

EG800Q&EG91xQ Series

MUX Application Note

LTE Standard Module Series

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About the Document

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1.0	2023-11-06	Sean FANG	First official release
1.1	2024-05-22	Sean FANG	Updated EG915Q-NA to EG915Q series.

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1 Introduction

The document outlines Quectel MUX (multiplexer) protocol between UE and TE and provides examples of how to use the MUX function on Quectel LTE Standard EG800Q series and EG91xQ family (EG915Q series and EG916Q-GL) modules.

2 Quectel Multiplexing System Overview

The MUX protocol provides mechanisms for transmitting data streams between TE and UE over a single physical port. Quectel multiplexing system creates four virtual channels on one physical port for simultaneous transmission of multiple data streams. It enables the physical port to function like four distinct physical channels for the application. Each virtual channel supports functionalities such as SMS, PPP dialing, etc.

All data from the application are packed into different frames, which consist of the data and protocol fields that clearly indicate channel number, information length, FCS, and related parameters. The frames are transmitted as data streams via the serial port. After arriving at the other end, the data are unpacked as four streams by the MUX protocol stack and transmitted to the application. In addition to the information field, the control signals are also simulated.

Each channel between TE and UE is called a DLC (Data Link Connection) and is established separately and sequentially.

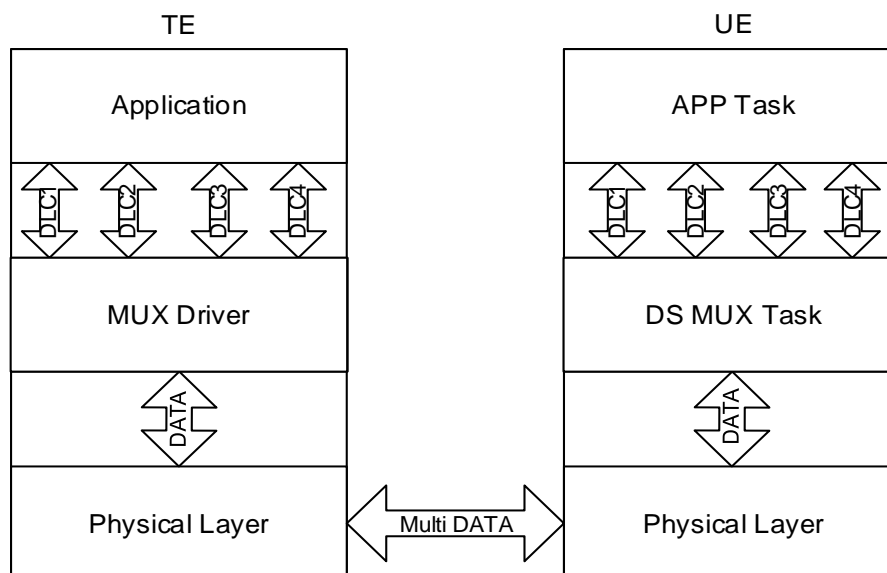


Figure 1: MUX Architecture

3 MUX AT Command

3.1. AT Command Introduction

3.1.1. Definitions

- **<CR>** Carriage return character.
- **<LF>** Line feed character.
- **<...>** Parameter name. Angle brackets do not appear on the command line.
- **[...]** Optional parameter of a command or an optional part of TA information response. Square brackets do not appear on the command line. When an optional parameter is not given in a command, the new value equals its previous value or the default settings, unless otherwise specified.
- **Underline** Default setting of a parameter.

3.1.2. AT Command Syntax

All command lines must start with **AT** or **at** and end with **<CR>**. Information responses and result codes always start and end with a carriage return character and a line feed character: **<CR><LF><response><CR><LF>**. In tables presenting commands and responses throughout this document, only the commands and responses are presented, and **<CR>** and **<LF>** are deliberately omitted.

Table 1: Types of AT Commands

Command Type	Syntax	Description
Test Command	AT+<cmd>=?	Test the existence of the corresponding command and return information about the type, value, or range of its parameter.
Read Command	AT+<cmd>?	Check the current parameter value of the corresponding command.
Write Command	AT+<cmd>=<p1>[,<p2>[,<p3>[...]]]	Set user-definable parameter value.
Execution Command	AT+<cmd>	Return a specific information parameter or perform a specific action.

