# S7 Program for Acquiring UTC Time and Date Information from a GPS Signal

## SIMATIC S7-300/400 CPU

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# Question

How can time and date be acquired from a GPS signal?

# Answer

The instructions and notes listed in this document provide a detailed answer to this question.

# Table of Contents

# 1 Introduction

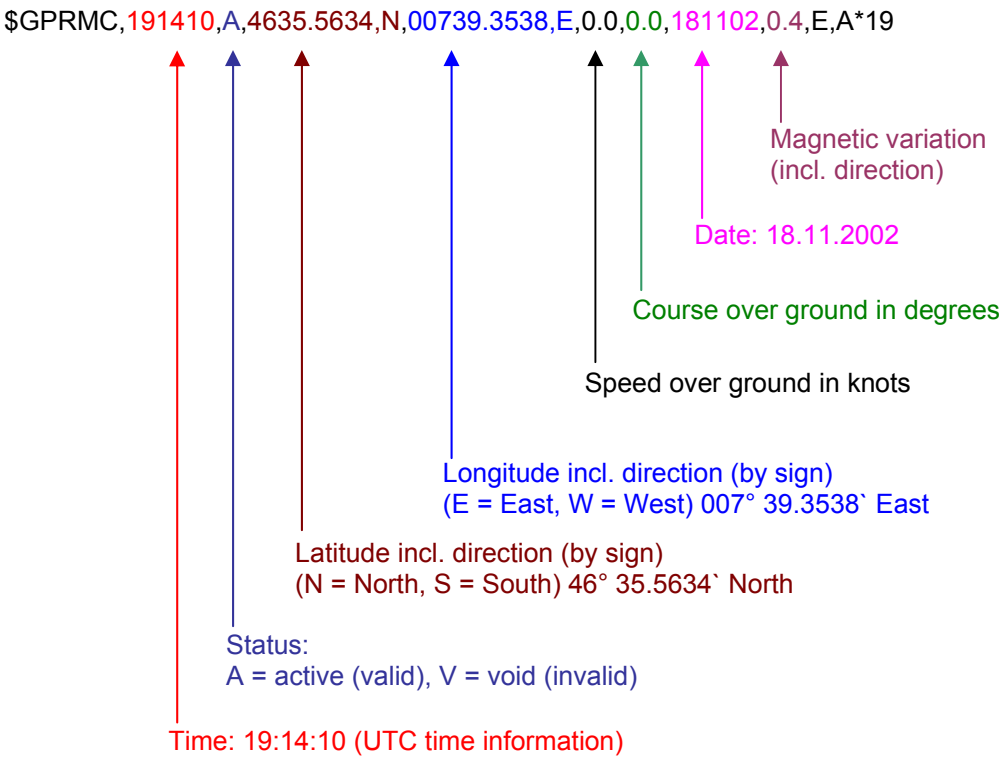
## 1.1 Application

The S7 program described in this document is used to acquire UTC time and date information on the basis of a GPS signal. To do so, a GPS receiver – also called GPS mouse – receives the GPS signal in the form of an NMEA protocol and transmits it to a SIMATIC S7-300 CPU via an ET 200S interface module.

## 1.2 The NMEA protocol

The NMEA protocol (NMEA = National Marine Electronics Association) is a most common GPS protocol which encompasses a variety of protocol sentences. Each of these sentences is used to transmit one or several pieces of information.

Date and time can be acquired from the RMC sentence (recommended minimum sentence C) with the following structure:

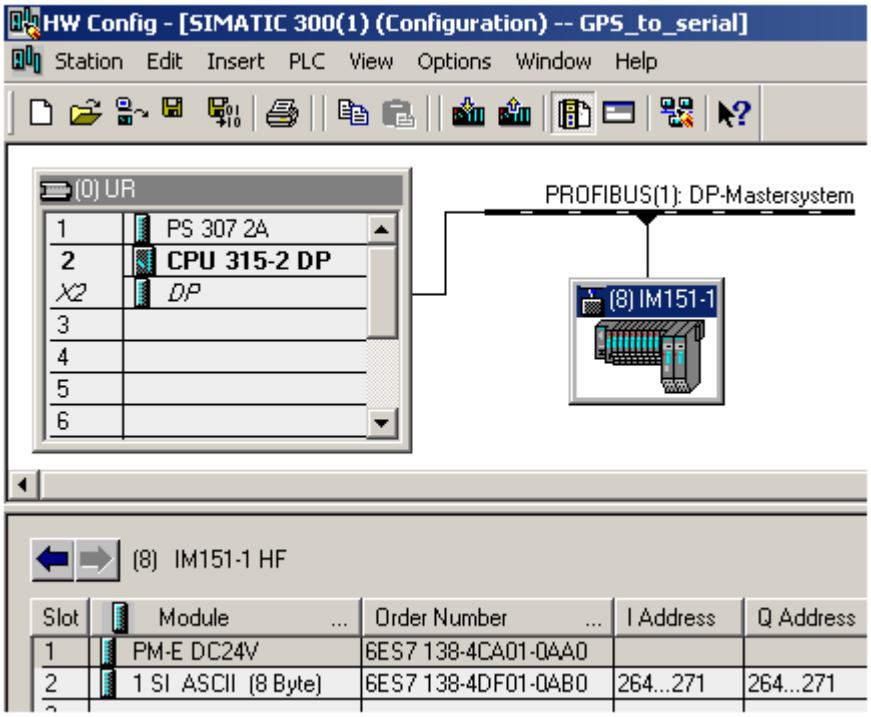


# 2 Hardware Configuration

## 2.1 Configuration of SIMATIC components

Hardware configuration is effected with the following SIMATIC components:

Figure 2-1: SIMATIC components used



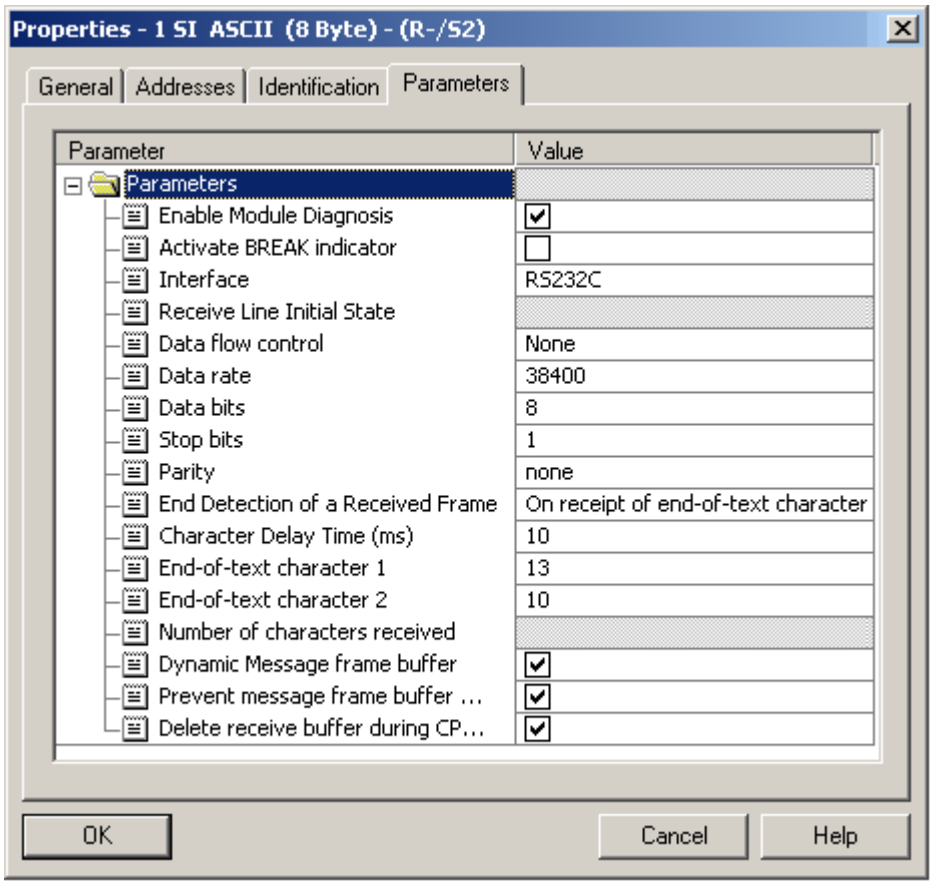

The ET 200S used in this program includes the following components:

Table 2-1: ET 200S components

| Component | Order number |
|---|---|
| IM 151 PROFIBUS-DP | 6ES7 151-1BA00-0AB0 |
| PM-E DC24V | 6ES7 138-4CA01-0AA0 |
| 1 SI ASCII (8 bytes) | 6ES7 138-4DF01-0AB0 |

Figure 2-2 shows how the parameters of the ET 200S 1SI interface module are configured.

Figure 2-2: Setting the parameters of the ET200S interface




## 2.2 The GPS mouse

For the solution provided in this FAQ document, a GPS mouse type GNS 9833 by Global Navigation Systems (GNS) has been used.

