Mode S Reply Encoding
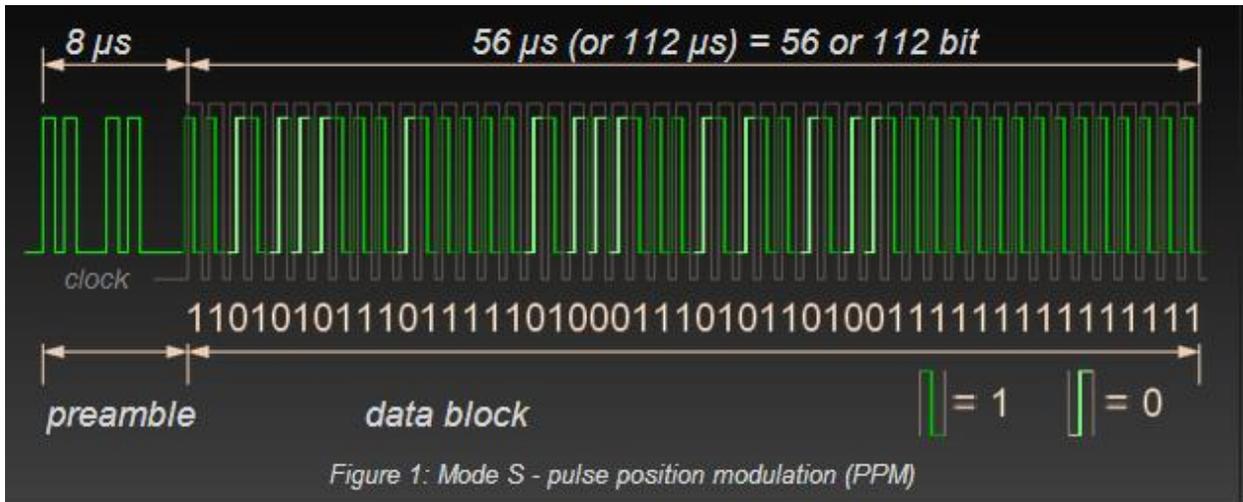

Figure 1: Mode S - pulse position modulation (PPM)

Mode S replies consists of a certain number of pulses at a 1 µs spacing. (The bit update rate allows a 1 µs per data bit transfer rate that can be translated to a one megabit per second data rate.) The Mode S reply consists of two distinct parts:

1. a preamble and
2. a data block.

Pulse position modulation is a form of signal modulation in which the data information is encoded in the time delay between pulses in a sequence of signal pulses.

Figure 2: Content of the short messages data block

Preamble

Every Mode S reply starts with a preamble with a length of 8 microseconds. The pattern of the preamble consists of four pulses with a length of 0.5 microseconds per pulse. The interspaces (to the first pulse) are 1; 3.5 and 4.5 microseconds.

Data block

The data block consists of either 56 or 112 bits with a length of either 56 or 112 microseconds. The short data block format is divided in a format identifier of 5 bits, a surveillance and control word of 27 bits and the 24 bits for the individual airplane code including a parity information.

Downlink format message format Content

Downlink format	message format	Content
DF0	Fig. 2	Short Air to Air ACAS
DF4	Bild 2	Surveillance (roll call) Altitude
DF5	Bild 2	Surveillance (roll call) IDENT Reply
DF11	Fig. 2	Mode S Only All-Call Reply (Acq. Squitter if II=0)
DF16	Fig. 3	Long Air to Air ACAS
DF17	Fig. 3	1090 Extended Squitter
DF19		Military Extended Squitter
DF20 DF21	Fig. 3	Comm. B Altitude, IDENT Reply
DF22		Military use only
DF24	Fig. 4	Comm. D Extended Length Message (ELM)

Table 1: Mode S Downlink format numbers

Table 1: Mode S Downlink format numbers

The longer downlink formats using 112 bit length of data block can exhibit an additional message field of 56 bits, or an extended length message field of 80 bits. All messages content the airplanes identification number including

a parity information in co-operation with the surveillance and communication control word.

The format number defines 25 coding formats. Each Mode S downlink format has a particular purpose. The formats DF0, DF4, DF5, DF11, DF16, DF20, DF21 and DF24 are used in civil aviation at present. The format DF0 provides informations for ACAS. The DF17 format is used for the ADS-B system.

Replies with the DF0 format are responses to ACAS or TCAS interrogations. Downlink format 16's are transmissions which are used by ACAS or TCAS units to communicate between aircraft. The responses for ground based interrogations have the DF4 format. DF11 and DF17 are "squittered" by Mode S transponders at a nominal rate of 1 Hz.

Figure 3: Content of the long messages data block (communication reply)

Figure 3: Content of the long messages data block (communication reply)

Figure 4: Content of an extended length message data block (communication reply)

Figure 4: Content of an extended length message data block (communication reply)

The downlink format DF24 is the one and only format number beginning with two High-bits and contains an extended length message data block. The decoder need to examinate these two bits only for reading this format number. The amount of bits can be shorten in the format number block therefore, as shown in Figure 4.