

Document	Global Top EPO Format and Protocol				
Author	Hector Su	Date	2011/12/21	Ver.	1.4

Global Top EPO Format and Protocol

V 1.4
Hector Su

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Version History

History			
Date	Rev.	Author	Description
2010/08/17	1.0	Hector Su	First Release
2010/08/26	1.1	Hector Su	Second Release. It adds 6.2.4 EPO File Verification
2010/10/05	1.2	Hector Su	Third Release. It adds EPO Expire Date Calculation, refer to P.18~P.20
2010/11/29	1.3	Hector Su	Forth Release. It adds "MCU implemented updating EPO via GPRS module"
2011/12/21	1.4	Hector Su	Fifth Release. It adds sample code of "MCU implemented updating EPO via GPRS module"

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1. Description

EPO file format and transferring protocol for tool development for EPO file parse and update.

2. MTK Binary Protocol

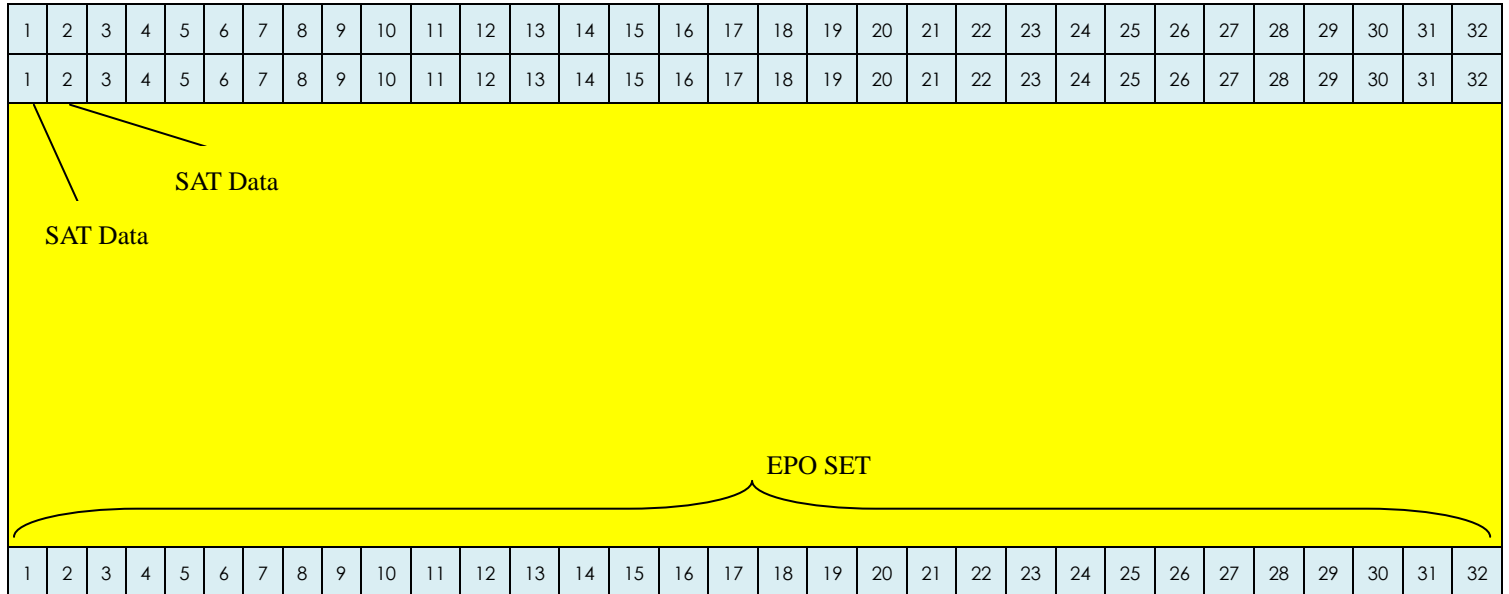
Preamble		Length	Command ID	Data	Checksum	End Word	
0x04	0x24					0x0D	0x0A
2Bytes		2Bytes	2Bytes	Variable	1Bytes	2Bytes	

- Preamble (2byte word): 0x2404
- Length: Total number bytes in the packet from Preamble to End Word.
Maximum packet size: 256bytes
- Use little endian
- Use one byte alignment
- Command ID:
 - 0 ~ 999: conform to PMTK ASCII Protocol
 - 1000 ~ 65535: designated for MTK Binary Protocol
- Checksum:
The checksum is the 8-bit exclusive OR of all bytes in the packet between but not including the "Preamble" and the "Checksum"
- End Word (2-Byte word): 0x0A0D

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3. EPO File Format



The basic unit of an EPO file is SAT Data, the data size of a SAT Data is 60 bytes. One EPO SET contains 32 SAT Data, the data size for an EPO SET is 1920 bytes. Each EPO file contains several EPO SETs. The file size must be a multiple of 1920. An EPO SET is valid for 6 hours. Therefore, there will be 4 EPO SETs for one day. A 7-day EPO file, for example, there will be $7 \times 4 = 28$ EPO SETs and the file size will be $28 \times 1920 = 53760$ bytes.