3.2. Declaration of AT Command Examples

The AT command examples in this document are provided to help you learn about the use of the AT commands introduced herein. The examples, however, should not be taken as Quectel's recommendations or suggestions about how to design a program flow or what status to set the module into. Sometimes multiple examples may be provided for one AT command. However, this does not mean that there is a correlation among these examples, or that they should be executed in a given sequence.

3.3. AT+CMUX Multiplexing Mode

This command enables the MUX protocol control channel and sets parameters for the control channel.

AT+CMUX Multiplexing Mode	
Test Command AT+CMUX=?	Response +CMUX: (list of supported <transparency>s),(list of supported <subset>s),(list of supported <port_speed>s),(range of supported <N1>s),(range of supported <T1>s),(range of supported <N2>s),(range of supported <T2>s),(range of supported <T3>s),(range of supported <k>s) OK
Read Command AT+CMUX?	Response +CMUX: <transparency>[,<subset>[,<port_speed>[,<N1>[,<T1>[,<N2>[,<T2>[,<T3>[,<k>]]]]]]] OK
Write Command AT+CMUX=<transparency>[,<subset>[,<port_speed>[,<N1>[,<T1>[,<N2>[,<T2>[,<T3>[,<k>]]]]]]]	Response OK Or ERROR If there is an error related to ME functionality: +CME ERROR: <err>
Maximum Response Time	300 ms
Characteristics	The command takes effect immediately. The configurations are not saved.

Parameter

<transparency>	Integer type. MUX transparency mechanism. 0 Basic option
<subset>	Integer type. Defines how to establish MUX control channel. After MUX control channel is established, a virtual channel can be established in different ways. Without specific negotiation, the virtual channel can only be established according to the predefined configuration of the control channel <subset> . 0 UIH frame used only
<port_speed>	Integer type. Transmission rate of physical port. Unit: bps 1 9600 2 19200 3 38400 4 57600 5 115200 6 230400 7 460800 8 921600
<N1>	Integer type. Maximum frame size. Range: 1–2048. Default value: 127. Unit: byte.
<T1>	Integer type. Acknowledgement timer, i.e., the time UE waits for an acknowledgement before taking alternative actions (e.g., transmitting a frame). Range: 1–255. Default value: 10. Unit: ten milliseconds.
<N2>	Integer type. Maximum number of re-transmissions. Range: 0–100. Default value: 3.
<T2>	Integer type. Response timer for the MUX control channels. Range: 2–255. Default value: 30. Unit: ten milliseconds. <T2> must be longer than <T1> .
<T3>	Integer type. Wake-up response timer. Range: 1–255. Default value: 10. Unit: second. (Not supported currently)
<k>	Integer type. Window size. Defines the maximum number of I frames that can be parsed by a DLC. Range: 1–7. Default value: 2. (Not supported currently)
<err>	Integer type. Error codes. See document [1] for details.

Example

```

AT+CMUX=0
OK
AT+CMUX?
+CMUX: 0,0,5,127,10,3,30,10,2
OK

```

NOTE

AT+CMUX can only be executed on UART1 since both module series only support MUX function on UART1.

4 MUX Protocol

This chapter outlines the technical details of the MUX protocol.

4.1. Frame Structure

All information between the TE and UE is transmitted in frames.

Table 2: MUX Frame Structure

Opening Flag	Address	Control	Length	Information	FCS	Closing Flag
1 octet	1 octet	1 octet	1–2 octet	Uncertain length	1 octet	1 octet

4.1.1. Flag Sequence Field

Each frame begins and ends with a flag sequence octet (0xF9).

4.1.2. Address Field

The address field consists of a single octet. It contains the DLCI (Data Link Connection Identifier), the C/R bit and the address field extension bit (EA) as shown in the table below.

Table 3: Address Field

Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7	Bit 8
EA	C/R						DLCI

4.1.2.1. DLCI

The DLCI identifies the virtual channel between TE and UE. Multiple DLCIs are supported but the number is implementation-specific. The DLCIs are dynamically assigned.

4.1.2.2. C/R

The C/R (command/response) bit identifies the frame as either a command or a response. TE sends a command to the UE with the C/R bit set to 1, and the UE responds with the C/R bit set to 1. The UE sends a command with the C/R bit set to 0, and the TE responds with the C/R bit set to 0.