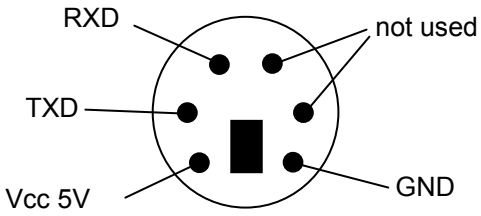
### 2.2.1 Technical data

Table 2-2: Technical data of the GPS mouse

| | | |
|---|---|---|
| Chipset SiRF | 3 | |
| Data protocol | GNS protocol 2.0 & NMES 2.0, 38400 bauds | |
| Startup times | cold start | approx. 40 sec. |
| | warm start | approx. 8 sec. |
| | hot start | approx. 1 sec. |
| Data interface[1] | GNS Mini DIN 6pin connector | |
| Dimensions | 65 x 65 x 18 mm | |
| Operating temperature | -10°C … +70°C | |
| Power supply | 5.0V +/- 5% DC | |
| Power consumption | 0.5W at 5.0V DC | |

[1]Pin assignment of the GPS-mouse is illustrated in Figure 2-3.

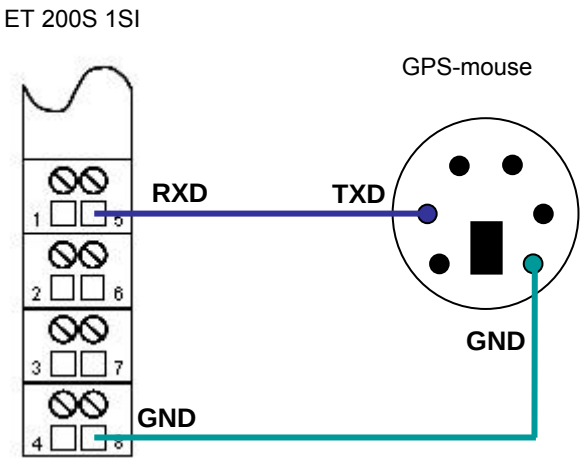
Figure 2-3: Pin assignment of the data interface




### 2.2.2 Connection of the GPS-mouse

The GPS mouse and the ET 200S interface module are connected by two lines.

Figure 2-4: Wire connection between ET 200S and GPS-mouse




**Note** Don’t forget the power supply for the GPS mouse.

# 3 The S7-Program

## 3.1 Structure of the S7-program

The S7-program described in this FAQ document includes the following blocks:

Table 3-1: Function blocks of the S7-program

| Block | Function |
|---|---|
| FB 2 "S_RCV" | Receipt of data from the ET 200S interface module |
| FB 10 "GPS_TIME" | Retrieval and processing of time and date information from a GPS signal |

Table 3-2: Data blocks of the S7-program

| Block | Function |
|---|---|
| DB 2 "S_RCV_DB" | Instance DB of FB 2 |
| DB 5 "DB_GPS_Data" | Storage of data received from the ET 200S |
| DB 10 "DB_instance_FB10" | Instance DB of FB 10 |

## 3.2 FB 2 "S_RCV"

The function block "S_RCV" is used to transmit data from the ET 200S 1SI module to an S7 data area. This function block is statically called either for cyclic data transfer or in a time-controlled program.

Figure 3-1: Call of FB "S_RCV"

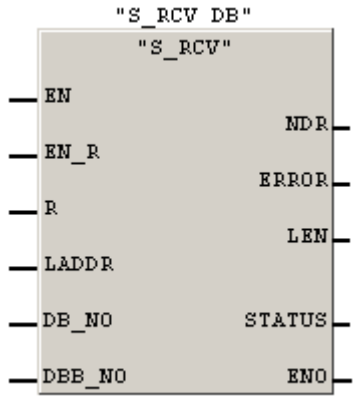


Table 3-3: The parameter FB "S_RCV2

| Name | Type | Data type | Description |
|---|---|---|---|
| EN_R | INPUT | BOOL | Enable the reading of data |
| R INPUT | | BOOL | Job cancelled |
| LADDR | INPUT | INT | Base address of the ET 200S 1SI module |
| DB_NO | INPUT | INT | Data block number |
| DBB_NO INPUT | | INT | Data byte number |
| NDR | OUTPUT | BOOL | Job completed without error, data accepted |
| ERROR | OUTPUT | BOOL | Job completed with error |
| LEN | OUTPUT | INT | Length of the telegram received |
| STATUS | OUTPUT | WORD | Specification of the error |

With the help of FB "S_RCV", the GPS data can be read in via the ET 200S 1SI module and stored in the data block "DB_GPS_Data".

**Note** For detailed information on the function block "S_RCV", please refer to the operating instructions for the ET 200S interface module.

## 3.3 FB 10 "GPS_TIME"

The function block 10 "GPS_TIME" is used to acquire the date and time information (UTC time) from the GPS protocol received.

