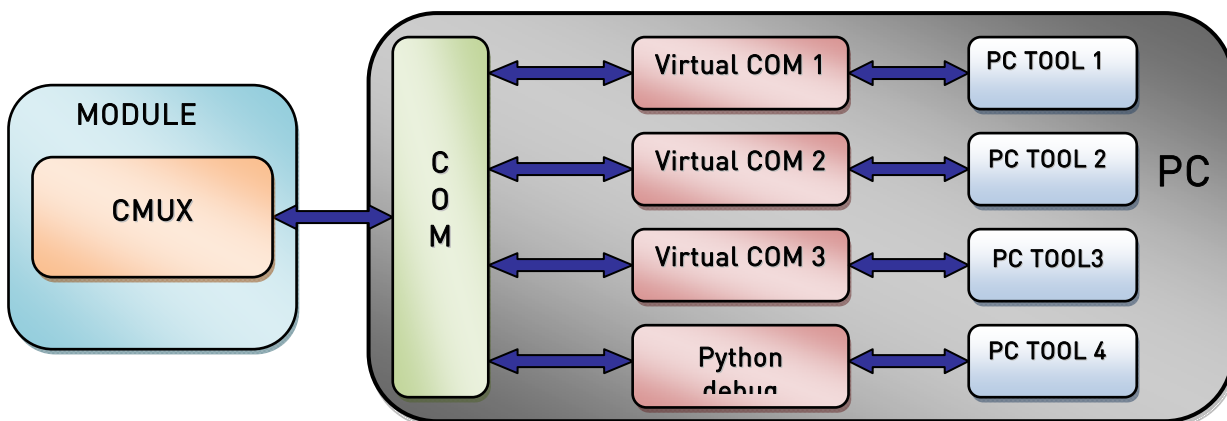


5. Telit serial port PC interface for CMUX

5.1. 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.

5.2. Scenario



As you can see, it is possible to run 3 different applications using the same CMUX module, for example 3 HyperTerminal can send AT commands at the same time to the same module.



5.3. Graphical Interface

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

Modem Port Panel:

- Real port (COM) used for communication with PC
- Speed (Baud rate)
- Status

Virtual Port Panel:

- Virtual port number
- Status
- Baud Rate
- Bytes Transmitted\Received
- RTS: Request to send
- DTR: Data Terminal Ready
- CTS: Clear To Send
- DCD: Data Carrier Detect
- DSR: Data Set Ready
- RI: Ring Indicator

Tray icon: when Telit Serial Port Mux is working, there is a Tray Icon that shows the state of the connection

Modem Port Panel: 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)



CMUX User Guide




30268ST10299A Rev. 5 – 2011-03-01

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”, “idle no DCD”, “Error”, “Opened”.
3. Baud Rate.
4. Number of bytes received and transmitted (RX Bytes, TX Bytes).
5. All the common serial port signals like RequestToSend, DataTerminalReady, ClearToSend, DataCarrierDetected, DataSetReady and RingIndicator.

