

Telit's CMUX Implementation User Guide

1VW0300994 Rev. 2 – 2012-07-05



APPLICABILITY TABLE

NOTICE: *the product features covered by the present document are supported by the products having a software version equal or greater than the versions showed on the following table. The platform version is indicated by the first two digits (e.g. 07, 10, etc.). The **software version** is indicated by the digits in bold style.*

If some features are changed/improved during the product evolution path and the changes/improvements are strictly connected with a particular platform or software version, suitable information will be pointed out on the document where it will be required.

	Platform & Software Ver.
GM Family (Modem)	
GM862-GPS	07. 03 .xx3
GC Family (Compact)	
GC864-QUAD	10. 00 .xx5
GC864-QUAD-V2	10. 00 .xx5
GC864-DUAL-V2	10. 00 .xx5
GE/GL Family (Embedded)	
GE863-GPS	07. 03 .xx3
GE863-PRO3	07. 03 .xx3
GE864-QUAD	10. 00 .xx5
GE864-QUAD-V2	10. 00 .xx5
GE864-QUAD-Automotive-V2	10. 00 .xx5
GE864-QUAD-ATEX	10. 00 .xx5
GE864-DUAL-V2	10. 00 .xx5
GE864-GPS	10. 00 .xx5
GE865-QUAD	10. 00 .xx5
GL865-DUAL	10. 00 .xx5
GL865-QUAD	10. 00 .xx5
GL868-DUAL	10. 00 .xx5
GE910-QUAD	13. 00 .xx2
GT Family (Terminal)	
GT863-PY	10. 00 .xx5
GT864-QUAD	10. 00 .xx5
GT864-PY	10. 00 .xx5
HE910 Family	
HE910 ¹	12. 00 .xx2
HE910-GA	12. 00 .xx2
HE910-D	12. 00 .xx2
HE910-EUR / HE910-EUD	12. 00 .xx2
HE910-EUG / HE910-NAR	12. 00 .xx2
HE910-NAD / HE910-NAG	12. 00 .xx2
HE863 Family	
HE863-X	11.xx.xxx
UC864 Family	
UC864-X	08.xx.xxx

Tab. 1: Covered Modules Families

¹ HE910 is the “type name” of the products marketed as HE910-G & HE910-DG



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1. Introduction

The purpose of the present document is to provide the reader with the necessary information to develop a Multiplexing Protocol running on his equipment (e.g.: PC-Windows, User μ Processor, etc.) in order to use the CMUX Protocol provided by Telit Modules.

1.1. Scope

The User Guide covers the description of the Multiplexing Protocol supported by the Telit Modules, the guideline to develop the protocol, and the use and configuration of the Telit Serial Port MUX tool running on a PC-Windows.

1.2. Audience

This document is intended for users/integrators interested to implement a Multiplexing Protocol running on a generic processor.

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:

<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.

Telit appreciates feedback from the users of our information.



1.4. Related Documents

- [1] 3GPP TS 07.10 Version 7.1.0, Release 4
- [2] Virtual Service Device, Application Note, code: 80000NT10045A
- [3] HE910 Family Ports Arrangements, User Guide, code: 1w0300971
- [4] AT Commands Reference Guide, code: 80000ST10025A
- [5] HE910 AT Commands Reference Guide, code: 80378ST10091A
- [6] Telit Modules Software User Guide, code: 1w0300784
- [7] IP Easy, User Guide, code: 80000ST10028A
- [8] SIM Access Profile, User Guide, code: 80000ST10029a
- [9] Easy Script in Python, code: 80000ST10020a

1.5. Document History

Revision	Date	Changes
0	2012-02-15	The present Revision supersedes the CMUX User Guide, 30268ST10299A Rev. 5 – 2011-03-01 and all the previous revisions.
1	2012-06-18	Updated the Application Table. Added the AT#CPUMODE=3 command.
2	2012-07-05	Updated chapter 7.1. Updated Document History (Changes field of the Revision 0).

1.6. Abbreviation and Acronyms

DCE	Data Communication Equipment
DTE	Data Terminal Equipment
MUX	Multiplexer
NVM	Non Volatile Memory
OS	Operating System
TT	Trace Tool (Generic Trace Tool)
VSD	Virtual Service Device



2. Overview

Before dealing with the technical characteristics of the CMUX Standard Protocol [1] provided by the Telit Modules and the setting up and use of the Telit Serial Port MUX tool running on DTE (PC-Windows), it is useful to show how the two software components can be used together and which advantages they give. The fig. 1 shows four virtual connections (VC1, VC2, VC3 and VC4) which are running on a unique physical serial line (COM1/ASC0); the Module has entered the Multiplexed Mode. The four different Applications running on DTE are tied, via the virtual connections, to four Access Points in order to communicate with four different Services provided by the Telit Module.

Follow the example below to enter the Virtual Service Device Configuration² (Multiplexed Mode) showed on fig. 1:

- Telit Module and DTE are physical connected via ASC0/COM1 serial ports, and both are powered on;
- Run the Telit Serial Port MUX tool on DTE, refer to chapter 6;
- On DTE start, for example, three Hyper Terminals connected to three virtual ports provided by the Telit tool, e.g. COM3, COM4, COM5;
- Now the Hyper Terminals can send and receive data from the Module on three independent Virtual Channels by means of the Multiplexer Protocol implemented by the Telit Tool.

Tab. 2 summarizes the VSD Configuration of fig. 1.

Legend:

“ASC0/VCx”: Virtual Connection (channels) that must be used to reach the Access Point indicated on the top of the column. The user can use one or more Access Points.

VSD Access Points			
AT0	AT1	AT2	Trace
Instance #1	Instance #2	Instance #3	
ASC0/VC1	ASC0/VC2	ASC0/VC3	ASC0/VC4

Tab. 2: CMUX vs. Access Points

Refer to fig. 1: with the term “instance” is intended an AT Commands Parser. TELIT modules provide three logically independent AT Commands Parsers. Any instance is connected to an Access Point. In

² VSD is a function that manages the logical connections between the physical serial ports and the Access Points. To have more information concerning the several VSD configurations see [2], [3].



general, the Access Point is the connection between the communication path and the Service offered by the module.

Same considerations are valid for modules belonging to the HE910 Family, of course with the required adjustment, see fig. 2.

