EC2x&EG2x&EG9x&EM05 Series

PPP Application Note

LTE Standard Module Series

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History

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1 Introduction

This document gives a brief introduction on the PPP function of Quectel EC2x family, EG2x family, EG9x family and EM05 series modules, including application mode, procedures for PPP setup and termination, modes for PPP connection, and examples for PPP dial-up, etc.

This document is applicable to following Quectel modules.

1.1 Applicable Module

Table 1: Applicable Modules

<table>
<thead>
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<td>EC21 Series</td>
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<td>EG2x</td>
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<td>EG9x</td>
<td>EG91 Series</td>
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<td></td>
<td>EG95 Series</td>
</tr>
<tr>
<td>-</td>
<td>EM05 Series</td>
</tr>
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</table>
2 Application Mode

The usage of PPP (Point-to-Point Protocol) is illustrated in the figure below. Either UART or USB can be used for PPP connection. The module provides a PPP server for application, and the application side provides a PPP client for the module. Meanwhile, the application side has to provide protocols such as TCP/IP, HTTP(S), etc. When PPP connection has been set up, the IP packet flow from the application side will be transmitted to Internet through the module.

Most standard operating systems (e.g. Windows, Unix/Linux) include the PPP protocol stack. For other operating systems which do not have existing application to set up PPP connection, it is very important to develop applicable application software to accomplish PPP connection first.

Figure 1: PPP Application Mode
3 Procedures for PPP Setup

3.1. General Procedures for PPP Setup

After the module has registered on GPRS network, please set APN for PPP by AT+CGDCONT and start PPP by ATD*99#. When ATD*99# is executed, the module enters into the procedure of PPP frame interaction which is carried out on the basis of standard Point-to-Point Protocol. Description about the module’s packet interaction is included in the figure below. Please get more details about standard Point-to-Point Protocol from RFC 1661.

![Diagram of PPP Setup Procedures]

Figure 2: General Procedures for PPP Setup
3.2. Recommended Procedures for PPP Setup

**Packet Interaction**

- **Return CONNECT**
- **LCP negotiation**
- **AUTH negotiation**
- **IPCP negotiation**

**Exception handling**

- **Send Count++**
- **MCU receives PPP Terminate Ack packet in 3s**
- **MCU sends PPP Terminate Request packet**

**Packet Interaction**

- **Start timer when IPCP negotiation begins**
- **Succeed to negotiate IPCP in 90s**
- **MCU gets IP and DNS**
- **Data transmission**

**Network**

- It indicates that the module has registered on network when AT+CREG? returns 1 or 5.
- It is able to go to next step without registering on PS in 60s.

**PS Network**

- It indicates that the module has registered on PS when AT+CREG? returns 1 or 5.
- 60s is a recommended procedure for PPP Setup.

**APN Configuration**

- APN must be set by AT+CGDCONT.
- Use AT+CGACT to check whether the current content has been activated when AT+CGDCONT returns enter.

**Query (U)SIM Card Status**

- AT+CPIN: Reboot the module if it fails to detect (U)SIM card in 20s with AT+CPIN?
- AT+CGREG?: Query (U)SIM card status

**Recommended Power ON/OFF**

- Power OFF, Pull Power Key from high to low. Then cut off power when STATUS pin switches to low for 1s.
- Power ON: Pull Power Key to low for 1s.
- Pull Power Key back to high when pushing Power OFF/ON.

**Flowchart of Recommended Procedures for PPP Setup**

---

**Figure 3: Flowchart of Recommended Procedures for PPP Setup**
When the module is powered on, if the main UART is used, baud rate of the UART should be set by \texttt{AT+IPR=xxx;&W}. Before using \texttt{ATD*99#} to set up PPP, the status of (U)SIM card must be checked via \texttt{AT+CPIN?}. When (U)SIM card is ready, please check the network registration status periodically via \texttt{AT+CREG?} and \texttt{AT+CGREG?} until the network condition is prepared.

### NOTES

1. Please ensure MCU and the module are synchronized successfully after rebooting the module. MCU sends \texttt{AT<CR><LF>} to the module every 100 ms until \texttt{OK} is received from the module. If the UART is used, MCU sets and saves baud rate via \texttt{AT+IPR=xxx;&W} after successful synchronization.
2. Please note that MCU has to wait for the response (for example \texttt{OK}, \texttt{CME error}, \texttt{CMS error}) to the previous AT command before inputting the next AT command. The module can be rebooted if there is no response in 60s.
3. It is strongly recommended that do NOT power on/off the module frequently. If the dial-up retry is failed for 3 times continuously, the module could be powered off/on (reset) immediately for the fourth time. After that, if the fourth dial-up retry still fails, reset the module for the fifth time after 10 minutes, the sixth time after 30 minutes, and the seventh time after one hour.
4. If MCU fails to transmit data to network after PPP connection has been set up, please check the configuration of PPP and the state of network, and then reboot the module.
5. If the module has registered on CDMA network, please do NOT use \texttt{ATD#777} command to set up PPP. \texttt{ATD*99#} command should be used.
4 Modes for PPP Connection

4.1. Data Mode and Command Mode

The module communicates information (including AT commands and data) with application via USB/UART port. There are two working modes for the two ports: data mode and command mode.