Table 4: C/R Bit Usage

Command/Response	Direction	C/R Value
Command	TE → UE	1
	UE → TE	0
Response	UE → TE	1
	TE → UE	0

4.1.2.3. EA

EA bit extends the range of the address field. When the EA bit is set to 1 in an octet, it signifies that this octet is the last octet of the address field. When the EA bit is set to 0, it signifies that it is followed by another octet of the address field.

NOTE

EA can only be set to 1 currently.

4.1.3. Control Field

The content of the control field defines the frame type. See **Chapter 4.2** for more information about frame types.

Table 5: Coding of Control Field

Frame Type	HEX (P/F=0)	1	2	3	4	5	6	7	8
SABM (Set Asynchronous Balanced Mode)	0x2F	1	1	1	1	P/F	1	0	0
UA (Unnumbered Acknowledgement)	0x63	1	1	0	0	P/F	1	1	0
DM (Disconnected Mode)	0x0F	1	1	1	1	P/F	0	0	0

DISC (Disconnect)	0x43	1	1	0	0	P/F	0	1	0
UIH (Unnumbered Information with Header Check)	0xEF	1	1	1	1	P/F	1	1	1
UI (Unnumbered Information)	0x03	1	1	0	0	P/F	0	0	0

P/F is the Poll/Final bit. The poll (P) bit set to 1 is used by one station to solicit (poll) a response or a sequence of responses from the other station.

The final (F) bit set to 1 is used by a station to indicate the response frame transmitted as the result of a soliciting (poll) command.

The poll/final (P/F) bit serves a function in both command frames and response frames. (In command frames, the P/F bit indicates a poll; in response frames, it indicates the final frame.)

- When DCE sends a message frame, P/F is set to 0.
- When DCE receives a message frame whose P/F is set to 1 from DLCI 0, DCE will give priority to responding to it and set response frame's P/F to 1.
- When DCE sends a control frame, P/F is set to 1.
- When DCE sends UIH frame via a DLC other than DLCI 0, P/F is set to 0.
- DCE only processes SABM and DISC frames whose P/F is set to 1.

4.1.4. Length Field

Table 6: Length Field Structure

Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7	Bit 8
EA	L1	L2	L3	L4	L5	L6	L7

L1 to L7 bits indicate the length of the following data field that contains less than 128 bytes.

Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7	Bit 8
0	L1	L2	L3	L4	L5	L6	L7

Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7	Bit 8
L8	L9	L10	L11	L12	L13	L14	L15

EA bit can be used to extend the length field. When the EA bit is set to 1 in an octet, it signifies that this octet is the last octet of the length field. When the EA bit is set to 0, it signifies that it is followed by another octet of the length field. The total length of the length field is 15 bits in that case.

4.1.5. Information Field

The information field is the payload of the frame and carries the user data and any convergence layer information. The field is octet structured and present only in UIH frames.

4.1.6. FCS Field

In case of UIH frame, the contents of the information field are not included in FCS calculation. FCS is calculated only based on the contents of the address, control, and length fields. This means that only the the contents transmitted to the correct DLCI is protected rather than the information.

4.2. Frame Types

4.2.1. SABM

SABM is a command frame and is used to establish DLC between TE and UE.

4.2.2. UA

The UA frame is a response to SABM or DISC frame, as illustrated in the following figure.