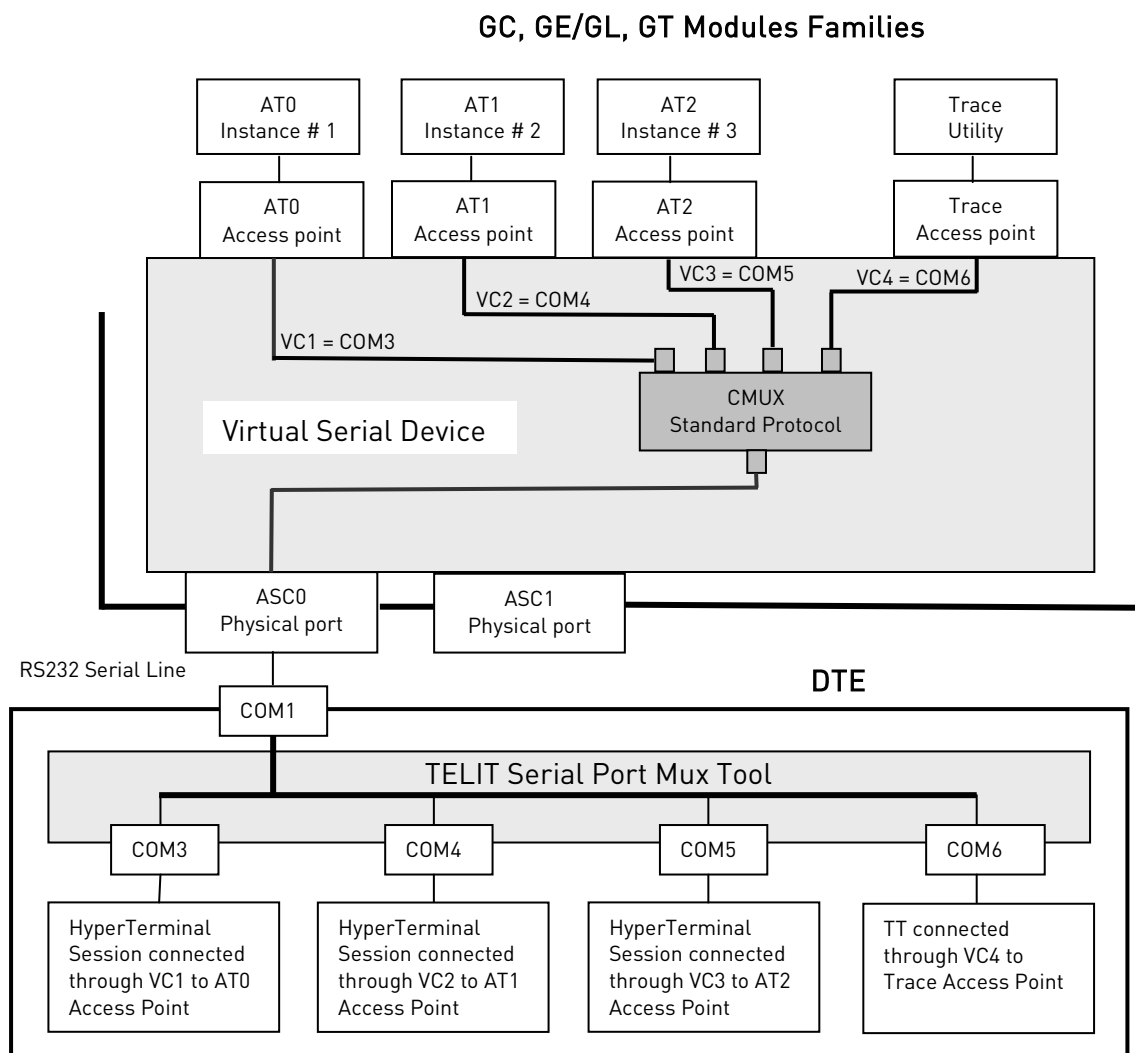


fig. 1: GM, GC, GE/GL, GT Modules Families



HE Module Family

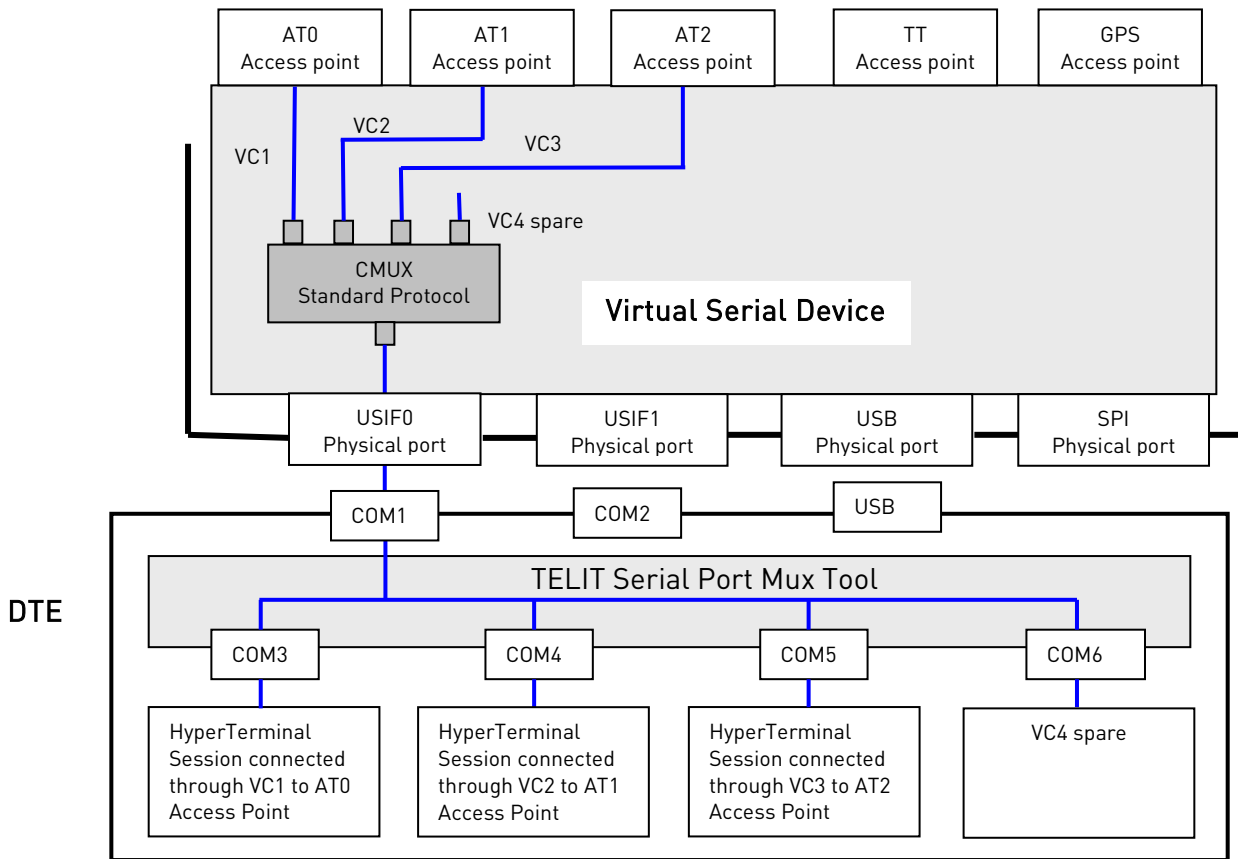


fig. 2: HE910 Module Family

Thanks to the multiplexing feature, operations such as controlling the module or using the SMS service can be performed via vacant virtual channels without disturbing the existing data flow and no access to a second Serial Port is needed.