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4. EPO Binary Packet Format

For the convenience, we named the EPO binary packet as MTK_BIN_EPO packet (packet type 722).

Preamble		Length	Command ID	Data			Checksum	End Word	
0x04	0x24	0x00BF	0x02D2	EPO SEQ	SAT Data	SAT Data	SAT Data	0xFF	0x0D 0x0A
2Bytes		2Bytes	2Bytes	2Bytes	60Bytes	60Bytes	60Bytes	1Bytes	2Bytes

An EPO file will be divided into several SAT Data and encapsulated in several MTK_BIN_EPO packets to be transferred to MTK GPS module. Each MTK_BIN_EPO packet contains a 2-bytes EPO SE and 3 SAT Data. The packet length of MTK_BIN_EPO is 191 bytes. The EPO SEQ is used for synchronization of MTK_BIN_EPO packets in transferring protocol.

Sometimes, there's no enough EPO data to full fill the three SAT Data fields. You can leave some of the three fields as blank, that is, to fill them with 0x00. A MTK_BIN_EPO packet that only contains 0 ~ 2 SAT Data is possible and acceptable. The following three MTK_BIN_EPO packets are examples:

MTK_BIN_EPO (contains 2 SAT Data)

Preamble		Length	Command ID	Data			Checksum	End Word	
0x04	0x24	0x00BF	0x02D2	EPO SEQ	SAT Data	SAT Data	0x00	0xFF	0x0D 0x0A
2Bytes		2Bytes	2Bytes	2Bytes	60Bytes	60Bytes	60Bytes	1Bytes	2Bytes

MTK_BIN_EPO (contains 1SAT Data)

Preamble		Length	Command ID	Data			Checksum	End Word	
0x04	0x24	0x00BF	0x02D2	EPO SEQ	SAT Data	0x00	0x00	0xFF	0x0D 0x0A
2Bytes		2Bytes	2Bytes	2Bytes	60Bytes	60Bytes	60Bytes	1Bytes	2Bytes

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MTK_BIN_EPO (contains no SAT Data)

Preamble		Length	Command ID	Data			Checksum	End Word	
0x04	0x24	0x00BF	0x02D2	EPO SEQ	0x00	0x00	0x00	0xFF	0x0D 0x0A
2Bytes		2Bytes	2Bytes	2Bytes	60Bytes	60Bytes	60Bytes	1Bytes	2Bytes

Acknowledge for MTK EPO BIN

MTK GPS module will return an acknowledge packet for each received MTK_BIN_EPO. For convenience, we named the acknowledge as MTK_BIN_ACK_EPO (packet type 2)

Preamble		Length	Command ID	Data		Checksum	End Word	
0x04	0x24	0x000C	0x0002	EPO SEQ	Result	0xFF	0x0D	0x0A
2Bytes		2Bytes	2Bytes	2Bytes	1Byte	1Bytes	2Bytes	

EPO SEQ: sequence number to indicate the corresponding received MTK_BIN_EPO

Result: '0' the received MTK_BIN_EPO is invalid and means fail.

'1' the received MTK_BIN_EPO is valid and means success.

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5. EPO Data Transfer Protocol

EPO data are packaged in MTK_BIN_EPO packets using MTK Binary Protocol and then be transferred from EPO Management Host to EPO Transfer Agent in a MTK GPS module. At the beginning of the transferring protocol, EPO Management Host have to split the EPO file and encapsulated into several MTK_BIN_EPO packets, and gives each MTK_BIN_EPO packet a sequence number starting from zero. The sequence number is order to make sure the MTK_BIN_EPO packets are transferred in correct order and there are no packet miss. Then EPO Management Host and EPO Transfer Agent follow the "EPO Data Transfer Protocol" to transfer EPO data into MTK GPS module.

