MC60&MC90 GNSS AGPS Application Note

GSM/GPRS/GNSS Module Series

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About the Document

History

Revision	Date	Author	Description
1.0	2016-08-02	Hyman DING	Initial
1.1	2016-08-18	Hyman DING	Updated the operation flow chart of QuecFastFix Online (figure 8)
1.2	2018-09-19	Simon HU	1. Added MC90 as the applicable module of the document. 2. Updated the operation mechanism and processes of EPO^{TM}. (Chapter 3.2) 3. Updated the example and operation flow chart of QuecFastFix online function. (Chapter 3.3)

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1 Introduction

This document mainly introduces the AGPS functions (EPO™ and QuecFastFix Online) of MC60&MC90 internal GNSS engines. The following chapters will describe the operation mechanism and processes of the two functions when MC60/MC90 is in **all-in-one** solution.

2 General Overview

MC60/MC90 is a multi-purpose module which integrates a high performance GNSS engine and a quad-band GSM/GPRS engine. The GNSS part supports both GPS and GLONASS systems which help achieve fast and accurate positioning.

The module features the built-in EPO™ 1) technology which greatly reduces TTFF in cold start. EPO data, coupled with the reference location and real time information provided by QuecFastFix Online 2) technology, further reduces the cold start TTFF to only several seconds (approx. 4.5 seconds).

As compared with modules with single GPS function, MC60/MC90 provides advantages as listed below:

- The internal GNSS engine supports GPS+GLONASS dual positioning systems, which achieves fast and accurate positioning.
- The built-in EPO™ technology is able to download 6 days' EPO data from MTK EPO server and store it in local file system, which speeds up positioning in cold start.
- Automatic EPO data download and update: MC60/MC90 can automatically check the validity of EPO data. If it detects that the EPO data has expired, it will automatically download the latest data from MTK EPO server.
- QuecFastFix Online function further reduces TTFF in cold start, making it close to the TTFF in hot start.

The following is the connection method between GSM and GNSS parts in **all-in-one** solution:

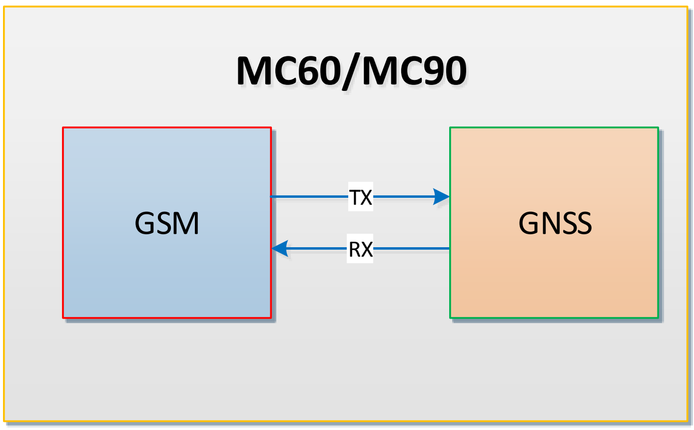

Figure 1: GSM and GNSS Connection in All-in-one Solution

NOTES

1. [1] EPO™ (Extended Prediction Orbit) technology is developed by MTK. It helps the GNSS part to achieve improved TTFF in cold start state.
2. [2] QuecFastFix Online is a technology further used for improving TTFF. Based on EPO data, it is able to additionally provide real time and reference location information. This shortens the TTFF to several seconds in cold start, which is comparable to the TTFF in hot start. The function has to be triggered via **AT+QGEPOAID** command, and please refer to the ***document [4]*** for details.

3 Operation Mechanism and Processes

3.1. EPO™ Operation Mechanism

After MC60/MC90 is powered on, the GNSS part has to be powered on separately via **AT+QGNSSC=1** command. After that, **AT+QGEPOAID** command has to be executed to trigger EPO™ function. The function can also be triggered automatically through enabling EPO™ before powering on GNSS. EPO™ provides a great solution to improve the TTFF of the GNSS part.

Operation flow of EPO™ function:

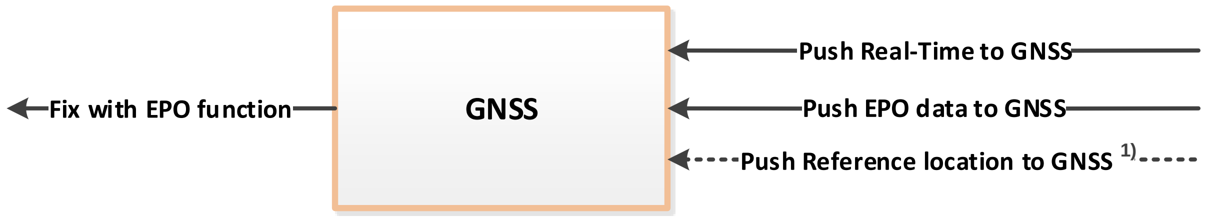

Figure 2: EPO™ Function Operation Flow

NOTE

1) The action will be triggered when customers use QuecFastFix Online function.

3.2. EPO™ Operation Processes

EPO™ function supports two kinds (Type A and Type B) of operation processes. Customers can choose any type according to demands.

3.2.1. Operation Processes of EPO™ Function (Type A)

Before using EPO™ function, please make sure time synchronization has been completed and the module has registered on network successfully.