NOTICE: the use of the multiplexing feature is strictly connected with the configuration of the VDS, it is suggested to see the several different configuration provided by Telit Modules, refer to [2], [3].



Telit CMUX implementation supports the following features:

- Operating Option: Basic, refer to [1];
- Only UIH frames are supported, refer to [1];
- Four full DLCI (four Virtual Ports);
- Every CMUX Virtual Channel connected to an AT Instance has its own user profile storage in NVM;
- Independent setting of Unsolicited Message;
- Every CMUX Virtual Channel has its own independent flow control.

NOTICE: *CMUX can be activated only with the SELINT 2 interface, before activating CMUX check the current AT Interface Style, see [4], and [5] in accordance with the used module.*



3. Serial Multiplexer Protocol

The next chapter introduces the CMUX Protocol and its Frames Structures with a particular attention to the Telit CMUX implementation. Refer to [1] to have the complete description.

3.1. CMUX Frames Structures

All information transmitted between the module and the application is based on frames that have the following structure (for Maximum Frame Structure Length see chapter 7.1):

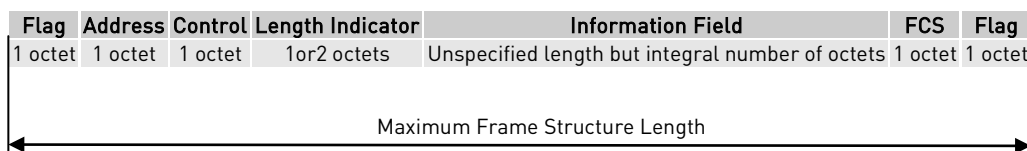


fig. 3: CMUX Frame Structure

Flag Octet

Each frame begins and ends with a flag octet defined as 11111001 in Binary format (0xF9 in Hexadecimal format).

Address Octet

The form of address octet is the following:

0	1	2	3	4	5	6	7
EA	C/R	DLCI					

EA: Extension Bit

It is set to 1.

C/R: Command/Response

The Initiator is the entity that sends the first SABM command using DLCI 0. In the Telit CMUX implementation, the Initiator is always the Application, consequently it sends a command to the Module with C/R = 1; when the Module (Responder) answers C/R is still 1. If on the same Data Link session the Module sends a command towards the Application C/R is 0; when the Application answers C/R is still 0. The table below summarizes the concept.



Session Initiator	Direction	Responder	C/R Value	Command/Response
Application	→	Module	1	Command
Application	←	Module	1	Response
Application	←	Module	0	Command
Application	→	Module	0	Response

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	Virtual Port #4 Its use depends on the used module, refer to [2], [3]

NOTICE: *the Services connected to Virtual Port #4 depend on the used Telit Module and the VSD configuration. To have detailed information refer to [2] and [3].*

Control Octet

The content of the control octet defines the type of frame as in the following table:

Frame Type	Control Octet							
	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:

Refer to [1] to have a detailed description.

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.

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 the application sends a disc for the DLCI 0 (the control channel), all the established channels will be closed. The module 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
E/A	L1	L2	L3	L4	L5	L6	L7

E/A Bit should be 1 in case 7 bits are enough for the *length* ($length \leq 127$) 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
L8	L9	L10	L11	L12	L13	L14	L15

To select the right length of the Information Field in accordance with the used Telit Module see chapter 7.1.

Information Field

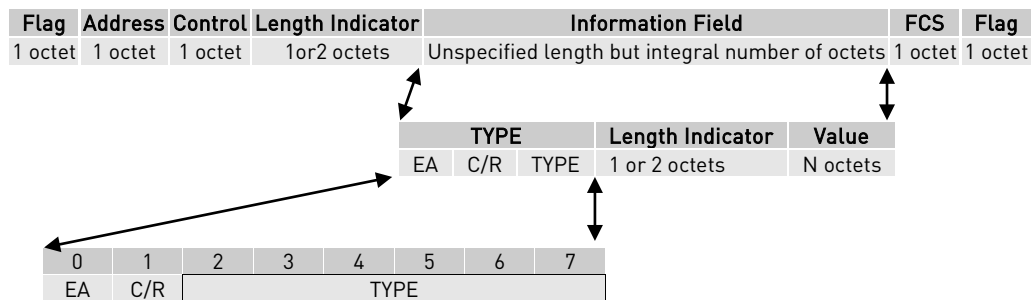
The information field is the payload of the frame and carries the user data. The field exists only for frame type that contains UIH Control Field. The P/F bit should be set to value 0 when this field is sent.



FCS (Frame Checking Sequence)
Refer to [1] to have a detailed description.

3.1.1. UIH Control Channel Frame Coding

Refer to fig. 3 and the figure below: the Information field can carry UIH Commands or User Data. The Information field exists only for UIH frame type. The P/F bit should be set to value 0 when this field is sent. This chapter focuses on the UIH Commands; in this case DLCI shall always have the value 0. It means that the UIH Command is transferred on the logical Control Channel.



Type Octet:

EA: Extension Bit
It is always set to 1.

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

TYPE: Hereafter are listed the UIH Commands TYPES followed by their Length Indicators (for its coding see chapter 3.1). If Length Indicators is not zero, it is followed the Values octets.

Multiplexer close down (CLD)

The **CLD** command is used to reset the link, exit Multiplexed Mode and enter AT Command Mode.

LSb								MSb		LSb								MSb	
		Type						Length Indicator											
E/A	C/R	0	0	0	0	1	1	E/A	0	0	0	0	0	0	0	0			



Test Command (Test)

Test command is used to test the connection between module and the user application. The Length Indicator describes the number of values bytes, which are used as a verification pattern. The opposite entity shall respond with exactly the same value bytes. Least Significant bit is on left side of the octet:

LSb								MSb						
Type								Length Indicator	Value 1	Value 2	Value ...	Value length		
E/A	C/R	0	0	0	1	0	0	E/A	length	Any Char	Any Char	Any Char	Any Char	

Modem Status Command (MSC)

MSC command is used to send Virtual V.24 Signals status. Each Virtual Connection has its own independent Virtual V.24 Signals status. The two entities exchange MSC messages which formats depend on the CMUXMODE value, refer to chapter 7.3, Tab. 4:

CMUXMODE = 0 or 4

When an entity sends its Virtual V.24 Signals status, the other one answers with a message containing its own Virtual V.24 Signals status. There are two scenarios depend on who sends first the message:

DTE (Application) sends the first message:

DLCI=0, MSC (command from DTE with its V.24 Signals) DLCI=1

DCE (Telit Module) answers:

DLCI=0, MSC (response from DCE with its V.24 Signals) DLCI=1

DCE (Telit Module) sends the first message:

DLCI=0, MSC (command from DCE with its V.24 Signals) DLCI=1

DCE (Application) answers:

DLCI=0, MSC (response from DTE with its V.24 Signals) DLCI=1

CMUXMODE = 1 or 5

When an entity sends its Virtual V.24 Signals status, the other one acknowledges the received message using the same message with C/R bit negated (octet Type of the Information Field). There are two scenarios depend on who sends first the message:



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DTE (Application) communicates its Virtual V.24 Signals status:

DLCI=0, MSC (command from DTE with its V.24 Signals) DLCI=1

DCE (Telit Module) acknowledges:

DLCI=0, MSC (response from DCE with DTE V.24 Signals) DLCI=1

DCE (Telit Module) communicates its Virtual V.24 Signals status:

DLCI=0, MSC (command from DCE with its V.24 Signals) DLCI=1

DTE (Application) acknowledges:

DLCI=0, MSC (response from DTE with DCE V.24 Signals) DLCI=1

Format without Break Indication

LSb							MSb												
Type							Length Indicator					DLCI		V24 octet					
E/A	C/R	0	0	0	1	1	1	E/A	0	1	0	0	0	0	E/A	1	DLCI	E/A	Lines Status

Format with Break Indication

LSb							MSb													
Type							Length Indicator					DLCI		V24 octet		Break octet				
E/A	C/R	0	0	0	1	1	1	E/A	1	1	0	0	0	0	E/A	1	DLCI	E/A	Lines Status	Break Status

V.24 Octet from Module to Application (see chapter 7.2)

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

fig. 4: V.24 Octet DCE → DTE

V.24 Octet from Application to Module (see chapter 7.2)

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

fig. 5: V.24 Octet DTE → DCE



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

NOTICE: *when a new instance is established the default settings are FC = 1, RTS = 0, DTR = 0, this means that the module will not be able to send the data to application until user changes the default setting to FC = 0, RTS = 1, DTR = 1. The application 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.



Not Supported Command Response (NSC)

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

LSb							MSb										
Type							Length Indicator							Command Type			
E/A	C/R	0	0	1	0	0	E/A	1	0	0	0	0	0	0	E/A	C/R	command type

Power Saving Control (PSC)

Standard **PSC** command is used to cause the Telit Module to enter the Power Saving Mode when it is in Multiplexed Mode. It simulates the **AT+CFUN=0** command.

LSb							MSb							
Type							Length Indicator							
E/A	C/R	0	0	0	0	1	E/A	0	0	0	0	0	0	0

Telit PSC command has one more octet containing the Power Saving Mode, see Tab. 3.

LSb							MSb								
Type							Length Indicator							Power Saving Mode	
E/A	C/R	0	0	0	0	1	E/A	1	0	0	0	0	0	0	mode

The table below shows which CFUN modes can be simulated using standard (Std) and Telit PSC to cause the Telit Module to enter the Power Saving Mode in accordance with the used Module Family, refer to [6] to get more information.

AT+CFUN mode	GM, GC, GE/GL, GT Families		HE910 Family		HE863 Family		UC Family	
	Std PSC	Telit PSC	Std PSC	Telit PSC	Std PSC	Telit PSC	Std PSC	Telit PSC
0	no mode octet	mode = 0	not supported	mode = 0	not supported	not supported	no mode octet	not supported
1	not supported	mode = 1		mode = 1				
2		not supported		not supported			not supported	
4		mode = 7		mode = 7				
5								
7								
9	mode = 9	mode = 9						

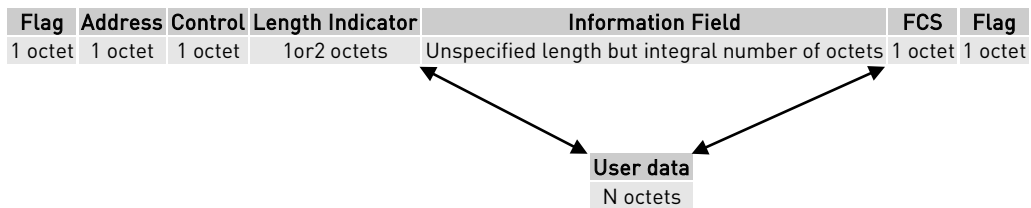
Tab. 3: Telit PSC

NOTICE: *AT+CFUN* command can't be used in Multiplexed Mode.



3.1.2. UIH Data Channel Frame Coding

Refer to fig. 3 and the figure above: the Information field is the payload of the frame and carries the user data. The Information field exists only for UIH frame type. The P/F bit should be set to value 0 when this field is sent.



Length indicator

It specifies the length of the Information field. See its coding in chapter 3.1.

User Data

User payload, the number of octets is defined by the Length Indicator



4. How to Develop a MUX User Application

Objective of this chapter is to provide the reader with the guidelines to develop a User Application able to cause the connected module enters Multiplexed Mode and support the Multiplexing Protocol without the assistance of the Telit Serial Port MUX tool.

Let's start with VSD Configuration at Module Power ON, see fig. 6, fig. 7 for all Telit Modules Families.

For example, take in consideration the fig. 6: VSD Configuration connects the physical port ASC0 to the AT0 AT command parser; AT0 parser is matching the instance # 1. Telit Module provides two more AT parser instances: instance # 2 and # 3. The user, by means of DTE, can enter AT commands; they are parsed by the AT0 parser and executed by the module engine. VSD also connects physical port ASC1 to the Trace utility. The user, by means of Telit RTD application running on DTE, can see the trace log. In this configuration the CMUX Standard Protocol [1] is not still used.

Same considerations are valid for modules belonging to the HE910 Family, of course with the required adjustment, see fig. 7.

