

Search for Preamble

The procedure for positively finding the *correct* preamble is as follows:

1. Search for either an upright or inverted preamble
2. When one is found, a check is required to see if it is a beginning of a 30-bit word. This is accomplished by collecting the following 22 bits and checking parity. If parity doesn't pass, the candidate preamble is discarded
3. If parity passes, it verifies that the preamble existed at the beginning of a word. The parity algorithm also resolves the sign ambiguity. However, there are also legitimate such patterns at beginning of other words, so additional checks are required. If it is the correct TLM word, the following word must be a HOW that contains a truncated *Z*-count. The first eight bits of this truncated *Z*-count can also resemble a preamble
4. Parity should pass on the HOW word. If not, the frame synchronization procedure should be restarted. Two checks could be made to verify a legitimate HOW word—the *Z*-count is reasonable, and it agrees with the subframe count. Of course, there is a small probability that these conditions could also occur elsewhere in the message. Thus, further checking is required
5. If the HOW seems legitimate, provisional demodulation of the other words can commence, and they can be stored in memory. A final check on the next preamble and the next *Z*-count solidifies the frame synchronization. That is, the preamble is where it is supposed to be, and the *Z*-count increments by one.

(van Dierendonck in Parkinson, page 398)

Z-count and TLM

The number of *X*1 epochs (1.5 s each) since the GPS zero time point modulo-1024 weeks is a 29-bit number called the *Z*-count. The 19 least significant bits of the *Z*-count are referred to as the *time of week* (TOW) count, which is defined as the number of *X*1 epochs (1.5 s each) since the transition from the previous week. A truncated version, the 17 most significant bits of the TOW word is defined as the handover word, which ranges from 0 to 100 799, corresponds to the number of 6-s subframes since the beginning of the week. The HOW removes any timing ambiguity caused by the 1-ms C/A-code period and aids in C/A- to P-code handover/acquisition. The ten most significant digits of the 29-bit *Z*-count represent the number of weeks since the GPS zero time point.

Each 10-word subframe begins with a telemetry (TLM) word, which in turn begins with an 8-bit preamble, for synchronization (a modified Barker sequence). Other parts of the TLM contain data needed by authorized users.

(Spilker in Parkinson, page 126)

The C/A code repeats every 1 ms and is therefore ambiguous every 1 ms of GPS time. There is a HOW at the beginning of every one of the five subframes of the satellite navigation message. The HOW contains the *Z*-count of the first data bit transition

boundary at the beginning of the next subframe. This is the first data bit of the telemetry message TLM that precedes every HOW. The beginning of this 20-ms data bit is synchronized with the beginning of one of the satellite's C/A code 1-ms periods, but there are 20 C/A-code periods in every data bit period. At this subframe epoch, the X1 register has just produced a carry to the Z-count, so the X1 count is zero. The C/A-code ambiguity is resolved by setting the Z-count to the HOW value and the X1 count to zero at the beginning of the next subframe.

(Kaplan, page 189)