Figure 3-2: Call of FB "GPS_TIME"

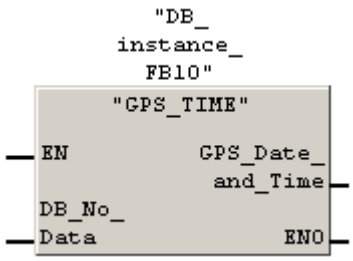



Table 3-4: The parameter FB "GPS_TIME"

| Name | Type | Data type | Description |
|---|---|---|---|
| DB_No_Data INPUT | | INT | Data block number of "DB_GPS_Data" |
| GPS_Date_and_Time | OUTPUT | DATE_TIME | Date and time |

To retrieve the date and time information from the GPS protocol, the function block "GPS_TIME" performs the following steps:

1. Selection of the RMC sentence
2. Determination of the required data block
3. Plausibility check of the data received
4. Data conversion from ASCII to binary-coded decimal (BCD)

After the receipt of time and date and if this information is plausible, it will be transferred to the output DATE_TIME. If no data is received or if the data received is not plausible, the output DATE_TIME will show 99.99.99, 99:99.

### 3.3.1 Selection of the RMC sentence

As described in chapter 1.2, the NMEA protocol comprises various sentences which are sent one after the other. For this reason, it must be identified, if a data set in the RMC sentence format has been received.

Then the time and date information can be retrieved from this RMC sentence.

This is effected in network 2. Each time the RMC sentence is received in the data block "DB_GPS_Data", it will be copied to the instance data block of the FB "GPS_TIME" with the help of SFC 20 "BLKMOV".

### 3.3.2 Determination of the required data block

The structure of the RMC sentence is described in chapter 1.2. This data structure is repeated in the data block "DB_instance_FB10".

Figure 3-3: Excerpt from the data block "DB_instance_FB10"

| | Type | Initial value | @Actual value | |
|---|---|---|---|---|
| 18 | BYTE | B#16#0 | B#16#24 | → $ |
| 19 | BYTE | B#16#0 | B#16#47 | → G |
| 20 | BYTE | B#16#0 | B#16#50 | → P |
| 21 | BYTE | B#16#0 | B#16#52 | → R |
| 22 | BYTE | B#16#0 | B#16#4D | → M |
| 23 | BYTE | B#16#0 | B#16#43 | → C |
| 24 | BYTE | B#16#0 | B#16#2C | → , |
| 25 | BYTE | B#16#0 | B#16#31 | |
| 26 | BYTE | B#16#0 | B#16#33 | |
| 27 | BYTE | B#16#0 | B#16#31 | |
| 28 | BYTE | B#16#0 | B#16#31 | UTC time |
| 29 | BYTE | B#16#0 | B#16#32 | |
| 30 | BYTE | B#16#0 | B#16#35 | |
| 31 | BYTE | B#16#0 | B#16#2C | → , |
| 32 | BYTE | B#16#0 | B#16#56 | → analysis status |
| 33 | BYTE | B#16#0 | B#16#2C | |

However, the accuracy of the data received depends on the reception quality of the GPS mouse. The number of longitude and latitude digits may vary.

For this reason, it is necessary to determine the position of the date information in the RMC sentence. This is effected by counting the data items of the sentence which are separated by commas [ ',' ].

The position of the ninth data block including the date information is determined in network 4 of FB "GPS_TIME".

**Note** The time information can be determined without counting of the data items.

### 3.3.3 Plausibility check of the data received

When having determined the ninth data block, the data contained therein is checked for plausibility. This includes:

- the day information must show a value between 0 and 31.
- the month information must show a value between 1 and 12.
- the year information must be greater or equal 10 (2010).

The UTC time data included in the first data block is also subject to a plausibility check. This includes:

- the hour information must show a value between 0 and 23.
- the minute and second information must show a value between 0 and 59.

### 3.3.4 Data conversion from ASCII to BCD

After completion of the plausibility check, the data and time values are converted from ASCII to BCD format.

In the BCD code, the data and time values can then be output in the "DATE_TIME" format. In this format, the date and time values can be used to set the CPU clock, for example.

### 3.3.5 Communication control

If the GPS-mouse fails or if the connection between GPS-mouse and ET 200S interface module is interrupted, the data in the data block "DB_GPS_Data" will no longer be updated.

If this happens and after the watchdog time of 2 seconds has elapsed, the date and time values will show the hexadecimal number 99.

Communication control is performed in network 3 of FB "GPS_TIME".

**Note** When the GPS mouse is started anew, observe the starting times of the GPS receiver used.

# 4 Internet Links

The following list is by no means complete and only provides a selection of appropriate sources.

Table 4-1: Internet links

| | Topic | Title |
|---|---|---|
| \1\ GNS | homepage | http://www.gns-gmbh.com |
| \2\ NMEA | protocol | http://www.nmea.org |
| \3\ NMEA | sentences | http://www.codepedia.com |

# 5 History

Table 5-1: History

| Version | Date | Revisions |
|---|---|---|
| V1.0 02/20 | 10 | First version |
| | | |
| | | |