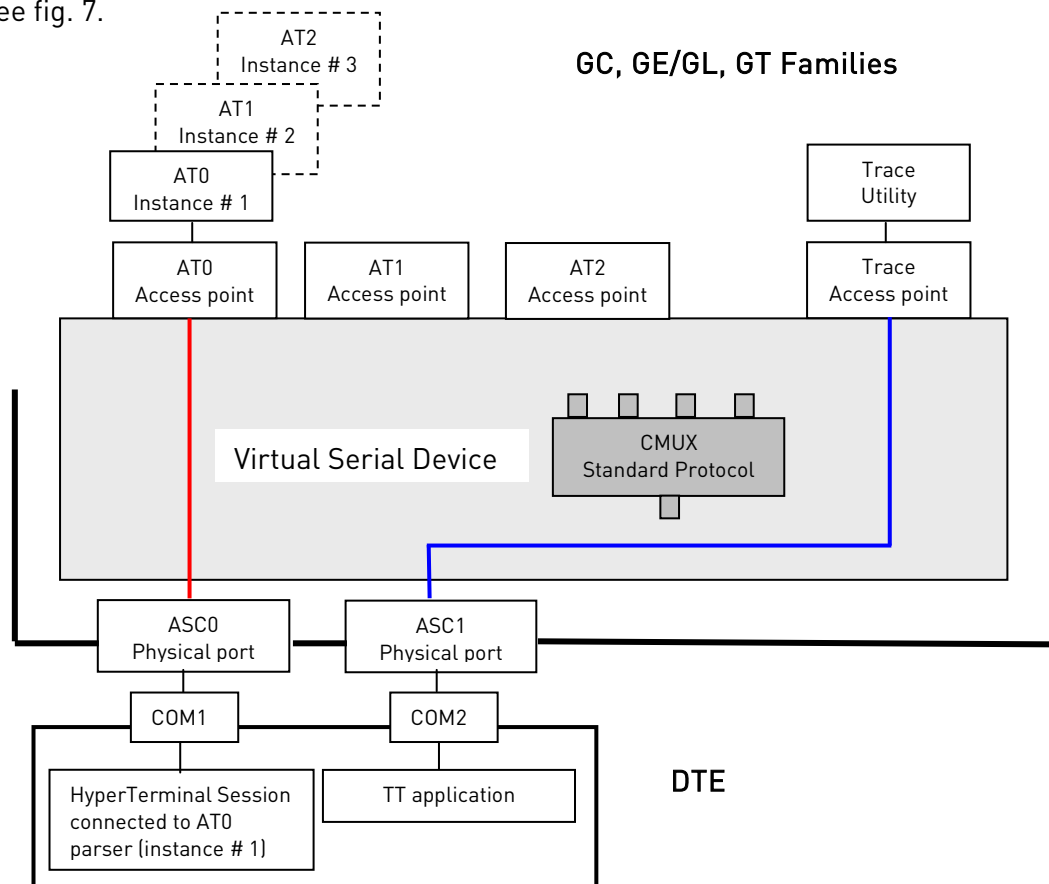


fig. 6: VSD Configuration at Power ON (GM, GC, GE/GL, GT Modules Families)



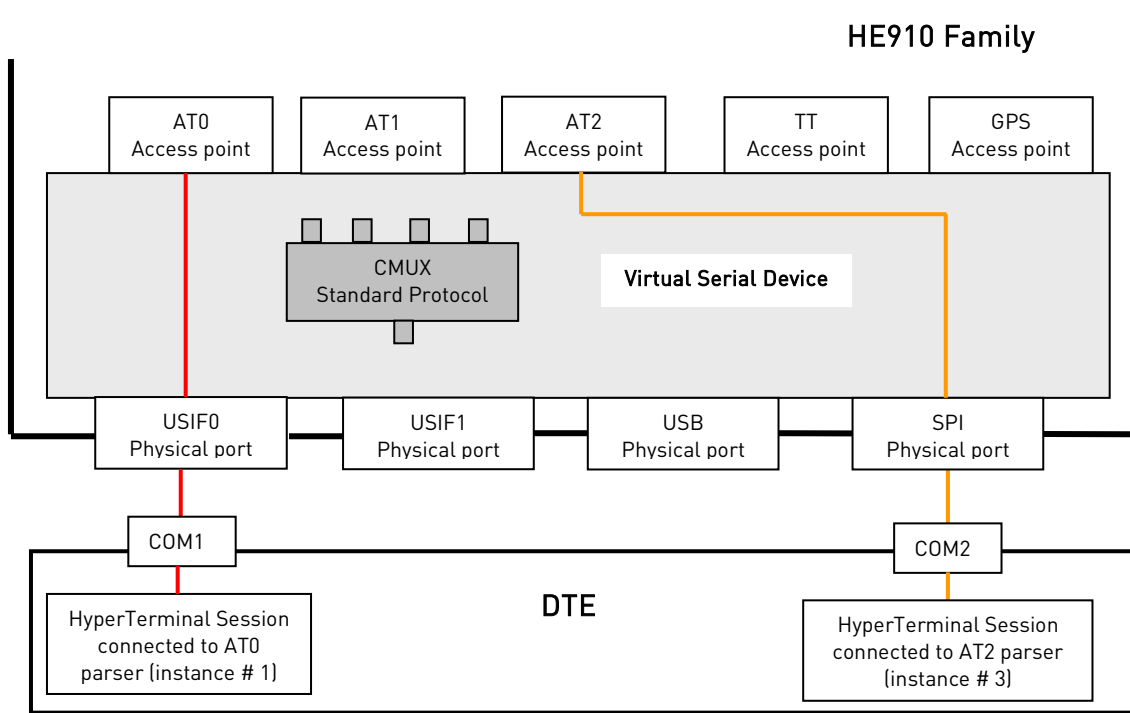


fig. 7: VSD Configuration at Power ON (HE910 Family)



First of all, the User Application must force the connected module in Multiplexed Mode. To do that, it sends the AT commands listed below, see [4], [5], and [6] to get more information concerning the AT commands in accordance with the used module.

NOTICE: *the commands are sent by means of a regular serial line protocol, no Multiplexing Protocol is still activated during this phase.*

Select #SELINT=2 AT Interface Style

AT#SELINT=2
OK

Disable Echo, Activate verbose format, Activate Hardware Flow Control, Program the DTR to close the current connection on its high to low transition.

ATE0V1&K3&D2
OK

The following entered AT commands are not echoed; only OK is answered by the module.

Select the Serial Port Speed.

AT+IPR=115200
OK

Store the setting on profile 0 and at power on use profile 0

AT&W0&P0
OK

Select the CMUX mode, refer to chapter 7.3.

AT#CMUXMODE=1
OK

Start MUX protocol (Module enters Multiplexed Mode):

For Telit Modules provided with no configurable CMUX, see chapter 7.1:

AT+CMUX=0
OK

For Telit Modules supporting configurable CMUX, see chapter 7.1:

AT+CMUX=0,0,,122
OK

When the User Application receives the OK response of the +CMUX command, the module entered the Multiplexed Mode and the regular serial line protocol is no more available. The User Application can



continue to be connected with the module only via the Multiplexing Protocol, see fig. 8 and the example of CMUX messages sequence in hexadecimal format listed on the next page.