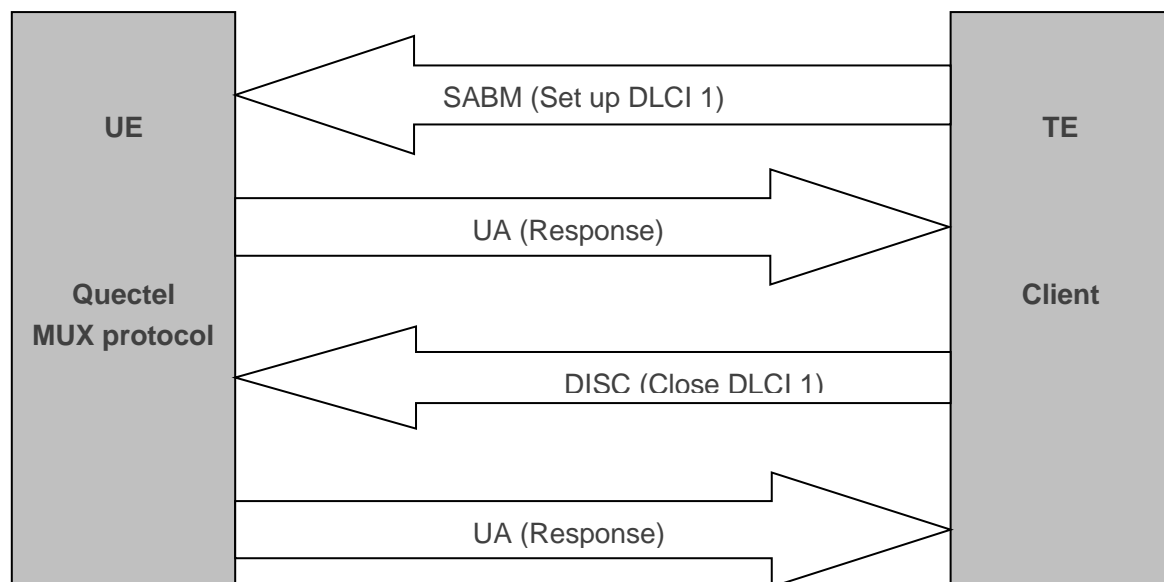


Figure 2: UA Frame (Response)

4.2.3. DM

The DM response frame is used to report a status when the station is logically disconnected from the data link. When in disconnected mode, no commands are accepted until the disconnected mode is terminated after receiving a SABM command. If a DISC command is received while in disconnected mode, a DM response is sent.

4.2.4. DISC

DISC is a command frame and is used to close down a DLC. Before executing the command, the client confirms the acceptance of the DISC command with a UA response. See **Figure 2** for details.

4.2.5. UIH

The UIH command/response sends user data at either end.

4.3. MUX Control Channel

At the initiation of communication between the TE and UE, a control channel is set up with DLCI 0. Control channel is the first channel established at the initiation of the MUX between the TE and UE and it has the DLCI value 0. This channel is used to convey information between the two MUXes.

MUX control channel is the basic channel used to establish a DLC, launch power saving, wake up from power saving and implement the flow control mechanism.

4.3.1. Message Format

All UIH frames are transmitted through the control channel and conform to the following type, length, and value format.

Table 7: Message Format

Type	Length	Value 1	Value 2	...	Value n
------	--------	---------	---------	-----	---------

Each box in the table above represents a field of minimum size per octet.

4.3.1.1. Type Field

Format of first type field octet:

Table 8: Message Format – Type Field

Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7	Bit 8
EA	C/R	T1	T2	T3	T4	T5	T6

The EA bit is an extension bit and is set to 1 in the last octet of the sequence. In other octets, the EA bit is set to 0. Since only one octet is transmitted in Quectel multiplexing system, EA is always set to 1.

The C/R bit indicates whether the message is a command or a response.

The T bits indicate the type coding. Each command has a unique bit sequence pattern. Consequently, a single-octet type field can encode up to 63 different message types. Only single octet message types are defined in this document.

4.3.1.2. Length Field

The structure of the length field octet:

Table 9: Message Format – Length Field

Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7	Bit 8
EA	L1	L2	L3	L4	L6	L6	L7

The EA bit is an extension bit. It is set to 1 in the last octet of the sequence. In other octets, EA is set to 0. In Quectel multiplexing system, only one octet is transmitted, so EA is always set to 1.

The L bits define the count of subsequent value octets. L1 is the LSB, while L7 is the MSB, thus enabling the creation of messages with up to 127 value octets.

4.3.1.3. Value Field

The contents of the value octets are defined for each message type in **Chapter 4.3.2**.

4.3.2. Message Type and Actions

4.3.2.1. MUX Close-Down (CLD)

MUX close-down command is used to reset the link to normal AT command mode without multiplexing. The MUX close-down command uses the following type field octet:

Table 10: MUX Close-Down Command – Type Field Format

Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7	Bit 8
EA	C/R	0	0	0	0	1	1

The length byte contains the value 0 and there are no value octets.

4.3.2.2. Flow Control on Command (FCon)

The software flow control command is used to handle the aggregate flow. When either entity is ready to receive new information, it transmits FCon command.

The length byte contains the value 0, and there are no value octets.

The format of the type field octet:

Table 11: Flow Control on Command – Type Field Format

Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7	Bit 8
EA	C/R	0	0	0	1	0	1

4.3.2.3. Flow Control off Command (FCoff)

The software flow control command is used to handle the aggregate flow. When either entity is not able to receive information, it transmits the FCoff command. Consequently, the opposite entity is not allowed to transmit frames except via the control channel (DLCI = 0).

