GPS Week Rollover Application Note

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APPLICABILITY TABLE

PRODUCTS

- HE910 SERIES
- DE910 SERIES
- GE910-GNSS SERIES
- GE310-GNSS SERIES
- ME910C1 SERIES
- LE910 SERIES
- LE910C1 SERIES
- LN940/LN941 SERIES
- LM940 SERIES
- LM960 SERIES

CONTENTS

1. INTRODUCTION

The present document provides a description of the GPS Week rollover effect on Telit's Cellular Modules integrating a GPS receiver.

1.1. Scope

The purpose of this document is to show how to test the week rollover event along with a possible workaround for the modules affected.

1.2. Audience

This document is intended for those users that need to develop applications integrating a Telit module potentially affected by the GPS week rollover.

1.3. Contact Information, Support

For general contact, technical support services, technical questions and report documentation errors contact Telit Technical Support at:

- TS-EMEA@telit.com
- TS-AMERICAS@telit.com
- TS-APAC@telit.com

Alternatively, use:

http://www.telit.com/support

For detailed information about where you can buy the Telit modules or for recommendations on accessories and components visit:

http://www.telit.com

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. Text Conventions

Danger – This information MUST be followed or catastrophic equipment failure or bodily injury may occur.

Caution or Warning – Alerts the user to important points about integrating the module, if these points are not followed, the module and end user equipment may fail or malfunction.

Tip or Information – Provides advice and suggestions that may be useful when integrating the module.

All dates are in ISO 8601 format, i.e. YYYY-MM-DD.

1.5. Related Documents

- *Telit_Modules_Software_User_Guide_2G_3G_4G_r21*
- *Telit_3G_Modules_AT_Commands_Reference_Guide_r12*

2. BACKGROUND INFORMATION

2.1. A Brief Week Rollover Introduction

The GPS week number is an element of the navigation signal used by Global Positioning System (GPS) to correctly handle the current date. The GPS Week count began at 00:00:00 UTC on Sunday, January 6, 1980 (week 0).

For limiting the size of the data broadcast by the satellites, GPS allocated only 10 bits for this number, corresponding to 1024 weeks (~19.7 years). At the completion of week 1023 the GPS week number will rollover back to 0.
Each of these 1024-weeks periods is termed as an “epoch”.

The first epoch of GPS time (weeks 0-1023) ended on August 1999 (corresponding to the first GPS week rollover). The next rollover will be at 23:59:42 UTC April 6, 2019, marking the end of the current epoch (weeks 1024-2047) and the start of the next one.

2.2. Test Methods and Conditions

The purpose of the test was to validate correct operation before, during and after the GPS week rollover. The units under test were connected through a common RF splitter to a Spirent GNSS signal simulator as part of our standard test setup.

All receivers were initialized and allowed to navigate before and through the simulated 2019 week rollover event: all the units were monitored for correct behavior during the test.

Simulator based testing of future real-world events contains an inherent limitation and actual events on the day may deviate from the expected scenarios.

This risk factor cannot be eliminated and should not be discounted.

2.3. Week Rollover Modules status

The table below shows the cellular modules with integrated GNSS and week rollover behavior[1]. Additional information on the affected modules and suggested workarounds are provided in the following chapters.

Family	STATUS		Family	STATUS
GE910-GNSS	NOT AFFECTED		HE910	**AFFECTED**
LE910C1	NOT AFFECTED		GE310-GNSS	NOT AFFECTED
LE910	**AFFECTED IN 2019**		LN940/LN941	NOT AFFECTED
DE910	**AFFECTED IN 2019**		LM940	NOT AFFECTED
ME910C1	NOT AFFECTED		LM960	NOT AFFECTED

[1] *DE910 and LE910 are not affected by GPS week rollover in April but undergo internal rollover at a later date, on 2nd of November 2019*