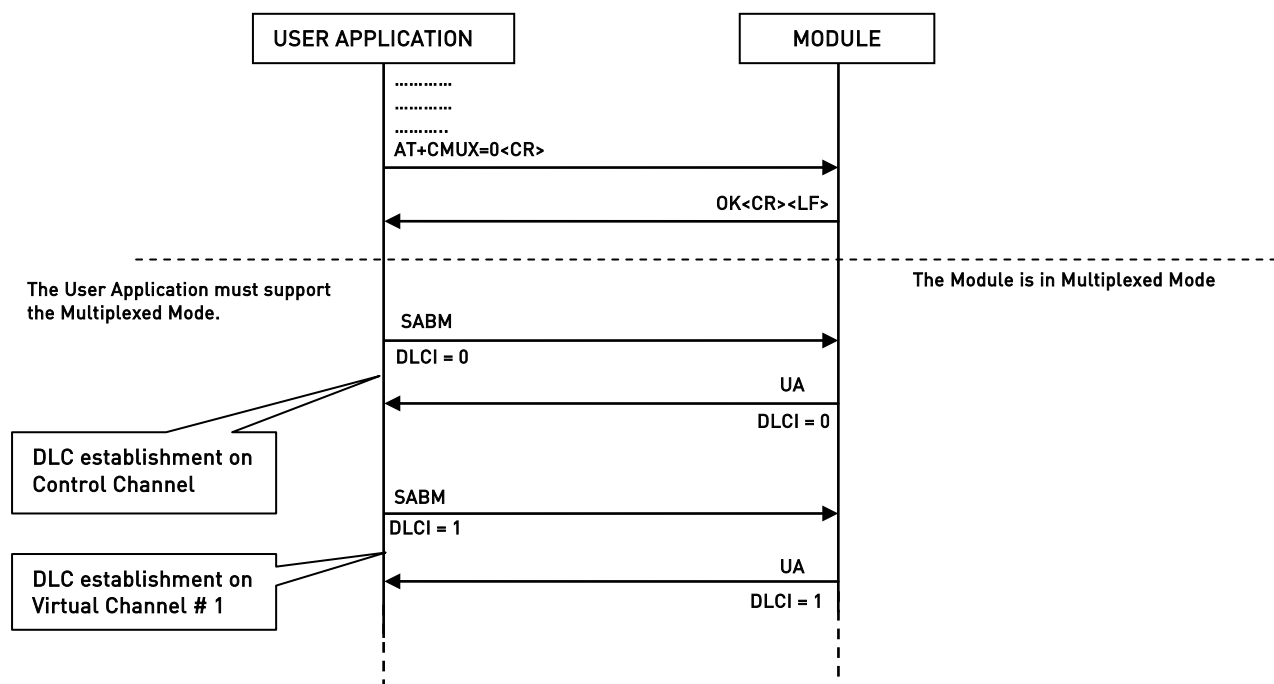


fig. 8: CMUX Protocol

After entering +CMUX AT Command, the CMUX protocol substitutes the regular serial line protocol. Hereafter is listed an example of CMUX protocol. The messages are in hexadecimal format.

Legend:

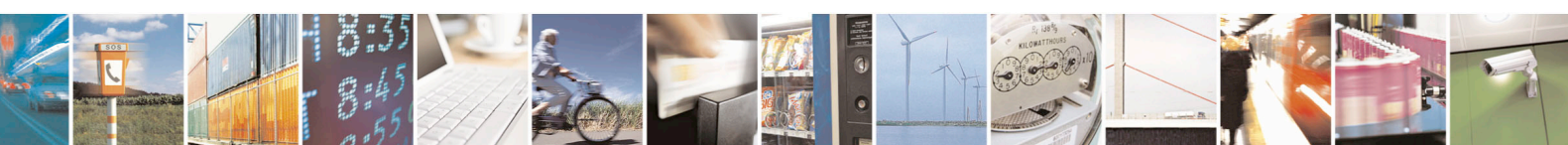
- Red** - messages sent from User Application (DTE) to Module (DCE)
- Green** - messages sent from Module to User Application
- Black** - comments

DLC establishment on Control Channel:

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

DLC establishment on Virtual Channel # 1 (Open Virtual Port #1):

- F9 07 3F 01 DE F9** -DLCI = 1, SABM CMD, POLL BIT=1
- F9 07 73 01 15 F9** -DLCI = 1, UA RESPONSE, FINAL BIT=1



.
.
DLC establishment on Virtual Channel # 2 (Open Virtual Port #2)
.
.

User Application sends the module the Virtual V.24 Signal status concerning its Logical Port (COMx) connected to Virtual Channel #2: FC=0, RTS=0, DTR=1

F9 03 EF 09 E3 05 0B 05 FB F9 -DLCI = 0; UIH Frame, MSC CMD for Virtual Channel (DLCI) =2

Module answers with the just received Virtual V.24 Signal status. C/R bit belonging to the TYPE octet is negated

F9 03 EF 09 E1 05 0B 05 9A F9 -DLCI = 0; UIH Frame, MSC CMD for Virtual Channel (DLCI) =2

Module sends its Virtual V.24 Signal status concerning Virtual Port #2: FC=0, DSR=1, CTS=1, RING=1, DCD=0.

F9 03 EF 09 E3 05 0B 4D 9A F9

User Application answers with the just received Virtual V.24 Signal status. C/R bit belonging to the TYPE octet is negated.

F9 03 EF 09 E1 05 0B 4D FB F9

.
.

User Application sends the AT Command: AT+CGMR

F9 07 EF 11 41 54 2B 43 47 4D 52 0D 2B F9

Module answers the AT command result: <CR><LF>07.02.504<CR><LF><CR><LF><OK>

F9 05 EF 27 0D 0A 30 37 2E 30 32 2E 35 30 34 0D 0A 0D 0A 4F 4B 0D 0A 80 F9

User Application causes the module to enter Power Saving Mode. UIH Frame, PSC CMD

F9 03 EF 05 41 00 F2 F9

NOTICE: *to get more information concerning Power Saving Mode refer to [6].*

NOTICE: *in absence of communication between the Telit Module and the User Application it is suggested to send a periodic Test Command to the Telit Module in order to verify the CMUX protocol operating state.*



5. Summary and Recommendations

- * The customer/integrator to design its own Multiplexer Protocol Application shall remember:
 - Telit Module supports the CMUX Basic Option and UIH Frames according to [1];
 - Serial Port must be so configured: 8 data bits, no parity, 1 stop bit;
 - It is mandatory to use the Hardware Flow control on the physical serial line that will support the Multiplexer Protocol. It should be set before entering Multiplexer Mode using AT command AT&K3 (both RTS/CTS active);
 - DTR Lines should be set correctly (pulled-up), since a transition of the DTR signal causes the exit from Multiplexer Mode, this is true only for legacy modules, see chapter 7.3, Tab. 4.

- * If the Telit Module is operating in Multiplexer Mode, the following restrictions will be applied:
 - Software Flow control XON/XOFF is not supported;
 - 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 using two or more different Virtual Channels at the same time, please note that only the last entry will be stored;
 - When in Multiplexed Mode, the escape sequence ‘+++’, sent on one Virtual Channel, will not be recognized and executed by the involved AT instance (except for HE910 Family). It is responsibility of the Application to use the Break Octet of the Modem Status Command (MSC). Break Octet simulates the escape sequence (not yet supported on HE910 Family).