5.1 Steps of EPO Transfer Protocol

(1) EPO Management Host:

Send one MTK_BIN_EPO packet, which contains 1 ~ 3 SAT data, to MTK GPS module. **The sequence number in the packet starts from zero and will be added one for each of the following MTK BIN EPO packets.**

(2) EPO Management Host:

Wait for the MTK_BIN_ACK_EPO that has the same sequence number with the transmitted MTK_BIN_EPO.

(3) EPO Transfer Agent in MTK GPS module:

Receive MTK_BIN_EPO packet from EPO Management Host. Then verify the validity of EPO data in the packet. If it's a correct packet, Transfer Agent will return a MTK_BIN_ACK_EPO packet to indicate success; otherwise, return a MTK_BIN_ACK_EPO packet to indicate fail.

(4) EPO Transfer Agent in MTK GPS module:

Wait for next EPO packet

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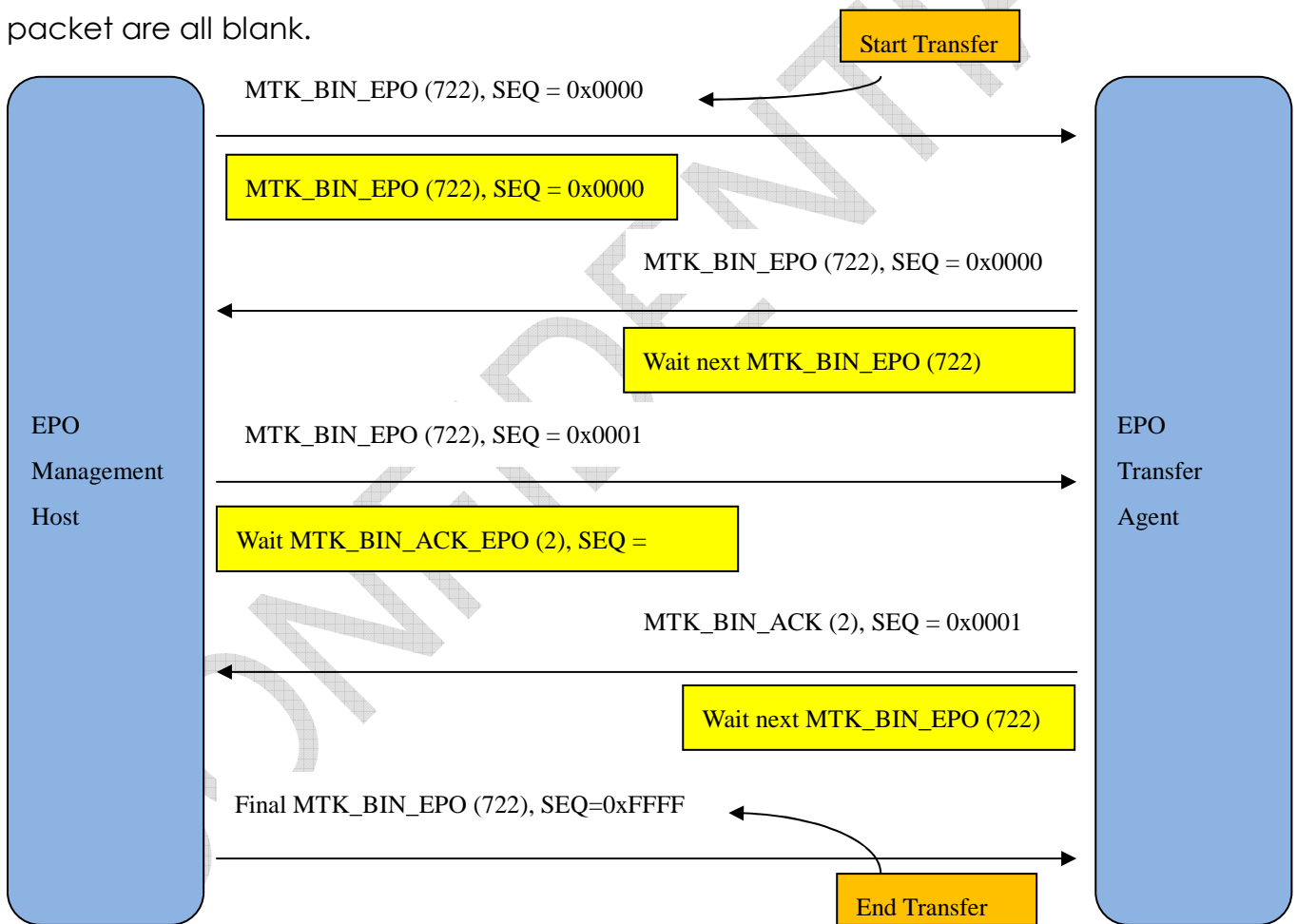
(5)EPO Management Host:

Receive MTK_BIN_ACK_EPO packet. If the acknowledge indicates success, Management Host prepares to send next MTK_BIN_EPO packet; otherwise, something wrong and needs to exit the protocol.

