The DAQ cards use a combination of GPS data and a 41.667MHz oscillator to time each event. This time is then bundled with other information, such as the state of the GPS system and the channel that was triggered, and sent out of the DAQ card to a computer to be analyzed.

Here is one line of code as output by the DAQ card:

80EE0049 80 01 00 01 38 01 3C 01 7EB7491F 202133.242 080803 A 04 2 -0389

Here is a break down of the code:

80EE0049

This is a hexadecimal count of the oscillator when the event happened. Since the oscillator has a frequency of 41.667MHz it oscillates once every 24ns (period=1/frequency).

80 01 00 01 38 01 3C 01

This data set is also in hexadecimal, and when converted to binary it provides data on the rising and falling edges of each signal on each channel as well as timing down to .75ns relative to the 24ns resolution timing.

7EB7491F

This is also a count of the oscillator, much like the first number, however this is the count when the last second occurred.

202133.242

This is very course time provided by the GPS system and must be corrected by the GPS offset discussed later. It is in the form *hhmmss.sss* meaning that the first two numbers are the hour, the second two are the minutes, and the last 5 are the seconds so this event happened at 8:21 and 33.242 seconds PM.

080803

Much like the previous data set, this is the date as provided by GPS. It is in the form *mmddyy* so this event happened August 8th, 2003.

A 04 2

This is data about the state of the GPS system. The A and the 2 mean that the information is valid, while the 04 is the number of satellites in communication with the receiver.

-0389

This is the GPS offset. This number is added to the course GPS time as milliseconds and the GPS time is then rounded off. This is necessary due to lag in GPS communication.

# Calculating the event time

The event time calculation is accurate to within 24ns and would be fairly easy to calculate except for that corrections must be made for imperfections in the DAQ card. Normally conditions such as atmospheric pressure, humidity and temperature would not be significant enough to affect your calculations, but since the DAQ card, and especially the 41.667MHz oscillator chip, operate at such high speeds even the slightest difference can have a significant impact.

Here is how to calculate the event time (from largest to smallest):

## 80EE0049 80 01 00 01 38 01 3C 01 7EB7491F 202133.242 080803 A 04 2 -0389

The date can be read straight from the DAQ card.

*080803=August 8th, 2003*

The hours, minutes, and seconds can also be read straight from the data.

*202133.242=8:21:33.242 PM*

The seconds must be corrected by adding the GPS offset as milliseconds and rounding to the nearest second.

*-0389=>33.242-0.389=32.853=>33*

*time is 8:21:33 PM*

The current operating frequency of the oscillator chip is determined by taking the difference of the counter count at this second and the counter count at the previous second.

*81331170 (acquired from a later pulse)-7EB7491F=027BC851=41666641Hz(decimal)*

The period of each oscillation is determined by inverting the frequency.

*1/4166641=24.000014784ns*

The number of counts since the last second is then determined (count at pulse-count at last second) and multiplied by the period of the oscillator.

### 80EE0049-7EB7491F=37140266 (decimal), 37140266\*24.00001478ns=0.891366384s

The time since the last second is then added to the corrected GPS data for the final absolute time.

*8:21:33+0.891366384=8:21:33.891366384PM, August 8th, 2003*