The ports are in command mode before PPP is set up, and the module can execute AT commands in this state. When PPP negotiation is started, the ports will enter into data mode, and will keep in this mode when PPP connection is set up. If the PPP connection is not set up successfully, the ports will enter into command mode. In data mode, the module cannot execute AT commands.

Quectel EC2x family, EG9x family, EG2x family and EM05 family modules provide convenient methods to switch between the two modes.

4.1.1. Switch from Data Mode to Command Mode

4.1.1.1. Change DTR Level to Switch from Data Mode to Command Mode

When PPP connection is already existed and the USB/UART port is in data mode, the ports can be switched to command mode by changing DTR level from low to high (AT&D1 should be executed first). The module will return OK when switched to command mode successfully.

4.1.1.2. Use Sequence +++ to Switch from Data Mode to Command Mode

The other way to switch USB/UART port from data mode to command mode is using sequence “+++” when PPP connection has been set up successfully. To prevent the “+++” escape sequence from being misinterpreted as data, the following sequence should be followed:

1) Do not input any character within 1s or longer before inputting “+++”.
2) Input “+++” within 1s, and no other characters can be inputted during the time.
3) Do not input any character within 1s after “+++” has been inputted.

When such particular sequence “+++” is received, the USB/UART port will switch from data mode to
command mode, and the module will return **OK** for the operation.

**NOTE**

Please make sure the above operations are performed after completion of PPP negotiation. If not, above operations will terminate the PPP negotiation and make USB/UART port quit from data mode. When USB/UART port is switched to command mode after accomplishing PPP negotiation, the data will be treated as AT command and the module still remains PPP connection.

### 4.1.2. Switch from Command Mode to Data Mode

#### 4.1.2.1. Use ATO to Switch from Command Mode to Data Mode

When the PPP connection exists, the USB or UART port is in command mode. Execute **ATO** to enter data mode.

**Example**

```c
//When PPP connection exists, and USB/UART port is in command mode.
ATO
CONNECT  //Indicates that TA has entered into data mode, and all data inputted from USB/UART port will be treated as PPP frames.
```

### 4.2. Handle URC in Data Mode

The URC for incoming calls and short messages will not be reported to the PPP dial-up port in data mode during PPP connection. But module’s RI pin level will change from high to low for 120ms as an indication. According to the RI pin status, MCU can switch the port to command mode to process the call or short message. After switching to command mode, the URC will be reported to the port if the incoming call or short message still exists.

### 4.3. Data Carrier Detection (DCD) Mode

DCD mode is determined by **AT&C**. If **AT&C0** is set, the DCD pin will not be used to indicate the data carrier status. If **AT&C1** is set, the DCD pin will be used to indicate the data carrier status. The pin will keep at low level when data carrier exists or PPP negotiation begins, otherwise it will keep at high level.
When switching module's USB/UART port from data mode to command mode (using "+++"), the DCD state does not change.
5 PPP Connection Termination

There are two methods to terminate the PPP dial-up connection:

1. Terminating the PPP connection through the LCP Terminate-Request message, which is recommended.

2. Terminating the PPP connection by changing the DTR level. Set the DTR function with `AT&D2`, change the DTR level from low to high, and the data connection will be automatically terminated. Once the PPP connection is terminated, the USB/UART port will enter the command mode.

Example

//USB/UART port is in command mode before PPP connection is established.

```
AT&D2
OK
```

NOTE

1. PPP connection termination procedures must be performed in data mode.
2. PPP connection termination procedures can be performed at any time during the PPP setting or connecting process.
6 PPP Dial-up Operation

This chapter mainly introduces how to establish PPP dial-up in Windows 10 and Linux system.

6.1. Preparation

It is necessary to finish the following steps before establishing a PPP dial-up connection in Windows.

1. Connect the module to PC and enter the PIN code if the (U)SIM card PIN is locked.
2. Make sure the (U)SIM card can successfully register on GPRS network.