3.2.1.1. Detailed Operation Processes (Type A)

1) After MC60/MC90 is powered on, send **AT+QGNSSC=1** to power ON the GNSS part to start positioning.
2) Switch to PDP context 2 to configure the APN of PDP context 2 for network. The PDP context 2 will be activated automatically and deactivated during the EPO download period. After configuring APN, the scenario can be switched back to context 0 or context 1 to perform TCP service.
3) Confirm whether MC60/MC90 has registered on network successfully.
4) Confirm whether time synchronization has been completed. MC60/MC90 will update local RTC time through NITZ via network. Some network operators may not support the function, and in this case, the time should be synchronized through NTP manually.
5) Enable EPO™ function via **AT+QGNSSEPO=1** command and then execute **AT+QGEPOAID** command to trigger EPO download if there is no valid EPO data and inject the data to GNSS. For the details of AT commands, please refer to ***document [4]***.
6) Get NMEA information.
7) Execute **AT+QGNSSC=0** to turn off GNSS. (This is an optional step, and customers can choose whether to perform this step according to their application needs)
8) Execute **AT+QGNSS=1** to turn on GNSS and EPO data will be injected. (This is an optional step, and customers can choose whether to perform this step according to their application needs)

3.2.1.2. Example

```
AT+QGNSSC=1             //Power ON GNSS
OK
AT+QIFGCNT=2
OK
AT+QICSGP=1,“CMNET”
OK
AT+CREG?;+CGREG?        //Check network status
+CREG: 0,2

+CGREG: 0,2

OK
AT+CREG?;+CGREG?        //Check network status
+CREG: 0,1
```

```
+CGREG: 0,1

OK
AT+QGNSSTS?            //Read time synchronization status
+QGNSSTS: 1            //Time synchronization completed

OK
AT+QGNSSEPO=1          //Enable EPOTM function
OK
AT+QGEPOAID            //Trigger EPOTM function
OK
AT+QGNSSRD?
+QGNSSRD: $GNRMC,125349.093,V,,,,,0.00,0.00,010716,,,N*50
$GNVTG,0.00,T,,M,0.00,N,0.00,K,N*2C
$GNGGA,125349.093,,,,,0,0,,,M,,M,,*54
$GPGSA,A,1,,,,,,,,,,,,,,,*1E
$GLGSA,A,1,,,,,,,,,,,,,,,*02
$GPGSV,1,1,02,09,,,29,06,,,29*74
$GLGSV,1,1,00*65
$GNGLL,,,,,125349.093,V,N*66

OK
AT+QGNSSRD?
+QGNSSRD: $GNRMC,125350.093,V,,,,,0.00,0.00,010716,,,N*58
$GNVTG,0.00,T,,M,0.00,N,0.00,K,N*2C
$GNGGA,125350.093,,,,,0,0,,,M,,M,,*5C
$GPGSA,A,1,,,,,,,,,,,,,,,*1E
$GLGSA,A,1,,,,,,,,,,,,,,,*02
$GPGSV,1,1,02,09,,,29,06,,,29*74
$GLGSV,1,1,00*65
$GNGLL,,,,,125350.093,V,N*6E

OK
……
AT+QGNSSRD?
+QGNSSRD: $GNRMC,125353.092,A,3150.8278,N,11711.9888,E,0.31,111.02,010716,,,A*7C
$GNVTG,111.02,T,,M,0.31,N,0.58,K,A*2F
$GNGGA,125353.092,3150.8278,N,11711.9888,E,1,5,1.63,145.5,M,0.0,M,,*7A
$GPGSA,A,3,06,09,07,02,12,,,,,,,,1.83,1.63,0.83*0E
$GLGSA,A,3,,,,,,,,,,,,1.83,1.63,0.83*1B
$GPGSV,4,1,15,02,68,022,28,05,61,286,,06,37,091,32,13,31,181,*73
$GPGSV,4,2,15,19,25,155,,29,24,318,,20,18,257,,12,17,243,25*7E
$GPGSV,4,3,15,25,13,278,,09,11,039,31,07,06,081,26,15,06,205,*7A
$GPGSV,4,4,15,30,05,107,,17,01,151,,193,,,*44
```

```
$GLGSV,1,1,04,85,77,105,,86,41,334,,84,26,139,,72,12,227,*65
$GNGLL,3150.8278,N,11711.9888,E,125353.092,A,A*4B

OK
```