3. HE910

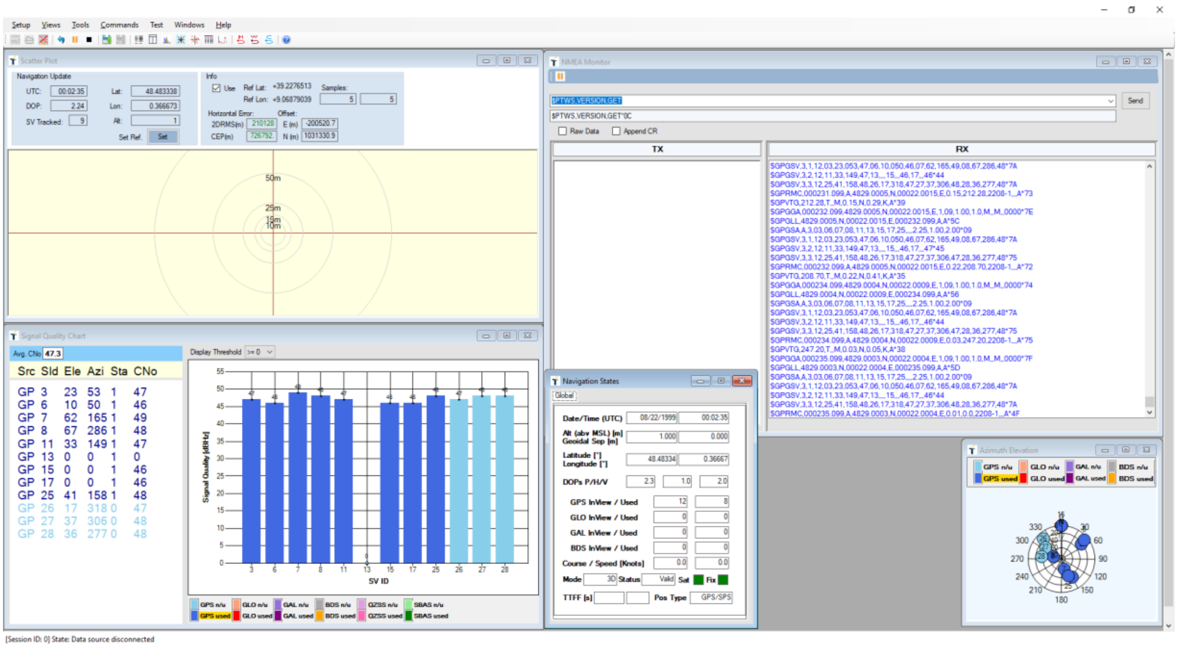
The GPS Week number count first began at 00:00:00 UTC, January 6, 1980.
This number size is ten-bit (modulo 1024) and at the completion of week 1023, the GPS week count will rollover to 0.
The next scheduled GPS Week rollover will happen at UTC 23:59:42 April 6, 2019.

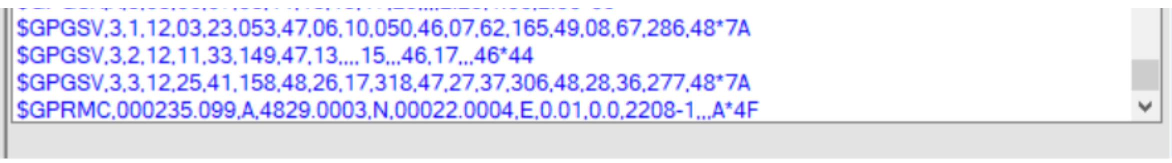
3.1. Test Methods and Conditions

HE910G unit under test was connected to a GPS signal simulator and allowed to navigate before and through the simulated week rollover event.

The module was monitored for correct behavior during the test.

3.2. Results after week rollover





After the week rollover, a wrong date is reported in the $GPRMC NMEA message. The reported date can appear in either of the following formats (highlighted):

*$GPRMC,,V,,,,,,,,,,N*53*

*$GPRMC,000231.42,A,4829.0005,N,00022.0016,E,0.16,212.28,220899,,,A*59*

*$GPRMC,000231.099,A,4829.0005,N,00022.0015,E,0.15,212.28,2208-1,,,A*73*

The date 220899 (dd/mm/yy) corresponds to the week 0 of the second epoch. In fact, the first week rollover occurred on August 21, 1999 (end of the first GPS epoch).

As shown in the example, the value “-1” for the year, instead of “99”, may also be displayed in the NMEA messages.