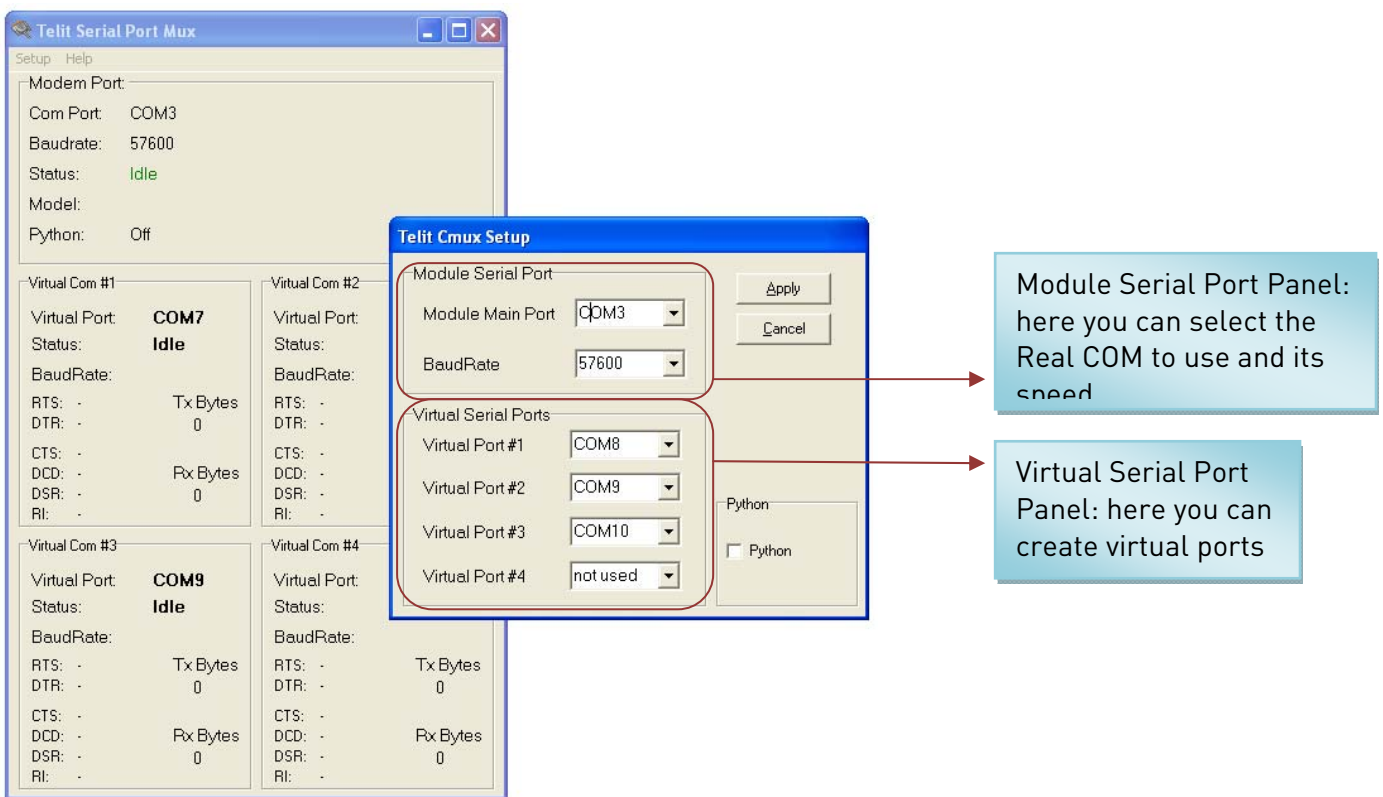
Tray Icon: indicates the status of the Serial Port Mux:

1.  CMUX connected: the Tray Icon is blinking.
2.  CMUX disconnected or connecting.
3.  CMUX error.



5.4. 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.



The image shows two overlapping windows from the Telit software. The background window is 'Telit Serial Port Mux' and the foreground window is 'Telit Cmux Setup'.

Telit Serial Port Mux:

- Modem Port: Com Port: COM3, Baudrate: 57600, Status: Idle, Model: , Python: Off
- Virtual Com #1: Virtual Port: COM7, Status: Idle, BaudRate: , Tx Bytes: 0, Rx Bytes: 0
- Virtual Com #2: Virtual Port: , Status: , BaudRate: , Tx Bytes: 0, Rx Bytes: 0
- Virtual Com #3: Virtual Port: COM9, Status: Idle, BaudRate: , Tx Bytes: 0, Rx Bytes: 0
- Virtual Com #4: Virtual Port: , Status: , BaudRate: , Tx Bytes: 0, Rx Bytes: 0

Telit Cmux Setup:

- Module Serial Port: Module Main Port: COM3, BaudRate: 57600
- Virtual Serial Ports: Virtual Port #1: COM8, Virtual Port #2: COM9, Virtual Port #3: COM10, Virtual Port #4: not used
- Buttons: Apply, Cancel
- Python: Python

Callouts:

- Module Serial Port Panel:** here you can select the Real COM to use and its speed
- Virtual Serial Port Panel:** here you can create virtual ports

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



6. AT Commands

AT commands related to the CMUX feature are the following:

command	description
+CMUX	Enable/Disable Multiplexing Mode
#CMUXSCR ⁷	CMUX Script Enable

For more detailed information please refer to AT Commands Reference Guide 80000ST10025a.

⁷ only for the modules with Python feature