3.2.1.3. Operation Flow Chart

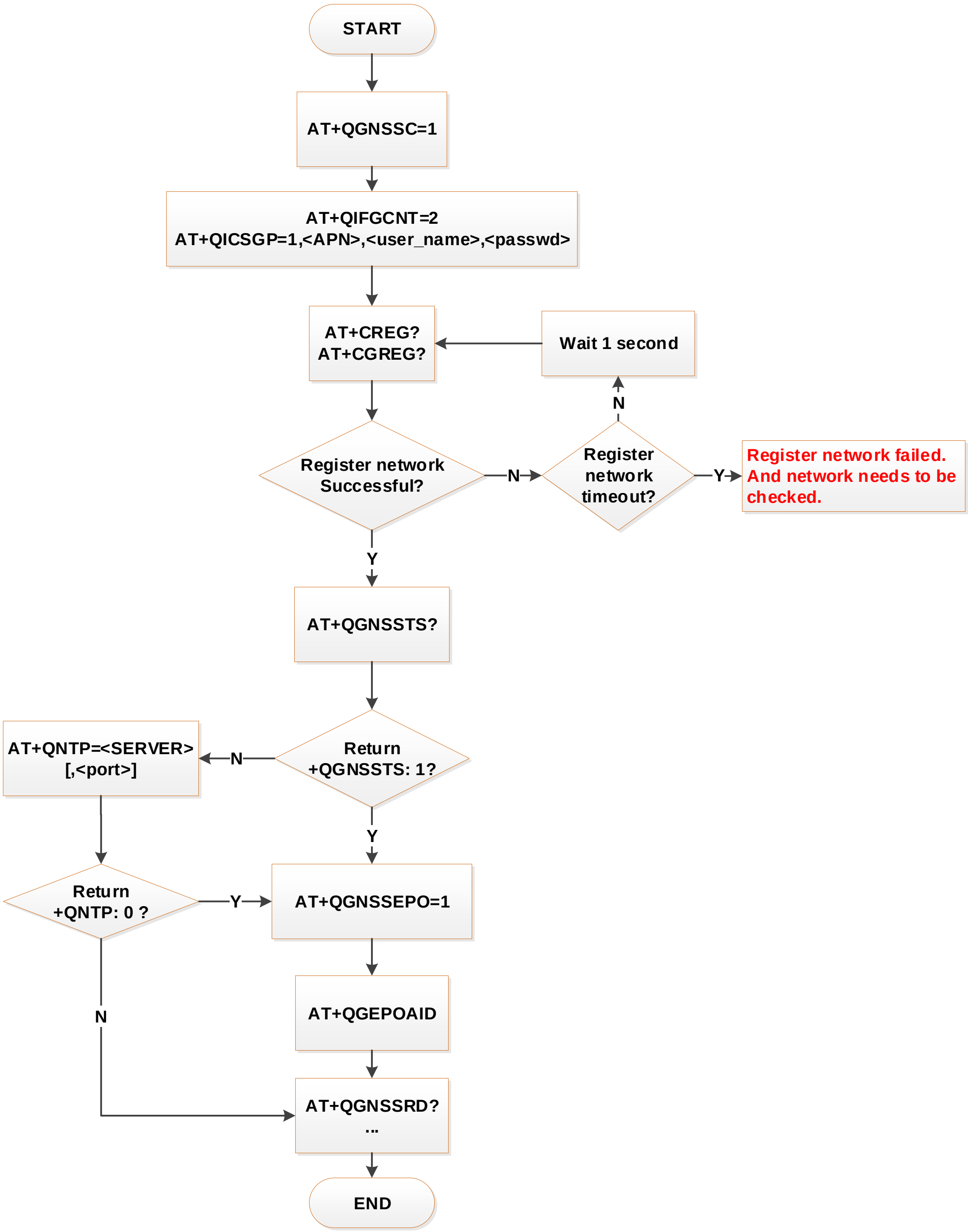

Figure 3: EPO(TM) Function Operation Flow Chart (Operation Process A)

3.2.2. Operation Processes of EPO™ Function (Type B)

This is the best solution for applications with high requirement on low power consumption. Customers can power ON the GNSS part after network has been registered on successfully and the time has been synchronized. After successful position fix, the GNSS part can be powered OFF to save power.

3.2.2.1. Detailed Operation Processes (Type B)

1) Switch to PDP context 2 to configure the APN of PDP context 2 for network. The PDP context 2 will be activated automatically and deactivated during the EPO download period. After configuring APN, the scenario can be switched back to context 0 or context 1 to perform TCP service.
2) Confirm whether MC60/MC90 has registered on network successfully.
3) Confirm whether time synchronization has been completed. MC60/MC90 will update local RTC time through NITZ via GSM/GPRS network. Some network operators may not support the function, and in this case, the time should be synchronized through NTP manually.
4) Enable EPO™ function via **AT+QGNSSEPO=1** command.
5) Power ON the GNSS part via **AT+QGNSSC=1** to trigger EPO download if there is no valid EPO data and inject the data to GNSS.
6) Get NMEA information.
7) Execute **AT+QGNSSC=0** to turn off GNSS. (This is an optional step, and customers can choose whether to perform this step according to their application needs)
8) Execute **AT+QGNSS=1** to turn on GNSS and EPO data will be injected. (This is an optional step, and customers can choose whether to perform this step according to their application needs)

