Application Note
GPS Week Rollover

1 GPS Week Rollover Concern

GPS revolutionized the world with its ability to provide an accurate, reliable, and cost-effective positioning, navigation, and timing (PNT) service with global coverage. Its rapid adoption and widespread deployment enhances our way of life, but has also led to a dependency on GPS to maintain that way of life. Critical infrastructure sectors such as wireline and wireless networks, power grids, financial services, data centers, and emergency services now depend on PNT information delivered by GPS.

Ongoing management of systems that use GPS is needed to ensure proper operation. One such event that can effect GPS operation is called a GPS rollover. In response to a GPS rollover event, Microsemi proactively simulates the event to test Microsemi timing products to assure proper behavior through the event. If required, product updates are made available providing peace of mind that timing service operations will perform smoothly through the GPS rollover event.

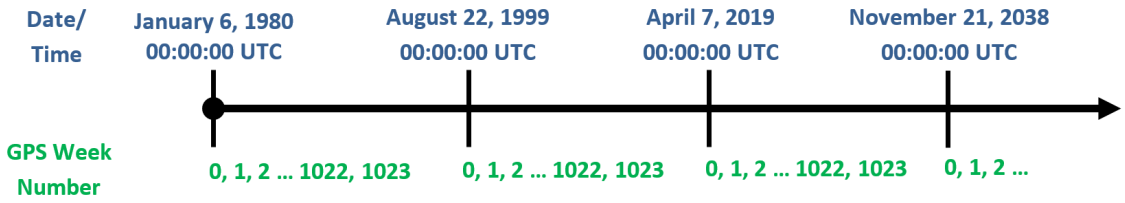
The following section describes the GPS week rollover concern and provides a recommendation of how Microsemi customers can stay more informed about GPS week rollovers and other GPS-related events.

1.1 GPS Week Numbers

The Global Positioning System (GPS) started its clock on the morning of January 6, 1980 at 00:00:00. GPS uses week numbers to identify how many weeks have passed since that start date. For example, on January 6, 1980, the week number would have been 0; on January 13, 1980, the week number would have been 1; on January 20, 1980, the week number would have been 2; and so on.

A limitation within the GPS signal specification is that only 10 bits are used to broadcast the current GPS week number. This equates to a maximum week number of ($2^{10} - 1$) or 1023. Thus, once the GPS week number reaches the value 1023, it can't count up any further and must rollover (that is, reset) to 0. At that point, it continues to count the weeks until it reaches the 1023 value again as shown in the following figure.

Figure 1 • GPS Week Number and Rollover Dates



1.2 GPS Receivers

It is impossible for a GPS receiver to determine which 1024-week period (often referred to as a GPS era or GPS epoch) is the correct one using the GPS signal broadcast alone. Therefore, additional information must be used by the GPS receiver to correctly determine the time. The most prevalent method is to program the manufacturing date of the receiver or the software release date into the GPS receiver. The GPS receiver then knows that the correct date can't possibly be before the date programmed into the receiver. If it receives a GPS week number that indicates an earlier date, then the receiver knows to add 1024 to the week number in order to obtain the correct date. Doing this enables the GPS receiver to operate for just over 19.5 years from the date that was programmed into the receiver.

In some GPS receivers the date programmed into the receiver may be updated. This enables it to operate past the 19.5 year period originally programmed in the receiver. This is typically accomplished using a command sent by the user but may also be performed by the GPS receiver itself. Other receivers have the date hard coded with no way update to prevent the receiver from rolling back to its internal week 0 date.

Given the varied methods used by vendors to resolve the inherent ambiguity associated with GPS week numbers, the date a GPS receiver will exhibit the rollover effect (jumping back in time by ~19.5 years) is actually quite random. The GPS receiver vendor is the best source of information on how any particular receiver will behave. Furthermore, a robust testing plan includes more than simply testing the actual GPS week rollover date.

1.3 GPS Week Rollover Testing

The equipment setup for GPS week rollover testing is illustrated in the following figure. Microsemi uses state of the art GPS simulators to validate that their precision timing products properly respond to GPS Week Rollover events.

Figure 2 • Equipment Setup for GPS Week Rollover Testing

1.4 Summary

Microsemi proactively tests its timing products for GPS Week Rollover events. Exhaustive test scenarios are performed and results of this testing are provided to customers through communications such as Field Service Bulletins (FSBs). As an example, please see FSB 098-40620-97, **GPS Week Number Rollover Event April 7, 2019.**

If you own or operate a Microsemi timing product, and would like to know more, please register on Microsemi's Online Support Portal. There, you can find the latest technical information about your products. And, when registering on the support portal, you can subscribe to your specific product and choose to receive email notification about product.

Microsemi Headquarters
One Enterprise, Aliso Viejo,
CA 92656 USA
Within the USA: +1 (800) 713-4113
Outside the USA: +1 (949) 380-6100
Sales: +1 (949) 380-6136
Fax: +1 (949) 215-4996
Email: sales.support@microsemi.com
www.microsemi.com

MSCC-0104-AN-0102-2.00-1118