(6)Repeat steps (1) ~ (5) until all the EPO data are transferred.

(7)EPO Management Host:

Send a final MTK_BIN_EPO packet which contains sequence number of 0xFFFF to indicate the finish of the protocol. The 3 SAT data fields in the final MTK_BIN_EPO packet are all blank.



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5.2 Error Handling

If there is any problem occurs in the transferring protocol, you shall stop the process and restart the transferring protocol again. Every time when the protocol starts, the EPO sequence number should be reset to zero to indicate the MTK GPS module that a new transferring process has begun. The MTK GPS module then needs to do preparation for the new process.

The interval of time between two continuous MTK_BIN_EPO packets shall not be longer than 10 seconds. Otherwise, the MTK GPS module will determine to have problem occurred and terminate the process.

5.3 Check EPO data in GPS module

It needs to ensure that the EPO data were successfully updated into the GPS module. After finishing the EPO transfer protocol, make sure current UART packet format is NMEA mode. Then you can issue the PMTK_Q_EPO_INFO command

```
$PTMK607*33<CR><LF>
```

to query the EPO data status. The GPS module will return you PMTK_DT_EPO_INFO like below

```
$PMTK707,56,1468,172800,1470,151200,1468,259200,1468,259200*1F<CR><LF>
```

This packet shows you the information of EPO data that stored inside GPS module. For 14-day EPO file, the first argument following PMTK707 will be 56; for 7-day EPO file, it will be 28; (1468, 172800) means the starting GPS time (GPS week, GPS TOW) of the EPO data, and (1470,151200) means the ending GPS time (GPS week, GPS TOW) of the EPO data. You have to convert (GPS week, GPS TOW) into UTC time format, so as to compare the UTC time to verify that the EPO data stored in the flash matches that of the EPO file.

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Please refer to section 6.1 for the details of EPO related PMTK commands:
PMTK_Q_EPO_INFO, PMTK_DT_EPO_INFO

6. Appendix

6.1 PMTK Commands

Packet Type: 253 PMTK_SET_OUTPUT_FMT

[Meaning]

Set data output format and baud rate for current port

[Format]

\$PMTK253,Flag,Baudrate

Flag: 0-NMEA mode

1-binary mode

Baud rate: baud rate for the new output mode

0: use default baud rate (do not suggest to use this)

UART1: default baud rate will be the value set in “Data Port UART1 baud rate” of Core Builder.

UART0: default baud rate will be the value set in “NMEA baud rate” of Core Builder.

We highly suggest you specifying an explicit baud rate value, all the other possible values are 4800,9600,14400,19200,38400,57600,115200

[Example]

Switch the UART protocol format to BINARY mode, and use default baud rate 115200

```
$PMTK253,1,0*37<CR><LF>
```

Switch the UART protocol format to NMEA mode, and use baud rate 9600

```
$PMTK253,0,9600*09<CR><LF>
```

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[Note]

When you switch **from binary mode to NMEA mode**, you will receive a binary ACK (Packet Type 1) after the command is processed. Please refer to MTK Binary Packet Types for the detail of ACK packet. When you switch **from NMEA mode to binary mode**, **NO ACK** will be sent.

Packet Type: 607 PMTK_Q_EPO_INFO

[Meaning]

Query the EPO data status stored in the GPS chip.

[Format]

NONE

[Return]

PMTK_DT_EPO_INFO

[Example]

\$PMTK607*33<CR><LF>

Packet Type: 707 PMTK_DT_EPO_INFO

[Meaning]

EPO data status in the GPS chip.

[Format]

PMTK707,Set,FWN,FTOW,LWN,LTOW,FCWN,FCTOW,LCWN,LCTOW

Set: Total number sets EPO data stored in GPS module

FWN,FTOW: GPS week number & TOW of the first set of EPO data stored in GPS module respectively.

LWN,LTOW: GPS week number & TOW of the last set of EPO data stored in GPS module respectively.

FCWN,FCTOW: GPS week number & TOW of the first set of EPO data that are currently used respectively.

LCWN,LCTOW: GPS week number & TOW of the last set of EPO data that are currently used respectively.