3.2.2.2. Example

```
AT+QIFGCNT=2              //Set PDP context
OK
AT+QICSGP=1,“CMNET”//Configure APN
OK
AT+CREG?;+CGREG?     //Check network status
+CREG: 0,2

+CGREG: 0,2

OK
AT+CREG?;+CGREG?     //Check network status
+CREG: 0,1

+CGREG: 0,1

OK
```

```
AT+QGNSSTS?            //Read time synchronization status
+QGNSSTS: 1            //Time synchronization completed

OK
AT+QGNSSEPO=1          //Enable EPO(TM) function
OK
AT+QGNSSC=1            //Power ON GNSS
OK
AT+QGNSSRD?
+QGNSSRD: $GNRMC,125349.093,V,,,,,0.00,0.00,010716,,,N*50
$GNVTG,0.00,T,,M,0.00,N,0.00,K,N*2C
$GNGGA,125349.093,,,,,0,0,,,M,,M,,*54
$GPGSA,A,1,,,,,,,,,,,,,,,*1E
$GLGSA,A,1,,,,,,,,,,,,,,,*02
$GPGSV,1,1,02,09,,,29,06,,,29*74
$GLGSV,1,1,00*65
$GNGLL,,,,,125349.093,V,N*66

OK
AT+QGNSSRD?
+QGNSSRD: $GNRMC,125350.093,V,,,,,0.00,0.00,010716,,,N*58
$GNVTG,0.00,T,,M,0.00,N,0.00,K,N*2C
$GNGGA,125350.093,,,,,0,0,,,M,,M,,*5C
$GPGSA,A,1,,,,,,,,,,,,,,,*1E
$GLGSA,A,1,,,,,,,,,,,,,,,*02
$GPGSV,1,1,02,09,,,29,06,,,29*74
$GLGSV,1,1,00*65
$GNGLL,,,,,125350.093,V,N*6E

OK
……
AT+QGNSSRD?
+QGNSSRD: $GNRMC,125353.092,A,3150.8278,N,11711.9888,E,0.31,111.02,010716,,,A*7C
$GNVTG,111.02,T,,M,0.31,N,0.58,K,A*2F
$GNGGA,125353.092,3150.8278,N,11711.9888,E,1,5,1.63,145.5,M,0.0,M,,*7A
$GPGSA,A,3,06,09,07,02,12,,,,,,,,1.83,1.63,0.83*0E
$GLGSA,A,3,,,,,,,,,,,,,1.83,1.63,0.83*1B
$GPGSV,4,1,15,02,68,022,28,05,61,286,,06,37,091,32,13,31,181,*73
$GPGSV,4,2,15,19,25,155,,29,24,318,,20,18,257,,12,17,243,25*7E
$GPGSV,4,3,15,25,13,278,,09,11,039,31,07,06,081,26,15,06,205,*7A
$GPGSV,4,4,15,30,05,107,,17,01,151,,193,,,*44
$GLGSV,1,1,04,85,77,105,,86,41,334,,84,26,139,,72,12,227,*65
$GNGLL,3150.8278,N,11711.9888,E,125353.092,A,A*4B
```

```
OK
AT+QGNSSC=0
OK
```