3.3. Customer Application Suggested Modifications

After the GPS week rollover, the receiver resets its count from week 0 of the previous epoch, therefore date 07/04/2019 is shown as 22/08/1999.

This section describes the processing algorithm to be applied at customer side so that the correct date is displayed.

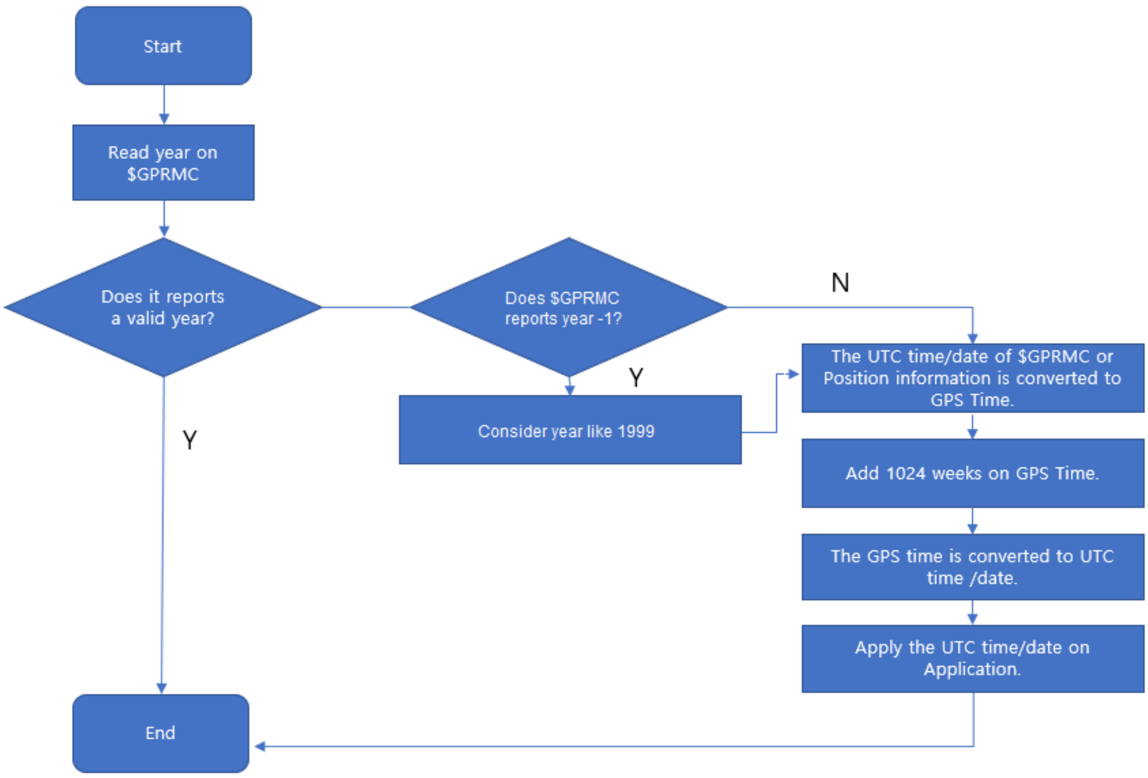
Before the week rollover, the provided date should be valid and no action is required.

After the rollover, the year displayed will be earlier than current one and the correction should be applied. Since it is possible to receive a “*-1*” instead of “*99*” in the date field, customer should consider such a value as “*99*” (year 1999).

In order to obtain the current date, the customer should add 1024 weeks to the date provided by the GPS receiver.

An example of the conversion between Calendar date and GPS time is provided in the appendix at the end of this document.

The flowchart of the algorithm is shown below.



4. DE910 / LE910

The GPS Week number count first began at 00:00:00 UTC, January 6, 1980.
This number size is ten-bit (modulo 1024) and at the completion of week 1023, the GPS week count will rollover to 0.
The next scheduled GPS Week rollover will happen at UTC 23:59:42 April 6, 2019.

However, DE910 / LE910 have been set with the minimum GPS week number equal to 1054 (corresponding to the week starting on Sunday, March 18, 2000). In this way, the GPS week rollover is internally delayed to GPS week 2077 (1054 + 1023).