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[Example]

\$PMTK707,56,1468,172800,1470,151200,1468,259200,1468,259200*1F<CR><LF>

Packet Type: 127 PMTK_CMD_CLEAR_EPO_INFO

[Meaning]

Clear the EPO data stored in the GPS chip.

[DataField]

NONE

[Example]

\$PMTK127*36<CR><LF>

6.2 MTK Binary Packet Types

6.2.1 Acknowledge Packet (Packet Type 1)

This packet is usually returned after receiving a MTK binary packet.

Example 1. Receive a valid MTK binary packet and return a success flag
0x04 0x24 0x0C 0x00 0x01 0x00 0xFD 0x00 0x03 0xF3 0x0D 0x0A

Preamble: 0x2404

Packet Length: 0x000C ←Packet length: 12 bytes

Command ID: 0x0001 ←Acknowledge packet

Data: 0x00FD ←The acknowledge is responding to packet type 253

Data:0x03 ←Flag: 0x03:success

0x02:fail

0x00,0x01: invalid packet

Checksum:0xF3

End Word:0x0A0D

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6.2.2 EPO Acknowledge Packet (Packet Type 2)

This packet is usually returned after receiving an EPO binary packet.

Example 1. Receive a valid EPO packet for sequence number 0x56
0x04 0x24 0x0C 0x00 0x02 0x00 0x56 0x00 0x01 0x59 0x0D 0x0A

Preamble: 0x2404

Packet Length: 0x000C ← Packet length: 12 bytes

Command ID: 0x0002 ← EPO Acknowledge packet

Data: 0x56 0x00 0x01 ← Valid EPO packet for sequence 0x56

Checksum: 0x59

End Word: 0x0A0D

Example 2. Receive a invalid EPO packet for sequence number 0x56
0x04 0x24 0x0C 0x00 0x02 0x00 0x56 0x00 0x00 0x58 0x0D 0x0A

Preamble: 0x2404

Packet Length: 0x000C ← Packet length: 12 bytes

Command ID: 0x0002 ← EPO Acknowledge packet

Data: 0x56 0x00 0x00 ← Invalid EPO packet for sequence 0x56

Checksum: 0x58

End Word: 0x0A0D

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6.2.3 Change UART Format Packet (Packet Type 253)

To change UART communication protocol and baud rate

Example 1. Change UART to PMTK protocol and baud rate 115200
0x04 0x24 0x0E 0x00 0xFD 0x00 0x00 0x00 0xC2 0x01 0x00 0x30 0x0D 0x0A

Preamble: 0x2404

Packet Length: 0x000E ←Packet length: 14 bytes

Command ID: 0x00FD ←Change UART packet protocol

Data: 0x00 ←PMTK protocol

Data: 0x00 0xC2 0x01 0x00 ←UART baud rate 115200 (0x0001C200)

Checksum:0x30

End Word:0x0A0D

Example 2. Change UART to PMTK protocol and use default baud rate

0x04 0x24 0x0E 0x00 0xFD 0x00 0x00 0x00 0x00 0x00 0x00 0xF3 0x0D 0x0A

Preamble: 0x2404

Packet Length: 0x000E ←Packet length: 14 bytes

Command ID: 0x00FD ←Change UART packet protocol

Data: 0x00 ←PMTK protocol

Data: 0x00 0x00 0x00 0x00 ←UART baud rate use default value

Checksum:0xF3

End Word:0x0A0D

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6.2.4 EPO File Verification

To calculate the GPS Week and GPS TOW for EPO file verification. It shows how to find out the GPS Week and TOW for start and end period of an EPO SET.

Example 1. A EPO SET contains 32 SAT Data, the data size for EPO SET is 1920 bytes. Each EPO file contains several EPO SETs. The file size must be a multiple of 1920. An EPO SET is valid for 6 hours. It shows some part of EPO SET in below.

The first four SAT sets are show in below:

	0	1	2	3	4	5	6	7	8	9	a	b	c	d	e	f
00000000h:	<u>E0</u>	<u>18</u>	<u>04</u>	<u>00</u>	<u>00</u>	<u>00</u>	<u>00</u>	<u>00</u>	<u>00</u>	<u>00</u>	<u>00</u>	<u>00</u>	<u>00</u>	<u>00</u>	<u>00</u>	<u>00</u>
00000010h:	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00000020h:	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
00000030h:	00	00	00	00	00	00	00	00	00	00	00	00	<u>E0</u>	<u>18</u>	<u>04</u>	<u>02</u>
00000040h:	48	07	00	00	19	<u>00</u>	<u>30</u>	<u>2A</u>	<u>AA</u>	<u>3A</u>	<u>04</u>	<u>06</u>	<u>CB</u>	<u>0E</u>	<u>3C</u>	<u>05</u>
00000050h:	3F	00	00	00	00	00	<u>A6</u>	<u>FF</u>	<u>E8</u>	<u>46</u>	<u>09</u>	<u>00</u>	<u>00</u>	<u>00</u>	<u>00</u>	31
00000060h:	F3	30	00	00	00	00	<u>F2</u>	<u>04</u>	<u>07</u>	<u>FB</u>	<u>00</u>	<u>00</u>	<u>00</u>	<u>00</u>	<u>00</u>	A3
00000070h:	A4	50	00	00	00	00	<u>7</u>	<u>3E</u>	<u>7F</u>	<u>E0</u>	<u>18</u>	<u>04</u>	<u>03</u>	DC	3F	00
00000080h:	2C	<u>00</u>	<u>30</u>	<u>2A</u>	44	37	3C	F7	74	15	2D	F9	C0	00	30	2A
00000090h:	DB	13	C7	00	1F	A0	13	80	A7	A5	FF	31	5E	D2	41	8D
000000a0h:	BE	83	F0	06	4B	DE	0D	A1	EB	FB	40	74	BB	A1	CF	25
000000b0h:	ED	E1	D5	29	<u>E0</u>	<u>18</u>	<u>04</u>	<u>04</u>	61	06	00	00	4A	<u>00</u>	<u>30</u>	<u>2A</u>
000000c0h:	5B	3B	6F	06	8C	0F	AB	05	34	FF	30	2A	A4	1C	1D	00
000000d0h:	D0	05	05	80	56	A3	FF	31	2D	5A	B2	0E	51	5F	B5	04
000000e0h:	A0	E0	0D	A1	DA	F8	F6	A3	DD	0D	3F	26	3F	5D	B0	19

Figure 1

GPS Hour: "E0 18 04" means the value 0x0418E0, the formula shown in below will convert it to GPS Week.

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GPS Week=0x0418E0/0xA8(2)=1598

SAT Number: The SAT count of an EPO SET. The maximum number is 0x20.

GPS TOW:"00 30 2A" means the value 0x2A300. The last byte "00" always be zero. Then 0x2A300 will be equal 172800.

The last four SAT sets are show in below:

```

00000690h: E0 18 04 1D 49 01 00 00 18 00 30 2A 66 2E 92 F9
000006a0h: 70 18 A5 F9 25 00 30 2A 8A 13 0A 00 E3 B8 04 80
000006b0h: FF AA FF 31 3F 77 3A 30 2E D4 6A 01 4E 89 0D A1
000006c0h: 17 A6 95 7A 7B D0 2A 27 93 F8 DD CC E0 18 04 1E
000006d0h: EA 3D 00 00 1F 00 30 2A 42 35 6B F8 EF 05 D8 F8
000006e0h: 94 FF 30 2A 82 28 96 FF 3B EA 08 80 6B A1 FF 31
000006f0h: BF 90 26 ED EE 05 72 06 A7 96 0D A1 2B 2A CC 4C
00000700h: 06 25 E9 68 3D E0 05 03 00 00
00000710h: GPS Hour A CC 2C E4 0B 5F SAT Number 00 30 2A
00000720h: F4 82 3F 80 A 12 30 4E
00000730h: OD 5E C3 03 15 FD OD A1 FB 17 12 24 3B AD D4 27
00000740h: 96 E8 2E D5 E0 18 04 20 1A 3A 00 00 B2 FF 30 2A
00000750h: AC 35 DE FA B3 0C D3 FB 27 1A 20 DB 00
00000760h: E6 C1 3D 80 45 A6 FF 31 5F GPS TOW F 74 7A 06
00000770h: AA 2E OD A1 76 54 17 D2 E8 42 66 D9
  
```

Figure 2

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Document	Global Top EPO Format and Protocol				
Author	Hector Su	Date	2011/12/21	Ver.	1.4

GPS Hour: "E0 18 04" means the value 0x0418E0, the formula shown in below will convert it to GPS Week.

$$\text{GPS Week} = 0x0418E0 / 0xA8(2) = 1598$$

SAT Number: The final of SAT number will be 0x20.

GPS TOW: "FF 30 2A" means the value 0x2A300. The last byte "FF" always be zero. Then 0x2A300 will be equal 172800. Then the value will be added 21600(3). That is, the value 194400.