3.2.2.3. Operation Flow Chart

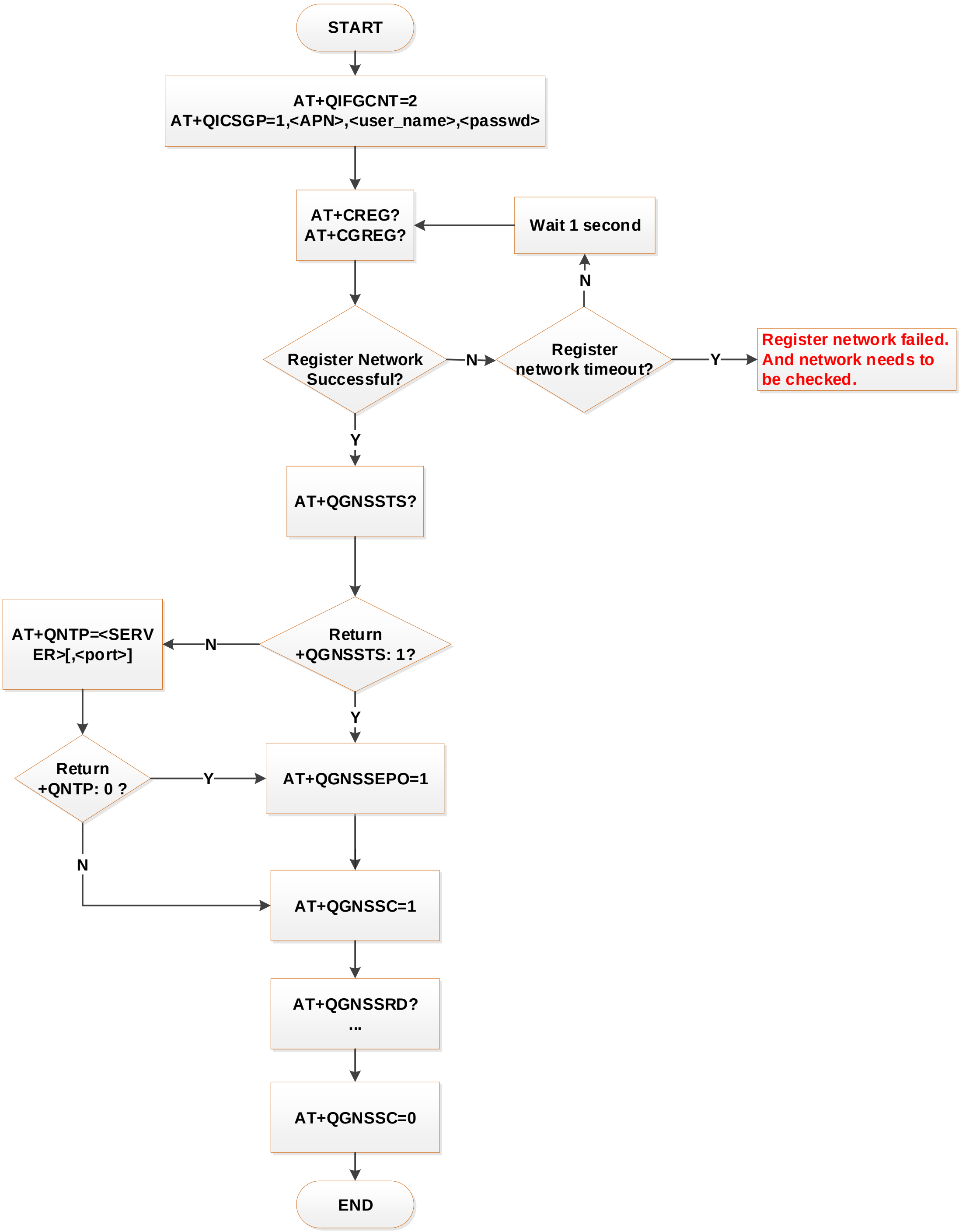

Figure 4: EPO™ Function Operation Flow Chart (Operation Process B)

3.2.3. The Influence of Time on EPO™ Function

Time plays a very important role in EPO™ function, and this is because:

- Before downloading EPO data, the system will check that whether the EPO data exits or has expired. During the process, if the time is incorrect, the local EPO data will be considered as expired.
- After power ON the GNSS part, the local time and EPO data will be pushed into the GNSS part successively. The local time will be used as an index to find out useful satellite information in EPO data. If the time is incorrect, EPO™ function would not be triggered successfully.

There are three ways to realize time synchronization: NITZ, NTP and GNSS.

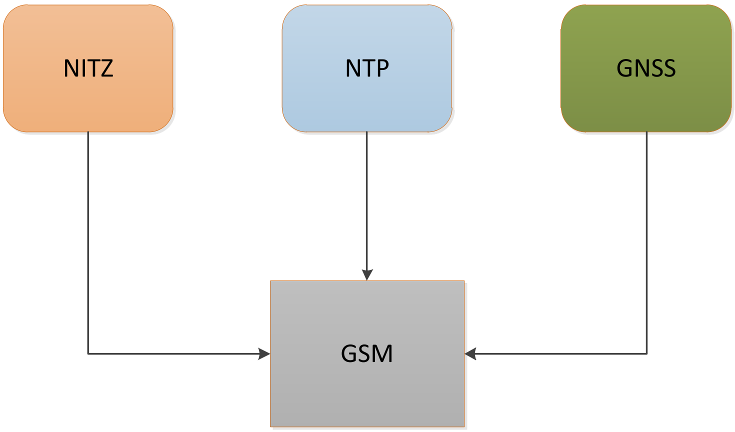

Figure 5: Three Ways for Time Synchronization

NOTES

1. NITZ for time synchronization: During network registration process after MC60/MC90 is powered on, it will get the real time through the network operator and then update the local RTC time. The function needs to be supported by the local network operator. If time synchronization status is queried via **AT+QGNSSTS?** at this time, the return value will be 1, which means the time is synchronized successfully.
2. NTP for time synchronization: the module gets the real time through NTP domain. If **AT+QGNSSTS?** is executed at this time, the return value will not be 1. NTP time synchronization function requires manual execution by customers.
3. GNSS for time synchronization: the module gets the real time from the satellite and then update the local RTC time. If **AT+QGNSSTS?** is executed at this time, the return value will be 1.

After the module is powered on, the time will be synchronized automatically via NITZ while the module is registering to the local network operator. The synchronization status can be inquired through **AT+QGNSSTS?** command. In some areas, the local network operator may not support NITZ function, and in this case, **AT+QNTP=<server>[,<port>]** command can be executed to synchronize time through

NTP domain. After the GNSS part is powered on, it can also get the real time from the satellite, and then update the RTC time if it has not been updated.

If the MCU of TE is able to provide exact RTC time, then the time can be synchronized to the module through **AT+CCLK** command.

NOTES

1. The time needed for time synchronization depends on the network quality. In general, the time is:
   - NITZ: about 10 seconds
   - NTP: about 50 seconds
2. The interval for time synchronization is about 12 hours.

3.2.4. EPO Data Download Processes

EPO™ is the abbreviation of Extended Prediction Orbit. EPO data is downloaded from MTK EPO server. After enabling EPO™ function through **AT+QGNSSEPO=1** command, the module will download 6-day EPO data from EPO server and store it in local file system. The process should be supported by GPRS network, so the network status needs to be confirmed before executing the command.