The length byte contains the value 0, and there are no value octets.

The format of the type field octet:

Table 12: Flow Control off Command – Type Field Format

Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7	Bit 8
EA	C/R	0	0	0	1	1	0

4.3.2.4. Modem Status Command (MSC)

The MSC command facilitates the transmission of virtual V.24 control signals within a data stream. The MSC commands includes one mandatory control signal byte and an optional interrupt signal byte. This command is only applicable when the basic option is chosen.

Send this command before transmitting any user data, immediately after setting up a DLC.

Table 13: Modem Status Command

Command	Length	DLCI	V.24 Signals	Interrupt Signals
---------	--------	------	--------------	-------------------

The length byte contains the value 2 or 3, and there are 2 or 3 value octets.

Both the DTE and DCE use this command to exchange information about their V.24 control signal statuses. MSC length is either 4 or 5 bytes depending on the presence of the interrupt signal.

NOTE

Interrupt signals are currently not supported.

The format of the command field octet:

Table 14: Modem Status Command – Command Field Format

Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7	Bit 8
EA	C/R	0	0	0	1	1	1

The C/R bit distinguishes between a Modem Status Command or a Modem Status Response.

Every time the signals change, the DTE or DCE sends this command to indicate the current status of each signal. Upon receiving a Modem Status Command, a DTE or DCE always responds with a corresponding Response. The correlation between V.24 signals and the control signal octet's bits is detailed in **Table 17** and **Table 18** below for the receiver and sender, respectively.

In an MSC command, the status of the sender's V.24 signals is sent. However, in a Response, the V.24 signals are mirrored from the returned Command frame.

The DLCI field identifies the specific DLC to which the command applies. Bit 2 is always set to 1 and the EA bit is set according to the description in **Chapter 4.1.2.3**.

Table 15: Format of Address Field

Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7	Bit 8
EA	1				DLCI		

The DLCI field is followed by the control signal field that contains a representation of the signal state in the format shown below. The use of the extension bit allows adding other octets to cater for other circumstances. At present, an optional second octet is defined for handling interrupt signal transmission.

Table 16: Format of Control Signal Octet

Bit No.	Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7	Bit 8
Signal	EA	FC	RTC	RTR	Reserved (0)	Reserved (0)	IC	DV

Description of the control signal byte:

Bit 1: The EA bit is set to 1 in the last octet of the sequence; in other octets, EA is set to 0. In Quectel multiplexing system, where only one octet is transmitted, EA is always set to 1.

Bit 2: Flow Control (FC). This bit is set to 1 when the device cannot accept frames.

Bit 3: Ready to Communicate (RTC). This bit is set to 1 when the device is ready to communicate.

Bit 4: Ready to Receive (RTR). This bit is set to 1 when the device is ready to receive data.

Bit 5: Reserved for future use. This bit is set to zero by the sender and ignored by the receiver.

Bit 6: Reserved for future use. This bit is set to zero by the sender and ignored by the receiver.

Bit 7: Incoming Call Indicator (IC). This bit is set to 1 to indicate an incoming call.

Bit 8: Data Valid (DV). This bit is set to 1 to indicate the transmission of valid data.

The control byte is mapped to V.24 signals according to the two tables below:

Table 17: Control Signal Octet Mapping – Receiving Entity

Control Signal Byte	DTE Receiving		DCE Receiving	
	Signal	V.24 circuit	Signal	V.24 circuit
3, RTC	DSR	107	DTR	108/2
4, RTR	CTS	106	RFR	133
7, IC	RI	125	Ignored	-
8, DV	DCD	109	Ignored	-

NOTE

Circuit 133, RFR (Ready for Receiving) is commonly assigned to the connector pin that is alternatively used for circuit 105, RTS (Ready to Send).

Table 18: Control Signal Octet Mapping – Sending Entity

Control Signal Byte	DTE Sending		DCE Sending	
	Signal	V.24 circuit	Signal	V.24 circuit
3, RTC	DTR	108/2	DSR	107
4, RTR	RFR	133	CTS	106
7, IC	Always 0	-	RI	125
8, DV	Always 1	-	DCD	109

NOTE

Circuit 133, RFR (Ready for Receiving) is commonly assigned to the connector pin that is alternatively used for circuit 105, RTS (Ready to Send).