Note 1: The two set of GPS Week and TOW will be indicated the Start and End period.

Note 2: 0xA8 → Hours of week

Note 3: 21600 → Second of 6 hours

Start Period:	UTC 2010-08-23 23:59:56	GPS Week 1598	Tow 172800
End Period:	UTC 2010-08-24 05:59:56	GPS Week 1598	Tow 194400

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```

/*
File EPOParser.c
Version 1.00
Build Date:2010/10/05
Revision Date:2010/10/05
Author Hector Su
Description Sample code for parsing UTC Time from EPO file
*/
#include <stdio.h>
#include <string.h>
#include <math.h>
#include <time.h>
#include <stdlib.h>
#define SecondOfHour 3600
#define CalibrationValue 315964786
#define SecondOfWeek 604800
#define HourOfWeek 168
struct tm * Convert2UTC(int GPSHour)
{
    int UTC;
    time_t UTC_Time;
    struct tm *timeinfo;
    UTC_Time=GPSHour;
    return gmtime(&UTC_Time);
}
int Convert2GPSWeek(int GPSHour,int ExpiryOfHour)
{
    return (GPSHour+ExpiryOfHour-(GPSHour%HourOfWeek))/HourOfWeek;
}
int Convert2Tow(int GPSTOW,int ExpiryOfHour)
{
    return ((GPSTOW+ExpiryOfHour*SecondOfHour)%SecondOfWeek);
}

```

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```

}
void main ()
{
    time_t UTC_Time;
    struct tm *timeinfo;
    int year, month ,day;
    int GPS_Hour=0;
    int GPS_TOW=0;
    int Expiry_Hour=0;
    int GPSWeek,Tow;
    long second;
    while(1)
    {
        printf("Input GPS_Hour,GPS_TOW,ExpiryOfEPO:");
        scanf("%d %d %d",&GPS_Hour,&GPS_TOW,&Expiry_Hour);
        getchar();
        timeinfo=Convert2UTC(GPS_Hour*SecondOfHour+CalibrationValue);
        GPSWeek=Convert2GPSWeek(GPS_Hour,0);
        Tow=Convert2Tow(GPS_TOW,0);
        printf("Start Period UTC %d-%d-%d %02d:%02d:%02d  GPSWeek=%d
Tow=%d\n",timeinfo->tm_year+1900,timeinfo->tm_mon+1,
timeinfo->tm_mday,timeinfo->tm_hour,timeinfo->tm_min,timeinfo->tm_sec,
GPSWeek,Tow);

        timeinfo=Convert2UTC(GPS_Hour*SecondOfHour+CalibrationValue+Expiry_
Hour*SecondOfHour);
        GPSWeek=Convert2GPSWeek(GPS_Hour,Expiry_Hour);
        Tow=Convert2Tow(GPS_TOW,Expiry_Hour);
        printf(" End  Period UTC %d-%d-%d %02d:%02d:%02d  GPSWeek=%d
Tow=%d\n",timeinfo->tm_year+1900,timeinfo->tm_mon+1,
timeinfo->tm_mday,timeinfo->tm_hour,timeinfo->tm_min,timeinfo->tm_sec,
GPSWeek,Tow);
    }
}