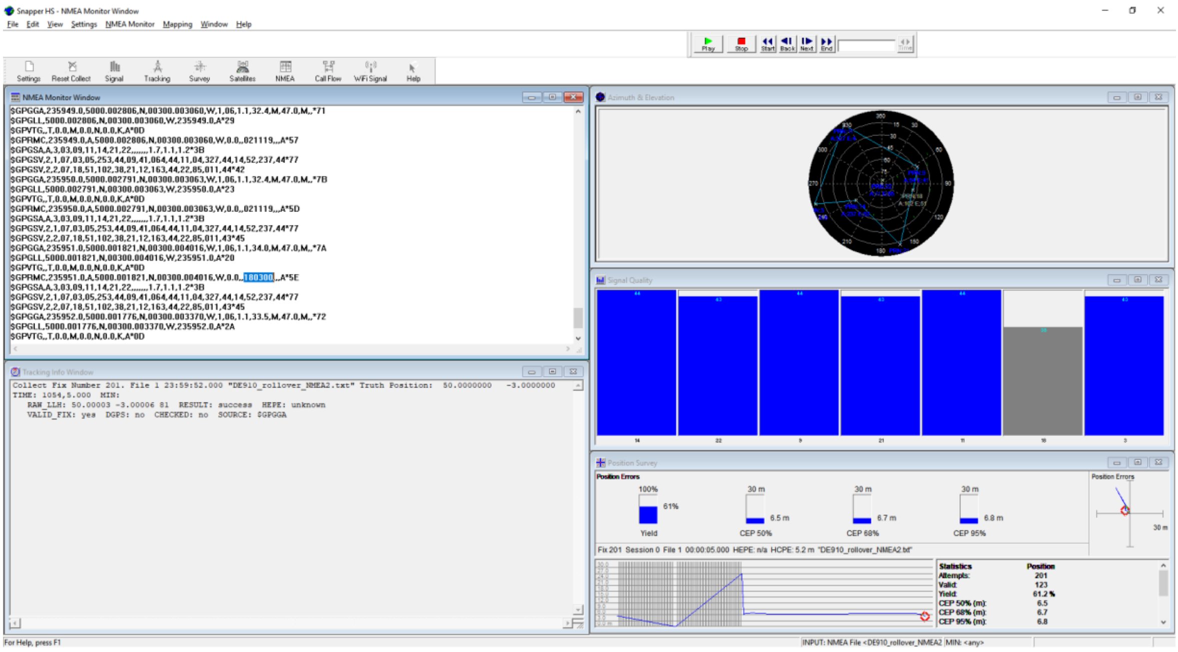
In other words, the next (internal) GPS week rollover for DE910 will occur at UTC 23:59:42 November 2, 2019. Then, week number count will revert to 0 (corresponding to the minimum GPS week 1054) and the module will output the date *180300*.