If a station is unable to transmit frames because of flow control but wishes to stop accepting further frames, it may send frames containing no user data (i.e., only the control signal octet and, optionally, the interrupt signal octet) to control signal flow.

4.4. Procedures

4.4.1. DLC Establishment

In most cases the establishment of a DLC will be initiated by the TE; however, it may be initiated by the UE, as well. The action taken by the higher layers of the TE in response to UE-initiated DLC establishment is out of scope of this document.

To initiate the establishment of a DLC, the station transmitting the request sends an SABM frame with the P-bit set to 1. The address field of this frame contains the DLCI value of the desired connection. If the responding station is ready to establish the connection, it will reply with a UA frame with the F-bit set to 1. If the responding station is not ready or unwilling to establish the particular DLC, it will reply with a DM frame with the F-bit set to 1.

Once a DLC has been established, both stations are in connected mode for the particular DLC, and the information transfer may commence.

If no UA or DM response has been received after **<T1>**, the initiating station may retransmit the SABM. This action may be repeated until a response is obtained or action is taken by a higher layer.

If no negotiation procedure is used, default DLC parameters are used.

4.4.2. DLC Release

The release of a DLC may be initiated by either station through the transmission of a DISC frame with the P-bit set to 1. Confirmation of the DLC release is signaled by the other station sending a UA frame with the F-bit set to 1. Once the DLC has been released, the stations enter disconnected mode for that particular DLC.

If the station receiving the DISC command is already in disconnected mode, it will respond with a DM frame.

If no UA or DM response has been received within **<T1>**, the initiating station may retransmit the DISC. This action may be repeated until a response is obtained or until further action is taken by a higher layer.

4.4.3. Information Transfer

In Quectel multiplexing system, data are transmitted using UIH frames. UIH frames may also be used for data transmission when the delays inherent in error-recovery procedures are unacceptable, such as voice data transmission.

The transmitter takes information from the convergence layer for the particular DLC and places it in the information field of the transmitted frame. Once a UIH frame has been correctly received, the contents of its information field are passed to the convergence layer.

The C/R bit of frames sent by the initiating station are set to 1 and C/R bit of those sent by the responding station are set to 0. The P-bit of both stations is set to 0. See **Chapter 4.1.2.2** for more information about the C/R bit.

The maximum length of the information field in UIH frames is **<N1>** in **AT+CMUX**.

4.4.4. Time-out Considerations

In order to detect a no-reply or lost-reply condition, each station provides a response time-out function (**<T1>**). The expiry of the time-out function is used to initiate appropriate error recovery procedures.

To prevent potential conflicts, the duration of the time-out function in the two stations is unequal.

The time-out function is started whenever a station transmits a frame that requires a reply. When the expected reply is received, the time-out function is stopped. The time-out function has to be restarted if other frames requiring acknowledgements are sent during the interval that the time-out function is running.

If the response time-out function expires, a command with the P-bit set to 1 may be (re)transmitted, and the response time-out function will be restarted.

4.4.5. Flow Control

Quectel multiplexing system supports a software flow control mechanism. Software flow control is implemented by *3GPP TS 27.010* MSC, FCoff and FCon message frames.

For software flow control, the TE uses MSC messages to communicate with the UE. When TE refuses to accept frames, it sends an MSC message to UE with FC bit set to 1 in V.24 control signals, whereas it sets the FC bit to 0 to signal the recovery of received frames. UE responds to MSC message to indicate data transmission recovery.

TE sends FCoff command to UE when it refuses to accept anything except the control messages on DLCI 0. In such a case, UE suspends frame sending on all data channels except the control channel, which remains operational for sending control messages. TE can send FCon command to UE to recover the transmission. When UE receives FCoff or FCon command, it sends a response back.

The difference between MSC and FCon is that the former only controls one data channel, while the latter controls all the data channels except the control channel.

5 Examples

5.1. Frame Structure Samples

Sample 1:

Opening Flag	Address Field	Control Field	Length Field	FCS	Closing Flag
F9	03	3F	01	1C	F9
Header	DLCI 0	SABM Frame	0, No Information Field		Tail

This sample is a SABM frame to open DLCI 0.