- The commands listed 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, refer to [4], [5].
 - AT+IPR
 - AT+IFC
 - AT+ICF
 - AT&F; AT&S; AT&T; AT&V; AT&W; AT&X; AT&Y; AT&Z
 - AT&S2; AT&S12; '+++'
 - AT&S25
 - AT+CMUX
 - AT#SELINT
 - AT&F, AT&Z, AT#Z

- Due to some restriction in the GSM/GPRS standard or limitation of the software the AT commands, listed below, will not be executed in parallel by the module. If one of the following commands are requested to be executed on one AT Instance (see chapter 2) while one of this command is running on another AT 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+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



NOTICE: *this limitation appears only when two or more of the commands listed above are combined. E.g.: commands AT#MONI, +CGMR, AT+COPS? will always be executed without suspension since only one of the commands listed above is running.*

NOTICE: *for further restriction on behavior of other commands please refer to the specific documentation: [4], [5], [7], and [8].*

* In general an AT command executed by the selected AT Instance modified only the behavior of the used AT Instance. It has its own User Profile stored in NVM. Vice versa, the AT commands listed below modify the behavior of the all set of AT Instances, regardless the used AT Instance and its connected Virtual Circuit.

- 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+COPS
- AT#CODEC
- AT#DVI
- AT#E2SMSRI
- AT#E2SLRI
- AT+CSCB

At Module power on, the physical port ASC0 is connected to the AT0 Instance as showed by fig. 6, in accordance with that, ASC0 uses the profile of AT0 Instance. When the Module is in Multiplexer Mode, the Virtual Channel 1 is connected to AT0 Instance (see fig. 1) and consequently uses the AT0 Instance profile. Same considerations are valid for HE910 Family.



* When Telit Module is in Multiplexed Mode don't use AT+CFUN command, use the Power Saving Command (PSC), see Tab. 3.
 For example, don't use AT+CFUN=5 with legacy Module because the transition High/Low of the DTR signal causes the disconnection of the CMUX protocol, see Tab. 4.

* CMUX Protocol and Python: see the AT command #CMUXSCR, refer to [9]

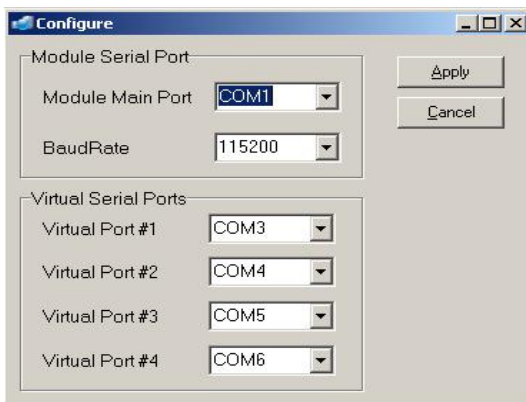
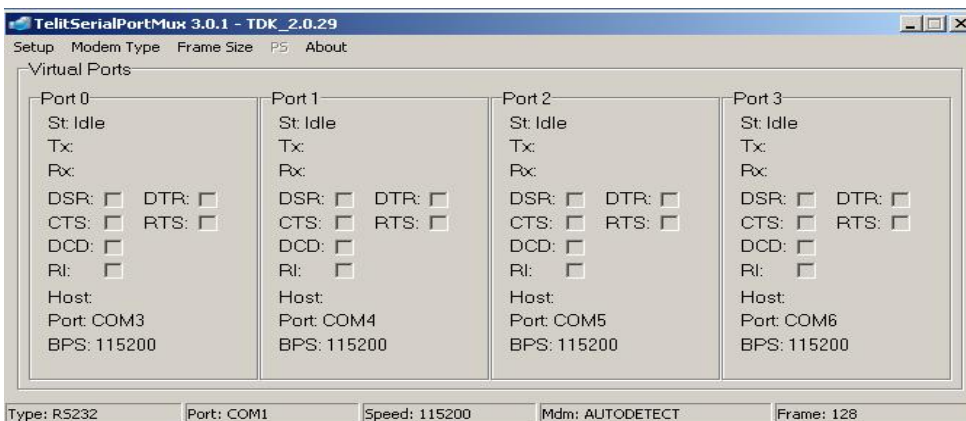


6. Telit Serial Port MUX tool

Telit has developed a tool called Telit Serial Port MUX showed in schematic manner on fig. 1 and fig. 2; the tool is running on a PC-Windows. From the figures it is possible infer that four Virtual Channels can exist at the same time on one physical line (COM1). Four logical COMx, provided by the Windows OS, can be used by four different PC-Applications to gain one of the four Virtual Channels.

6.1. Graphical Interface

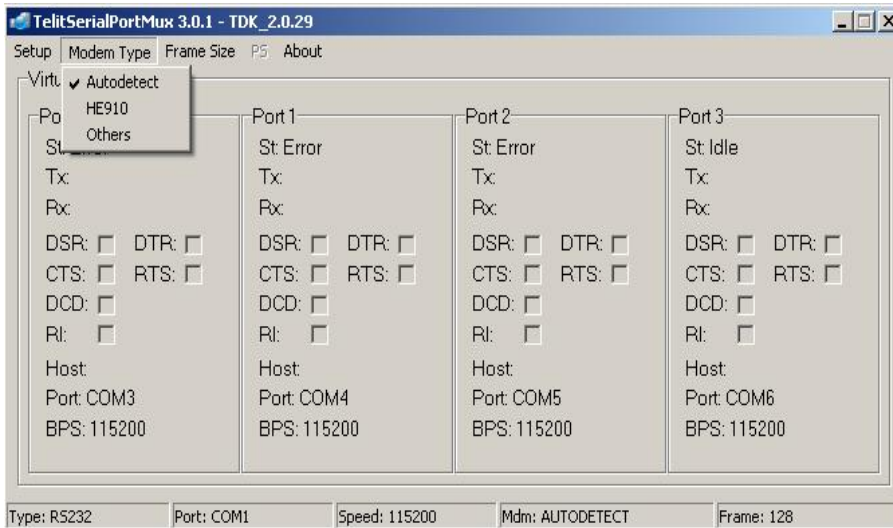
After installing Telit Serial Port Mux tool on PC-Windows, it looks as in the following figure:



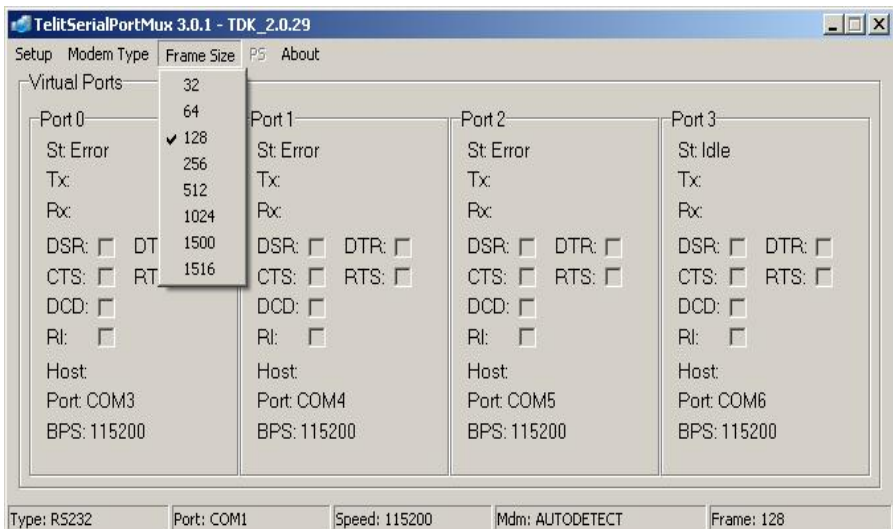
Select Setup Menu to configure the Main Port and the Virtual Ports. The Configure Panel is self-explanatory.