6.2. PPP Dial-up in Windows 10

6.2.1. Modem Configuration

6.2.1.1. Add New Modem

If the Standard 19200 bps Modem is not installed, add a new standard modem to the modem section of the control panel.
1. Search for “Phone” in the main interface, and then click “Phone and Modem” option:

![Search for "Phone and Modem" in Control Panel (Windows 10)](image)

Figure 4: Search for "Phone and Modem" in Control Panel (Windows 10)
2. Double-click the "Phone and Modem", and select "Modems" → "Add..." to add a new modem.

Figure 5: Add New Modem (Windows 10)
3. Follow the instructions on the screen to install the new modem:

- select "Standard 19200 bps Modem" and then the port (such as "COM10") to be installed;
- click "Next" button until the configuration is complete. For details, see the figures below.

Figure 6: Select Modem Model (Windows 10)

Figure 7: Select Port (Windows 10)
Figure 8: New Modem is Installed Successfully (Windows 10)
6.2.1.2. Configure Modem Driver

- Select the installed “Standard 19200 bps Modem” and click the “Properties” button.
- After entering the interface, select the “Modems” option and modify the “Maximum Port Speed” to “115200” (default value).
- Click the “Advanced” option, configure “Extra Settings” and input AT+CGDCONT=1,“IP”,“CMNET”.

Figure 9: Configure Modem Driver (Windows 10)
In the example above, AT+CGDCONT=1,"IP","CMNET" redefine a PDP context where CID=1, PDP type=IP and APN=CMNET. CMNET is the APN of the network operator China Mobile and it should be replaced with the value provided by the network operator.

6.2.2. Dial-up Network Configuration

6.2.2.1. Create a New Connection

1. Open “Control Panel”, click “Network and Internet”, “Network and Sharing Center” and finally “Set up a new connection or network”.

![Create New Connection](Windows 10)

**Figure 10: Create New Connection (Windows 10)**
2. Select “Connect to the Internet”, click “Next”. Then click “Set up a new connection anyway” and “Dial-up” to connect.

Figure 11: Set up New Connection (Windows 10)
6.2.2.2. Configure the Connection

Enter characters (such as "*99#") in "Dial-up phone number" box, and then click "Connect" button.

**Figure 12: Configure Connection (Windows 10)**
6.2.2.3. Configure the Dial-up Tool

- Enter characters (such as "*99#") in "Dial" window.
- Click "Properties" button, and configure the "Standard 19200 bps Modem (COM10)".
- Select "115200" from the drop-down list of "Maximum speed".
- Click "OK" button to finish the configuration.
- Click "Dial" button to initiate the PPP connection.

Figure 13: Configure Dial-up Tool (Windows 10)
6.2.2.4. Establish the Dial-up Connection

The interface will pop up a prompt box "Verifying username and password", and the pop-up box quickly pops up "Connected" to indicate a dial-up connection. See the following figures for details.

Figure 14: Connecting to Dial-up Connection (Windows 10)

Figure 15: Establish Dial-up Connection Successfully (Windows 10)
6.3. PPP Dial-up in Linux

6.3.1. Basic Procedure for Dial-up in Linux

![Flowchart for PPP Dial-up in Linux]

Figure 16: Dial-up Flowchart (Linux)

6.3.1.1. Dial-up Through pppd

The chat and options scripts are closely related to PPP connection. Among them, the chat script is used to make AT call and AT control with modules; the options script is used to configure PPP and set up the PPP connection.

Scripts provided by Quectel:

- The chat script: `quectel-chat-connect` and `quectel-chat-disconnect`
- The options script: `quectel-ppp`
1. Prepare the script:

```bash
~$ tar -zxvf xxxx.tar.gz
~$ cd /xxx/
~$ dos2unix *
```

2. Copy the PPP script to `/etc/ppp/peers/`:

```bash
~$ cp quectel-chat-connect quectel-chat-disconnect quectel-ppp /etc/ppp/peers/
```

3. Modify the script file:

```bash
~$ vi quectel-ppp
# Modem path Modify it as /dev/ttyUSB3 115200
# user name and passwd Set it to the default value.
```

![Figure 17: Modify the Profile](image1)

4. Modify APN:

```bash
~$ vi quectel-chat-connect
# Modify the APN information
```

![Figure 18: Modify APN](image2)

5. Start PPP dail-up:

```bash
~$ pppd call quectel-ppp &
```
Figure 19: Start PPP Dial-up (1)

Figure 20: Start PPP Dial-up (2)
6. Check the USBnet information:

   ```bash
   ~$ ifconfig ppp0
   ```

   ![Figure 21: Check the USBnet Information](image1)

7. Check the route information:

   ```bash
   ~$ route -n
   ```

   ![Figure 22: Check the Route Information](image2)

8. Check DNS information

   ```bash
   ~$ cat /etc/resolv.conf
   ```

   ![Figure 23: Check DNS Information](image3)

9. Check the network connection status:

   ```bash
   ~$ ping www.baidu.com
   ```
6.3.1.2. Dial-up Through quectel-pppd.sh

The dialing principle of the shell script is the same as that of the above dial-up through `pppd`, which sends AT command to the modem to perform PPP dial-up. The verification steps after successful dial-up are the same as that of the above dial-up through `pppd`.