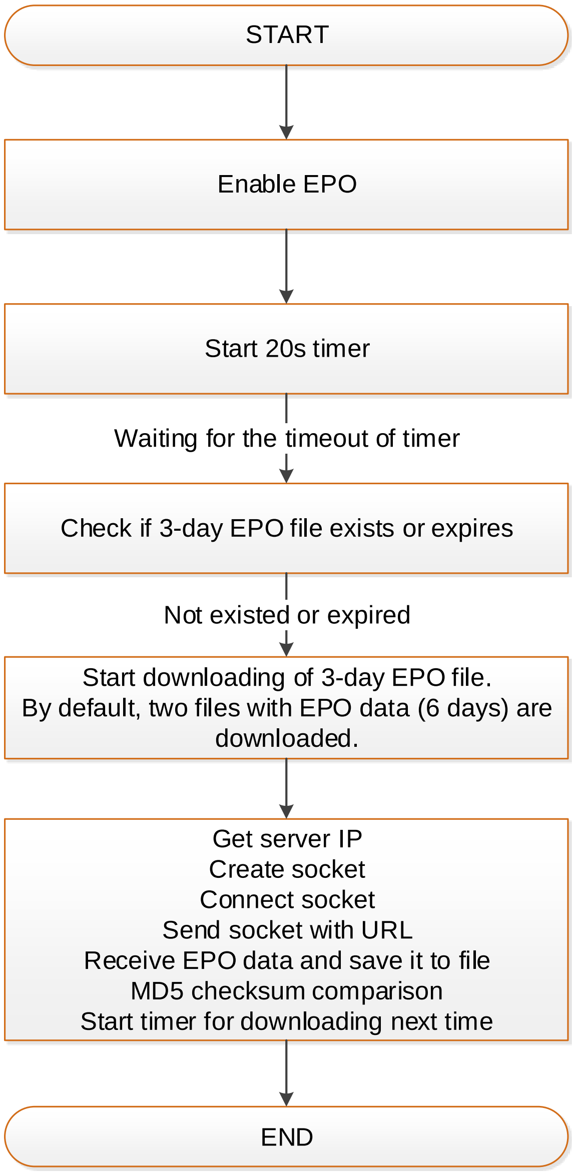

Figure 6: EPO Data Download Process

The EPO data download process is described as follows:

1. After executing **AT+QGNSSEPO=1**, the system will start a 20s timer. If the GNSS function is started before the timer times out, and there is no EPO data or valid data in local file system, a 6-hour EPO file will be downloaded first to assist the current positioning by default. After the timer times out, if there is no valid EPO data in local file system, the system will continue to download and download 2 copies of 3-day EPO files.

2. The timeout period for downloading each EPO file (6-hour file, first 3-day file, second 3-day file) is 60s; if the download fails due to network reasons, the module will try to reconnect to the server to download the 3-day files, the reconnection intervals in order are: 300s, 600s, 1200s, 2400s, 3600s, 3600s, 3600s....

3. When all EPO files are downloaded, the system will automatically start a timer according to the data validity period in the EPO file. If the module is always powered on during the validity period of the data, the system will automatically update the EPO file before the data expires (i.e. the timer times out).

NOTES

1. The 6-hour EPO file size is 4032B.
2. The two 3-day EPO file sizes are both 48384B.
3. In the Open Sky environment, when using EPO™ for assisted positioning, GNSS positioning in cold start mode takes about 15 seconds.

3.2.5. Judgment of Whether the EPO Process is Effective

The validity period of the EPO data currently used in GNSS can be queried by **AT+QGNSSCMD=0,"$PMTK607*33"** command. When the FCWN, FCTOW, LCWN, and LCTOW in the return result PMTK707 sentence are not zero, the EPO process is effective. For details of the command, please refer to ***document [5]***. An example of the process is as follows:

AT+QGNSSCMD=0,"$PMTK607*33"
OK

+QGNSSCMD: $PMTK707,0,0,0,0,0,0,0,0,0*2E //The query result is that EPO data is not used by GNSS currently.

AT+QGNSSCMD=0,"$PMTK607*33"
OK

+QGNSSCMD: $PMTK707,0,0,0,0,0,2004,450397,2004,471997*27 //The EPO data currently used by GNSS is valid from 2004 weeks and 450397 seconds to 2004 weeks and 471997 seconds.

3.3. QuecFastFix Online Function

QuecFastFix Online function can be used in combination with EPO™ technology to further improve TTFF and acquisition sensitivity in cold start. Based on the latest EPO data, QuecFastFix Online additionally offers adding information such as reference-location and NITZ/NTP time, which shortens TTFF to only several seconds (approx. 4.5s) in cold start. The function makes the cold start TTFF comparable to that in hot start.

After EPO data is pushed into GNSS, the reference location information will be pushed into GNSS automatically.