Sample 2:

Opening Flag	Address Field	Control Field	Length Field	Information Field	FCS	Closing Flag
F9	05	EF	09	41 54 49 0D	58	F9
Header	DLCI 1	UIH Frame	4	AT command string "ATI<CR>"		Tail

This sample is a UIH frame to transmit the AT command string "ATI<CR>".

Sample 3:

Opening Flag	Address Field	Control Field	Length Field	Information Field	FCS	Closing Flag
F9	01	EF	0B	E3 07 07 0D 01	79	F9
Header	DLCI 0	UIH Frame	5	MSC Message. Length: 3 octets		Tail

This sample is an MSC message carried in UIH frame to transmit V2.4 signal 0x0D.

5.2. Channel Establishment

Step 1: Launch MUX

No.	Step	Data Direction	Hex	Comment
1	TE launches UE MUX function via AT command	TE → UE	61 74 2B 63 6D 75 78 3D 30 0D 0D 0A 4F 4B 0D 0A 0D 0A	AT+CMUX=0<CR><LF>
	UE sends a response	TE ← UE	61 74 2B 63 6D 75 78 3D 30 0D 0D 0A 4F 4B 0D 0A 0D 0A	AT+CMUX=0<CR><LF>OK<CR><LF><CR><LF>

Step 2: Establish DLCI 0

No.	Step	Data Direction	Hex	Comment
1	TE requests to establish a control channel DLCI 0 by sending a SABM frame	TE → UE	F9 03 3F 01 1C F9	SABM frame
	Upon receiving an SABM frame, UE responds with UA and accepts to create DLCI 0	TE ← UE	F9 03 73 01 D7 F9	UA frame

Step 3: Establish DLCI 1–4

No.	Step	Data Direction	Hex	Comment
1	TE requests to establish DLCI 1 by sending an SABM frame	TE → UE	F9 27 3F 01 DE F9	
	Upon receiving the SABM frame, the UE responds with DM but refuses to create DLCI 1	TE ← UE	F9 27 1F 01 F4 F9	
2	TE requests to establish DLCI 1 by sending the SABM frame	TE → UE	F9 07 3F 01 DE F9	
	Upon receiving the SABM frame, UE responds with UA and accepts to create DLCI 1	TE ← UE	F9 07 73 01 15 F9	
	UE sends MSC message frames	TE ← UE	F9 01 EF 0B E3 07 07 0D 01 79 F9	
	UE sends OK	TE ← UE	F9 05 EF 0D 0D 0A 4F 4B 0D 0A 5F F9	
	TE sends MSC message frames	TE → UE	F9 01 EF 0B E3 07 07 0D 01 79 F9	

	UE responds	TE ← UE	F9 01 EF 0B E1 07 07 0D 01 79 F9
	TE requests to establish DLCI 2 by sending an SABM frame	TE → UE	F9 0B 3F 01 59 F9
	Upon receiving the SABM frame, the UE responds with UA and accepts to create DLCI 2	TE ← UE	F9 0B 73 01 92 F9
3	UE sends MSC message frames	TE ← UE	F9 01 EF 0B E3 07 0B 0D 01 79 F9
	TE sends MSC message frames	TE → UE	F9 01 EF 0B E3 07 0B 0D 01 79 F9
	UE responds	TE ← UE	F9 01 EF 0B E1 07 0B 0D 01 79 F9
4	DLCI 3 and DLCI 4 are established in the same way as DLCI 1 and DLCI 2.		
5	Finally, 4 channels are established, and Quectel multiplexing system can work normally.		

This sample is an MSC message carried in UIH frame to transmit V2.4 signal 0x0D.

5.3. Frame Transmission

Once the control channel and data channels are established, TE and UE can exchange data through UIH frames.

Frame Transmission:

No.	Step	Data Direction	Hex	Comment
	TE sends the AT command string "ATI<CR>" on DLCI 1	TE → UE	F9 05 EF 09 41 54 49 0D 58 F9	UIH frame
1	UE responds on DLCI 1	TE ← UE	F9 05 EF 09 41 54 49 0D 58 F9 F9 05 EF 9B 0D 0A 53 49 4D 43 4F 4D 5F 4C 74 64 0D 0A 53 49 4D 43 4F 4D 5F 53 49 4D 33 30 30 0D 0A 52 65 76 69 73 69 6F 6E 3A 53 49 4D 33 30 30 4D 33 32 28 53 50 41 4E 53 49 4F 4E 29 5F 56 31 30 2E 30 2E 38 5F 42 55 49 4C 44 30 33 0D 0A 0D 0A 47 F9	UIH frame

			F9 05 EF 09 4F 4B 0D 0A 58 F9	
2	TE sends the AT command string "AT<CR>" on DLCI 2	TE → UE	F9 09 EF 07 41 54 0D 35 F9	UIH frame
	UE responds on DLCI 2	TE ← UE	F9 09 EF 07 41 54 0D 35 F9 F9 09 EF 0D 0D 0A 4F 4B 0D 0A D8 F9	UIH frame
3	Frame transmission on DLCI 3 and DLCI 4 is the same as above.			