Start dial-up:

```
~$ ./quectel-pppd.sh /dev/ttyUSB3 cmnet test test ATD*99***2#
```

Among them, `QL_PDP`, `QL_IP` and `QL_APN` can be configured by `AT+CGDCONT=QL_PDP, "QL_IP","QL_APN",0,0` to modify or create a APN in PPP dial-up, and `QL_PDP` can be configured by `ATD*99***QL_PDP` to specify the channel to be used for dial-up.
6.3.1.3. Hang Up PPP Dial-up

- Hang up through **pppd**:
  ```
  ~$ sudo killall pppd
  ```

- Hang up through executing the script:
  ```
  ~$ sudo ./quectel-ppp-kill
  ```

- Hang up through AT command:
  ```
  ~$ sudo minicom -D /dev/ttyUSB2
  ~$ AT&D
  ```

The module should be rebooted after hanging up dial-up, otherwise the next dial-up will fail.
6.3.2. Process of PPP Dial-up through Scripts

**Figure 27: Process of PPP Dial-up Through Scripts**

- **PPP Setup:** The process starts with initializing PPP. The PPP daemon is launched, and the configuration script is executed.

- **Configuration Script:** The script is executed, and the PPP connection is configured. If the script fails, the PPP connection will not be established.

- **Authentication:** The script prompts for the user name and password. If the authentication fails, the connection attempt will be terminated.

- **Network Configuration:** The script configures the IP network parameters, including ARP and DNS.

- **Link Establishment:** The link is established, and the IP connection is configured. If the link cannot be established, the connection attempt will be terminated.

- **Data Transfer:** Data can now be transferred over the PPP connection.

- **Connection Termination:** The connection can be terminated by either the user or the system.


7 Appendix and References

Table 2: Terms and Abbreviations

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<th>Description</th>
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<td>Access Point Name</td>
</tr>
<tr>
<td>CHAP</td>
<td>Challenge Handshake Authentication Protocol</td>
</tr>
<tr>
<td>DCD</td>
<td>Data Carrier Detection</td>
</tr>
<tr>
<td>DNS</td>
<td>Domain Name Server</td>
</tr>
<tr>
<td>DTR</td>
<td>Data Terminal Ready</td>
</tr>
<tr>
<td>GPRS</td>
<td>General Packet Radio Service</td>
</tr>
<tr>
<td>GSM</td>
<td>Global System of Mobile Communication</td>
</tr>
<tr>
<td>IP</td>
<td>Internet Protocol</td>
</tr>
<tr>
<td>IPCP</td>
<td>IP Control Protocol</td>
</tr>
<tr>
<td>LCP</td>
<td>Link Control Protocol</td>
</tr>
<tr>
<td>MCU</td>
<td>Micro Control Unit</td>
</tr>
<tr>
<td>MS</td>
<td>Mobile Station</td>
</tr>
<tr>
<td>PAP</td>
<td>Password Authentication Protocol</td>
</tr>
<tr>
<td>PDP</td>
<td>Packet Data Protocol</td>
</tr>
<tr>
<td>PIN</td>
<td>Personal Identification Number</td>
</tr>
<tr>
<td>PPP</td>
<td>Point-to-Point Protocol. The Point-to-Point Protocol is designed for simple links which transport packets between two ports. These links provide full-duplex simultaneous bi-directional operation, and are assumed to deliver packets in order. It is intended that PPP provides a common solution for easy connection of a wide variety of hosts, bridges and routers.</td>
</tr>
<tr>
<td>RI</td>
<td>Ring Indicator</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Description</td>
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<tr>
<td>--------------</td>
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<tr>
<td>TA</td>
<td>Terminal Adapter</td>
</tr>
<tr>
<td>TE</td>
<td>Terminal Equipment</td>
</tr>
<tr>
<td>UART</td>
<td>Universal Asynchronous Receiver Transmitter</td>
</tr>
<tr>
<td>(U)SIM</td>
<td>(Universal) Subscriber Identity Module</td>
</tr>
</tbody>
</table>