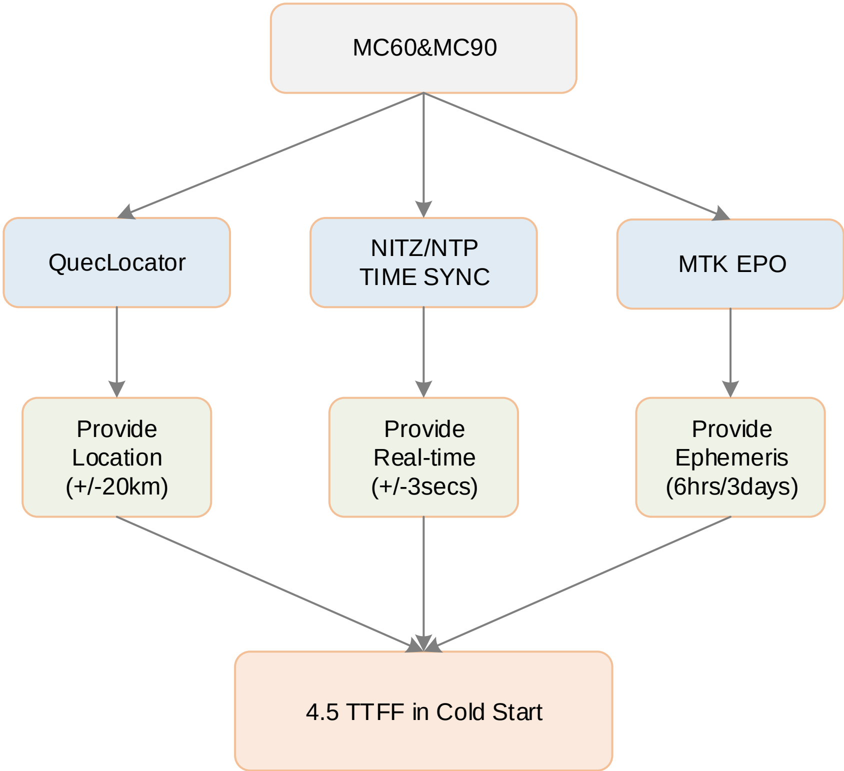

Figure 7: Operation Mechanism of QuecFastFix Online

NOTES

1. Real-time accuracy: ±3 seconds
2. Reference location accuracy: ±20km
3. The reference location can be acquired through QuecLocator, or the latest positioning information from GNSS.
4. Reference location range: -90°~90°(North Latitude), -180°~180°(East Longitude). Please refer to the ***document [5]*** for details.

3.3.1. Operation Processes

After powering ON MC60/MC90, customers can set reference location information into the module, so as to further improve TTFF based on EPO™. The detailed processes (based on EPO™ Operation Process Type B) are illustrated in ***Chapter 3.3.2*** and ***Chapter 3.3.3***.

3.3.2. Example

```
AT+QIFGCNT=2            //Set PDP context
OK
AT+QICSGP=1,“CMNET”//Configure APN
OK
AT+CREG?;+CGREG?        //Check network status
+CREG: 0,2

+CGREG: 0,2

OK
AT+CREG?;+CGREG?        //Check network status
+CREG: 0,1

+CGREG: 0,1

OK
AT+QGNSSTS?             //Read time synchronization status
+QGNSSTS: 1             //Time synchronization completed

OK
AT+QGREFLOC=31.844376,117.204536 // Set reference location information for QuecFastFix Online
OK
AT+QGNSSEPO=1           //Enable EPO(TM) function
OK
AT+QGNSSC=1             //Power ON GNSS
OK
AT+QGNSSRD?
+QGNSSRD: $GNRMC,125349.093,V,,,,,0.00,0.00,010716,,,N*50
$GNVTG,0.00,T,,M,0.00,N,0.00,K,N*2C
$GNGGA,125349.093,,,,,0,0,,,M,,M,,*54
$GPGSA,A,1,,,,,,,,,,,,,,,*1E
$GLGSA,A,1,,,,,,,,,,,,,,,*02
$GPGSV,1,1,02,09,,,29,06,,,29*74
$GLGSV,1,1,00*65
$GNGLL,,,,,125349.093,V,N*66

OK
AT+QGNSSRD?
+QGNSSRD: $GNRMC,125350.093,V,,,,,0.00,0.00,010716,,,N*58
$GNVTG,0.00,T,,M,0.00,N,0.00,K,N*2C
$GNGGA,125350.093,,,,,0,0,,,M,,M,,*5C
$GPGSA,A,1,,,,,,,,,,,,,,,*1E
```

```
$GLGSA,A,1,,,,,,,,,,,,,*02
$GPGSV,1,1,02,09,,,29,06,,,29*74
$GLGSV,1,1,00*65
$GNGLL,,,,,125350.093,V,N*6E

OK
……
AT+QGNSSRD?
+QGNSSRD: $GNRMC,125353.092,A,3150.8278,N,11711.9888,E,0.31,111.02,010716,,,A*7C
$GNVTG,111.02,T,,M,0.31,N,0.58,K,A*2F
$GNGGA,125353.092,3150.8278,N,11711.9888,E,1,5,1.63,145.5,M,0.0,M,,*7A
$GPGSA,A,3,06,09,07,02,12,,,,,,,,1.83,1.63,0.83*0E
$GLGSA,A,3,,,,,,,,,,,,1.83,1.63,0.83*1B
$GPGSV,4,1,15,02,68,022,28,05,61,286,,06,37,091,32,13,31,181,*73
$GPGSV,4,2,15,19,25,155,,29,24,318,,20,18,257,,12,17,243,25*7E
$GPGSV,4,3,15,25,13,278,,09,11,039,31,07,06,081,26,15,06,205,*7A
$GPGSV,4,4,15,30,05,107,,17,01,151,,193,,,*44
$GLGSV,1,1,04,85,77,105,,86,41,334,,84,26,139,,72,12,227,*65
$GNGLL,3150.8278,N,11711.9888,E,125353.092,A,A*4B

OK
AT+QGNSSC=0
OK
```