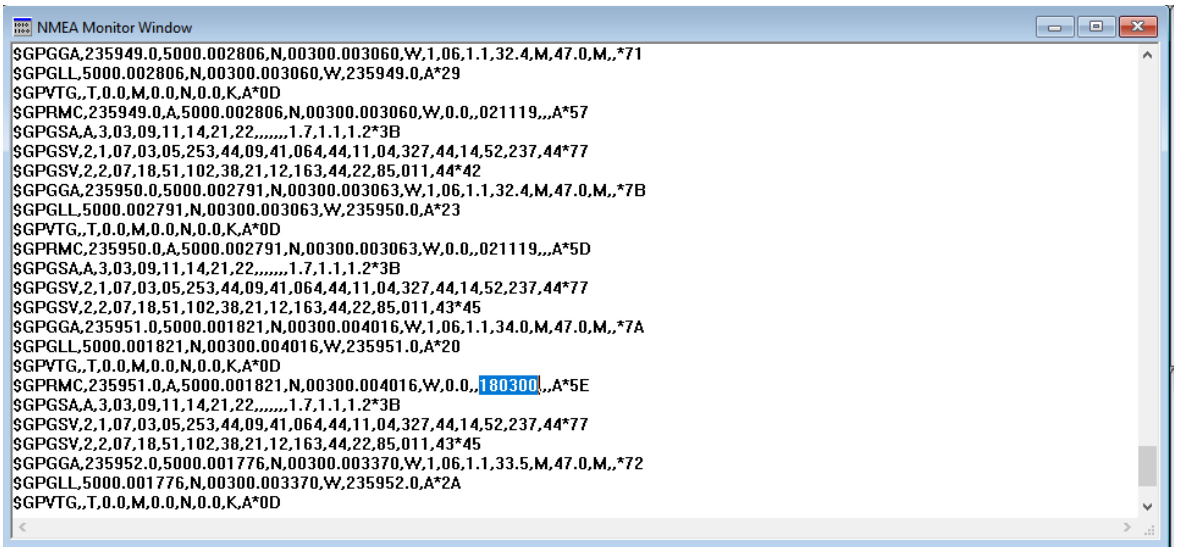
4.1. Test Methods and Conditions

DE910G unit under test was connected to a GPS signal simulator and allowed to navigate before and through the simulated week rollover event (2nd of November 2019).

The module was monitored for correct behavior during the test.

4.2. Results after internal week rollover





*$GPRMC,235951.0,A,5000.001821,N,00300.004016,W,0.0,,180300,,,A*5E*

This message should display the date *021119* but this value is reverted to the week 1053, ending on Saturday, March 18, 2000.[2]

*$GPRMC,000000.0,A,5000.001947,N,00300.003503,W,0.0,,190300,,,A*51*

This message should display the date *031119* but this value is reverted to the week 1054, starting on Sunday, March 19, 2000.

4.3. Customer Application Suggested Modifications

This section describes the processing algorithm to be applied at customer side so that the correct date is displayed.

Before the week rollover, the provided date should be valid and no action is required.

After the rollover, the year displayed will be earlier than current one and the correction should be applied.

In order to obtain the current date, the customer should add 1024 weeks to the date provided by the GPS receiver.

An example of the conversion between Calendar date and GPS time is provided in the appendix at the end of this document.

The flowchart of the algorithm is shown below.

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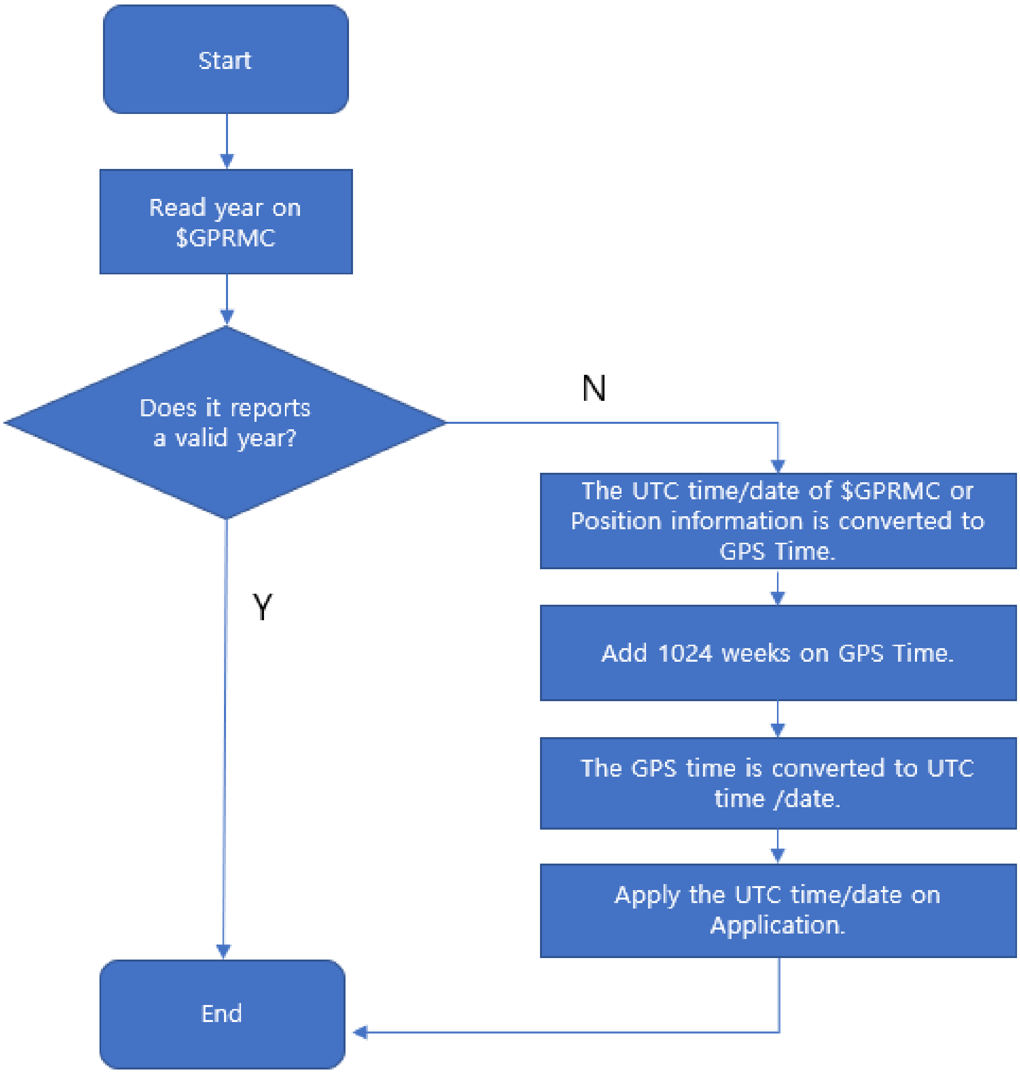
[2] *It can be noted that the rollover issue occurs before midnight due to the leap seconds offset between the UTC and the GPS time.*