5.4. Flow Control

Flow Control:

No.	Steps	Data Direction	Hex	Comment
1	UE sends an MSC message with FC bit set to 1 on control channel DLCI 0, to indicate refusal to accept anything on DLCI 1.	TE ← UE	F9 01 EF 0B E3 07 07 8F 01 79 F9	
2	UE sends MSC message with FC bit set to 0 on control channel DLCI 0, to indicate recovery of DLC1 data transmission.	TE ← UE	F9 01 EF 0B E3 07 07 8D 01 79 F9	
3	TE sends MSC message with FC bit set to 1 on control channel DLCI 0, to indicate refusal to accept anything on DLCI 1.	TE → UE	F9 01 EF 0B E3 07 07 8F 01 79 F9	
4	TE sends MSC message with FC bit set to 0 on control channel DLCI 0, to indicate recovery of DLC1 data transmission.	TE → UE	F9 01 EF 0B E3 07 07 8D 01 79 F9	
5	TE sends FCOFF message on DLCI 0, to indicate refusal to accept anything on all DLCs except DLCI 0.	TE → UE	F9 01 EF 05 63 01 93 F9	
6	TE sends FCON message through DLCI 0, to indicate recovery of data transmission.	TE → UE	F9 01 EF 05 A3 01 93 F9	

5.5. MUX Close-Down

Close-Down Procedures:

No.	Step	Data Direction	Hex	Comment
1	TE sends DISC frame to request closing down DLCI 1	TE → UE	F9 07 53 01 3F F9	
	UE replies with the UA frame to accept the request	TE ← UE	F9 07 73 01 15 F9	
2	TE sends DISC frame to request closing down DLCI 2	TE → UE	F9 0B 53 01 B8 F9	
	UE replies with the UA frame to accept the request	TE ← UE	F9 0B 73 01 92 F9	
3	TE sends DISC frame to request closing down DLCI 3	TE → UE	F9 0F 53 01 7A F9	
	UE replies with the UA frame to accept the request	TE ← UE	F9 0F 73 01 50 F9	
4	TE sends DISC frame to request closing down DLCI 4	TE → UE	F9 13 53 01 77 F9	
	UE replies with the UA frame to accept the request	TE ← UE	F9 13 73 01 5D F9	
5	TE sends a CLD message frame to request closing down the MUX on DLCI 0	TE → UE	F9 03 EF 05 C3 01 F2 F9	
	UE acknowledges the CLD message to accept the request	TE ← UE	F9 03 EF 05 C1 01 F2 F9	
6	Now, the MUX is closed down.			

6 Appendix References

Table 19: Related Document

Document Name
[1] Quectel_EG800Q&EG91xQ_Series_AT_Commands_Manual

Table 20: Terms and Abbreviations

Abbreviation	Description
ABM	Asynchronous Balanced Mode
C/R	Command/Response
CLD	Multiplexer Close Down
DCE	Data Communications Equipment
DISC	Disconnect
DLC	Data Link Connection
DLCI	Data Link Connection Identifier
DM	Disconnected Mode
DTE	Data Terminal Equipment (typically computer, MCU, external controller)
DV	Data Valid
FC	Flow Control
FCoff	Flow Control off Command
FCon	Flow Control on Command
FCS	Frame Check Sequence
IC	Incoming Call Indicator

MSC	Modem Status Command
MUX	Multiplexer
PSC	Power Saving Control
RFR	Ready for Receiving
RTC	Ready to Communicate
RTR	Ready to Receive
RTS	Ready to Send
SABM	Set Asynchronous Balanced Mode
TE	Terminal Equipment
UA	Unnumbered Acknowledgement
UE	User Equipment
UI	Unnumbered Information
UIH	Unnumbered Information with Header Check