3.3.3. Operation Flow Chart

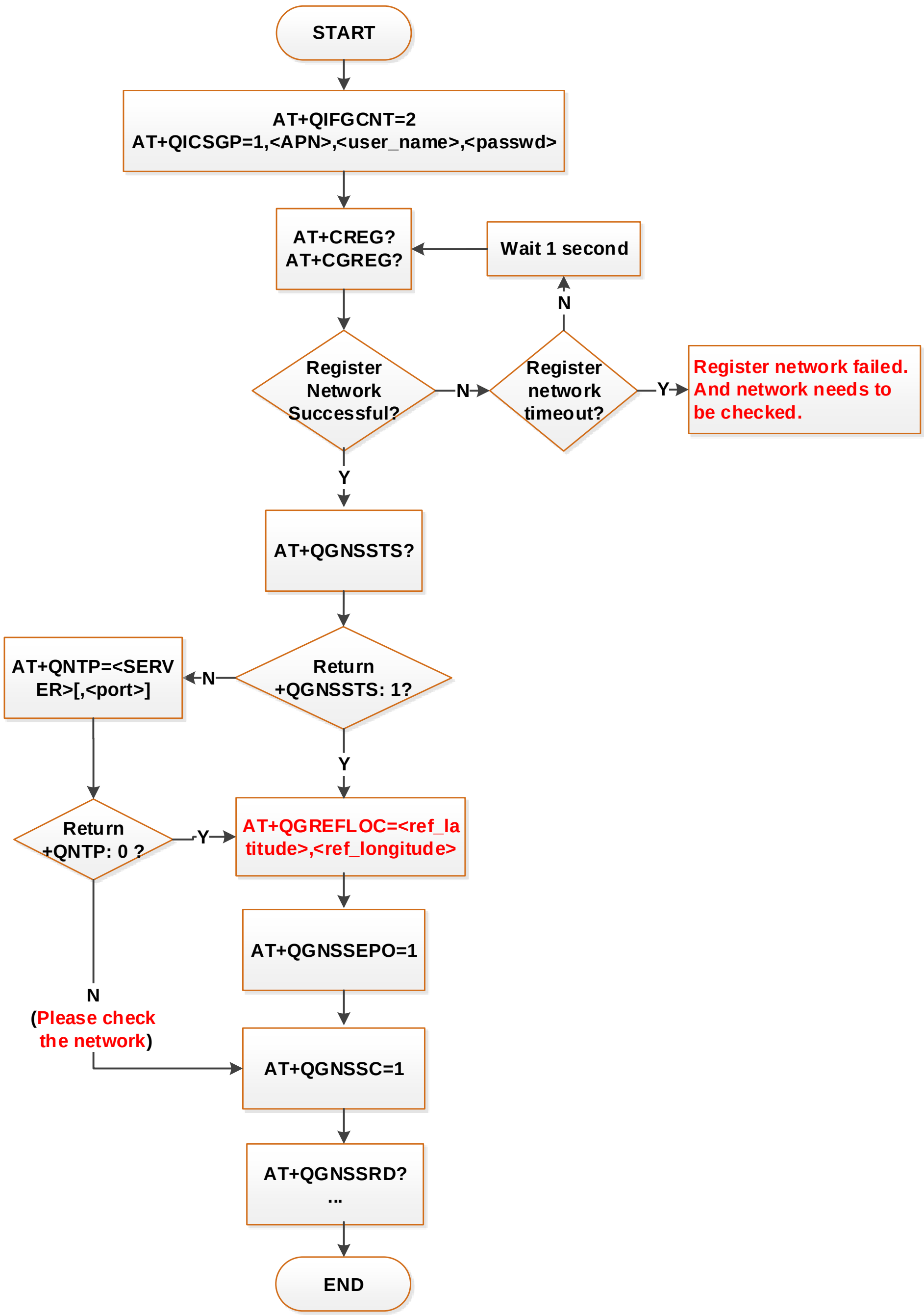

Figure 8: QuecFastFix Online Operation Flow Chart

NOTE

QuecFastFix Online shortens GNSS's cold start TTFF to 4.5s (reference only) in OpenSky.

4 Appendix

4.1. Related Documents

Table 1: Related Documents

SN	Document Name	Remark
[1]	NMEA 0183 Version 3.01	Standard for Interfacing Marine Electronic Devices
[2]	Quectel_MC60_Hardware_Design	MC60 Hardware Design
[3]	Quectel_MC90_Hardware_Design	MC90 Hardware Design
[4]	Quectel_MC60&MC90_AT_Commands_Manual	MC60&MC90 AT Commands Manual
[5]	Quectel_MC60&MC90_GNSS_Protocol_ Specification	MC60&MC90 GNSS Protocol Specification

4.2. Terms and Abbreviations

Table 2: Terms and Abbreviations

Abbreviation	Description
AGPS	Assisted Global Positioning System
EPO	Extended Prediction Orbit
GGA	Global Positioning System Fixed Data
GLL	Geographic Position – Latitude/Longitude
GLONASS	Global Navigation Satellite System
GNSS	Global Navigation Satellite System

GPS	Global Positioning System
GSA	GNSS DOP and Active Satellites
GSM	Global System for Mobile Communication
GSV	GNSS Satellites in View
NITZ	Network Identity and Time Zone
NMEA	National Marine Electronics Association
NTP	Network Time Protocol
RMC	Recommended Minimum Specific GNSS Data
TE	Terminal Equipment
VTG	Course Over Ground and Ground Speed