Start
Read year on $GPRMC
Does it reports a valid year?
N
Y
The UTC time/date of $GPRMC or Position information is converted to GPS Time.
Add 1024 weeks on GPS Time.
The GPS time is converted to UTC time /date.
Apply the UTC time/date on Application.
End

5. GLOSSARY AND ACRONYMS

	Description
GNSS	Global Navigation Satellite System
RMC	Recommended minimum specification Data
GPS	Global Positioning System
NMEA	National Marine Electronics Association
UART	Universal Asynchronous Receiver Transmitter
URC	Unsolicited Result Code

6. DOCUMENT HISTORY

Revision	Date	Changes
0	2019-02-28	First issue

7. APPENDIX: GPS TIME CONVERSION

Several software tools are currently available for manipulating and converting dates and time in different formats. It is beyond the scope of this document to investigate them.

Instead, aim of this section is to give a better understanding of the basic operation performed by such tools with an example of a Calendar Date to GPS Time conversion.

7.1. Calendar Date to GPS Time

Converting a calendar date to obtain the GPS time can be calculated as shown in the following example, using the calendar date 13:30:00[3] hours, April 10, 2019.

Number of years from January 6, 1980 to , April 10, 2019: 39 years

Number of days in 39 years (39 years x 365 days/year): 14,235 days

Add one day for each leap year (a year which is divisible by 4)[4] in that period:

+ 10 days

Add full days between January 6 to April 10 (consider April 10 is not ended yet):

+ 94 days

Total number of days = 14,339 days

Total number of seconds

(14339 days x 86400 seconds/day) =1,238,889,600 seconds

Total number of weeks (1,238,889,600 seconds / 604,800 seconds/week)

= **2048** + 0.42857… weeks

It can then be noted that GPS Week number is **2048** (week 0 of second epoch).

Days of the week (14,339 days - 2048 weeks x 7 days/week): 3 days

Number of seconds in 3 days (3 days x 86400 seconds/day): 259,200 seconds

Add number of seconds into the 4th day of week (Wednesday, April 10, 2019):

(13.5 hours x 3600 seconds/hour): + 48,600 seconds

Total seconds into week = 307,800 seconds

The resulting value for GPS Time is **Week 2048**, **307800 seconds**.

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[3] For simplicity, the offset between UTC and GPS time (leap seconds) has been omitted.

[4] Every 100 years, a leap year is skipped, unless when the year is also divisible by 400.

SUPPORT INQUIRIES

Link to **www.telit.com** and contact our technical support team for any questions related to technical issues.

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