```

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```
}
}
```

Example 2. It shows how to get Start and End Period of an EPO file.

Step 1

We have a EPO file which date of expiry is 6 hours, then we get an GPS Hour \ GPS Tow from it. Please refer to example 1.

Step 2

According to example 1, we have GPS Hour \ GPS Tow \ expiry of EPO file. Then we use "EPOParser.c" for calculation.

Step 3

Finally, we can get the start and end period of an EPO file.

Start Period:	UTC 2010-08-23 23:59:56	GPS Week 1598	Tow 172800
End Period:	UTC 2010-08-24 05:59:56	GPS Week 1598	Tow 194400

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6.3 Application Scenario

MCU implemented updating EPO via GPRS module

6.3.1 Architecture diagram

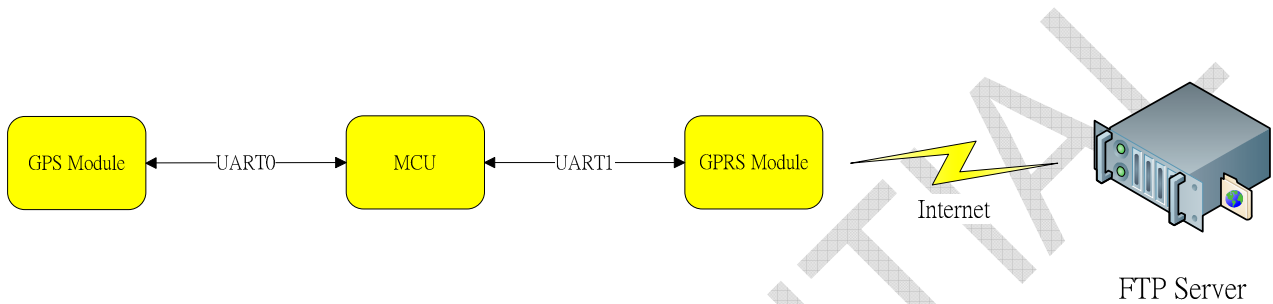


Figure 1

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6.3.2 MCU Flow chart

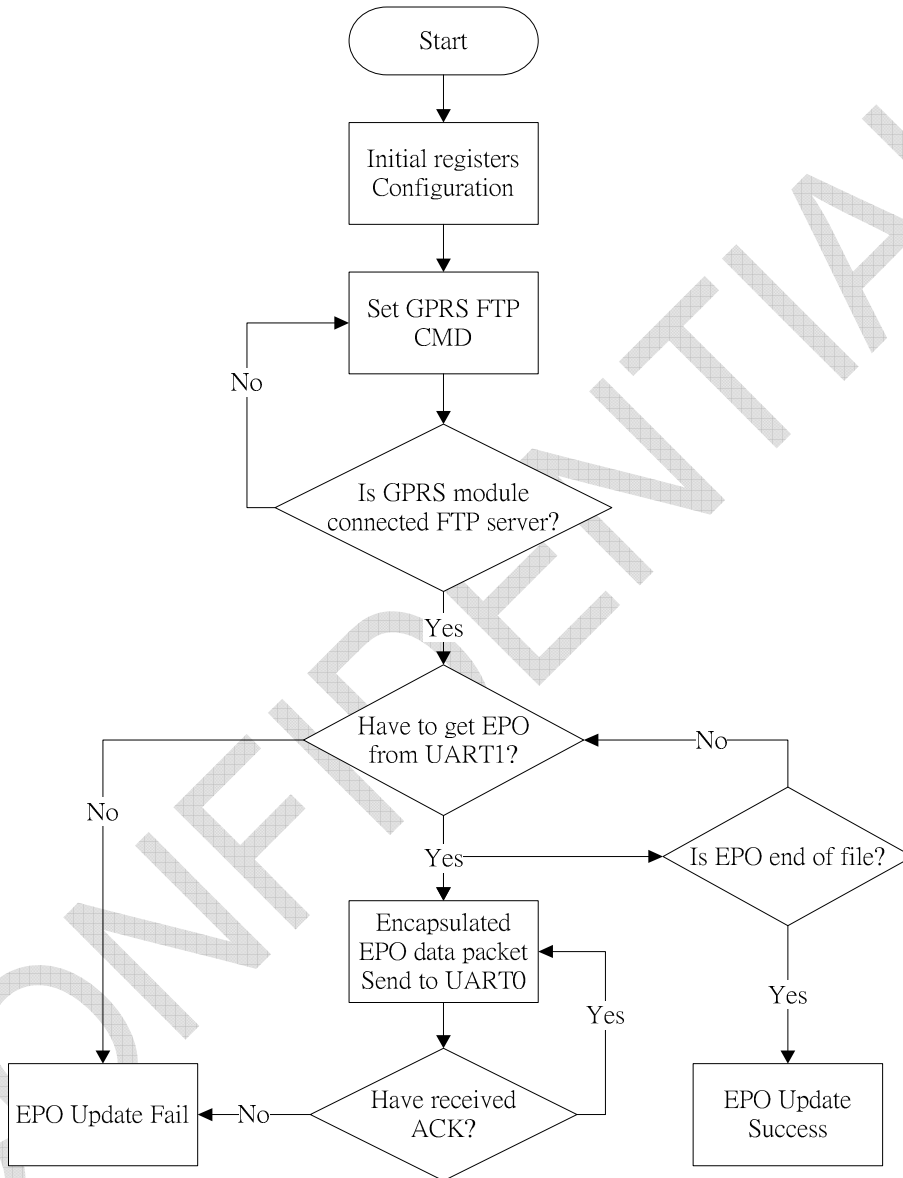


Figure 2

6.3.3 Sample code for MCU

Please refer to GprsAgps.rar. We use PIC24FJ32GA002 of Microchip for function demo.

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