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Click Modem Type Menu to select the Telit Modem in accordance with the actual Telit Modem connected to the DTE.



Click Frame Size Menu to define the *Maximum Frame Structure Length*, see fig. 3.



7. Appendix

7.1. How to select the Information Field length

To know if your actual used Telit Module supports a configurable CMUX protocol or if its configuration is fixed, use the following procedure. Assume a DTE is connected to your module and manually enter the listed below +CMUX commands.

Enter the command to see if the CMUX is configurable

```
AT+CMUX=?
+CMUX: (0),(0),(5),(1-1509),(1-255),(0-100),(2-255),(1-255),(1-7)
OK
```

The AT command response indicates that the CMUX can be configurable, several parameters can be changed.

NOTICE: *Some Telit Modules can answer only with the first four ranges.*

Enter the command to get the actual values of the CMUX parameters

```
AT+CMUX?
+CMUX: 0,0,5,128,10,3,30,0,0
OK
```

NOTICE: *Some Telit Modules can answer only with the first four parameters.*

The fourth parameter is the **Information Field Length: 128 octets** (referring to the AT command above). In this case two octets are needed to constitute the **Length Indicator**, see 3.1. The user can use the +CMUX command to change the CMUX configuration on the module, see [4], [5].

NOTICE: for modules having the platform identifier equal to 10, see Tab. 1, it is mandatory to set the CPU clock with the AT#CPUMODE=3 command when the frame size is greater than 127 bytes.

For legacy Telit Module the CMUX protocol could not be configurable.

Enter the command to see if the CMUX is configurable

```
AT+CMUX=?
+CMUX: (0),(0)
OK
```



The CMUX is not configurable. In this case the *Maximum Frame Structure Length*, see fig. 3, is equal to 133 octets, in accordance with it the *Information Field length* is 127 (less than 128 octets). Only one octet is needed to constitute the *Length Indicator*.

7.2. V.24 Link

For reader convenience hereafter is showed the V.24 link supported by the Telit Modules. The reader can compare the physical V.24 interface with the two V.24 octets provided by the CMUX protocol for each Virtual Channel:

- V24 Octet from DCE (Module) to DTE (Application), refer to fig. 4
- V24 Octet from DTE (Application) to DCE (Module), refer to fig. 5

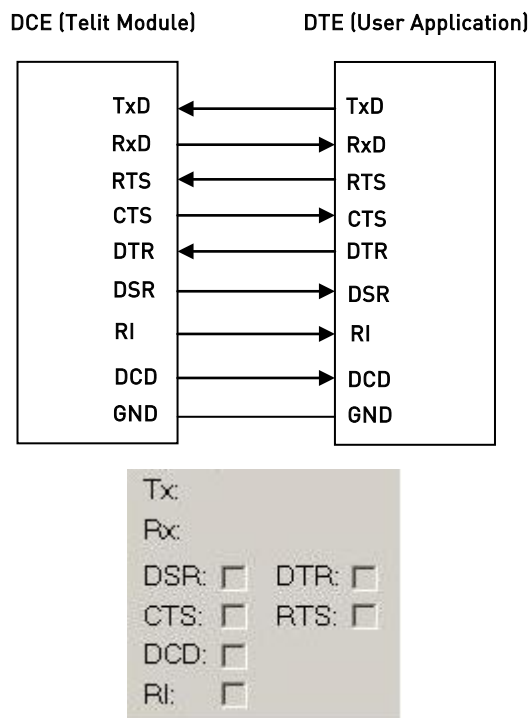


fig. 9: Complete V.24 Link versus Telit Serial Port MUX Panel

- DSR: Data Set Ready
- CTS: Clear To Send
- DCD: Data Carrier Detect
- RI: Ring Indicator
- DTR: Data Terminal Ready
- RTS: Request to send



7.3. DTR Signal vs. CMUX Protocol

It is worth to remind that High → Low transition of the DTR signal causes the Module to exit the Multiplexed Mode. To avoid that and make available to the user the selection of one of the two CMUX implementations that can be provided by a Module, Telit has developed the following proprietary AT Command:

AT#CMUXMODE=<mode>

In accordance with the response of the ***AT#CMUXMODE=?*** Command, you can know the features supported by your Telit Module concerning the interaction between the CMUX protocol implementation and DTR transition:

AT#CMUXMODE=?
#CMUXMODE: {0,1}
OK

You have a legacy Telit Module.

AT#CMUXMODE=?
#CMUXMODE: {0,1,4,5}
OK

You have a Telit Module supporting all modes.

The table below summarizes the command functionalities in accordance with the used Telit Module and the <mode> value selected by the user.

<mode>	LEGACY MODULES		MODULES supporting all modes	
	DTR transition (H→L) causes:	Is activated a CMUX protocol that:	DTR transition (H→L) causes:	Is activated a CMUX protocol that:
0 ³	CMUX is closed	preserves backward compatibility	CMUX is closed	preserves backward compatibility
1	CMUX is closed	is more adherents to the Standard	CMUX is closed	is more adherent to the Standard
4	/	/	No actions on CMUX	preserves backward compatibility
5	/	/	No actions on CMUX	is more adherent to the Standard

Tab. 4: CMUXMODE (con't)

Modes 4 and 5 have been introduced to manage the cases where the Application Processor moves the DTR signal to enter itself the Power Saving state.

³ Factory setting



If the command result is ***ERROR***, please refer to the *Tab. 5* to know the unique CMUX implementation provided by your Telit Module under test.

***AT#CMUXMODE=?
ERROR***

	Platforms Versions		
	07.xx.xxx <= 07.03.002	10.xx.xxx <= 10.00.002	12.xx.xxx
CMUX implementation	preserves backward compatibility (see mode = 0)	is more adherent to the Standard (see mode = 1)	

Tab. 5: CMUXMODE

NOTICE: *A new Application should be developed compliant with #CMUXMODE=1, where it is possible.
Warning: the mode is not stored in NVM.*

