

Modulating Signal Description

Source: RTCA Document DO-185A, "Minimum Operational Performance Standards for Traffic Alert and Collision Avoidance System II (TCAS II) Airborne Equipment"

2.2.3.8 Transmit Pulse Characteristics

2.2.3.8.1 Mode C Transmissions

Mode C interrogations from TCAS II equipment shall employ the "Mode-C-Only All Call" format which consists of three pulses P_1 , P_3 , and P_4 . This shall normally be preceded by a Mode C "whisper-shout" suppression pulse designated S_1 (see subparagraph 2.2.4.5.4.1). Sidelobe suppression is accomplished by transmitting a P_2 pulse via a separate control pattern. These formats are illustrated in Figure 2-1. The pulses shall have shapes and spacings as tabulated below except that the rise and decay time may be less than shown in the table, providing the side-band radiation does not exceed the spectral limits tabulated in subparagraph 2.2.3.3. The amplitude of P_3 shall be within 0.5 dB of the amplitude of P_1 , and the amplitude of P_4 shall be within 0.5 dB of the amplitude of P_3 . The amplitude of S_1 is specified in subparagraph 2.2.4.5.4.1.

Table 2-4 Mode C Pulse Shapes
(All values in microseconds)

Pulse Designator	Pulse Duration	Duration Tolerance	Rise Time		Decay Time	
			Min.	Max.	Min.	Max.
S_1, P_1, P_2, P_3, P_4	0.8	± 0.05	0.05	0.1	0.05	0.2

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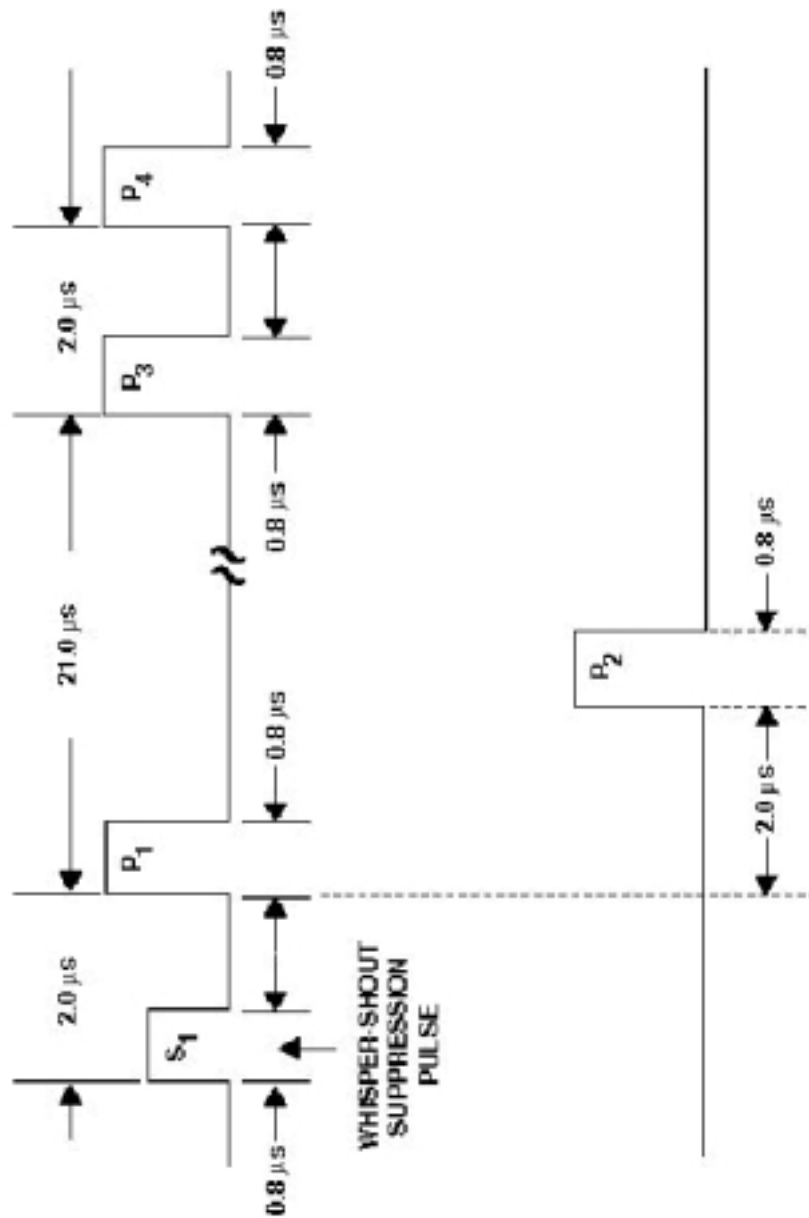


Figure 2-1 Mode C-Only All-Call Interrogation Pulse Sequence For TCAS.

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The pulse spacing tolerances shall be as follows:

S_1 to P_1	2 ± 0.10 microseconds;
P_1 to P_2	2 ± 0.10 microseconds;
P_1 to P_3	21 ± 0.10 microseconds;
P_3 to P_4	2 ± 0.04 microseconds.

Note: The tolerance values on these pulse widths, spacings, and amplitudes are smaller than the signal-in-space tolerance values defined in Ref. B in order to provide margin for waveform distortion due to multipath.

2.2.3.8.2 Mode S Transmissions

Mode S transmissions shall consist of P_1 , P_2 , and P_6 pulses as shown in Figure 2-2. The pulses shall have shapes and spacings as tabulated below except that the rise and decay time may be less than shown in the table, providing the side-band radiation does not exceed the spectral limits tabulated in subparagraph 2.2.3.3.

Table 2-5 Mode S Pulse Shapes
(All values in microseconds)

Pulse Designator	Pulse Duration	Duration Tolerance	Rise Time		Decay Time	
			Min.	Max.	Min.	Max.
P_1, P_2	0.8	± 0.05	0.05	0.1	0.05	0.2
P_6 (Short)	16.25	± 0.125	0.05	0.1	0.05	0.2
P_6 (Long)	30.25	± 0.125	0.05	0.1	0.05	0.2

The short (16.25-microsecond) and long (30.25-microsecond) P_6 pulses shall have internal modulation consisting of possible 180-degree phase reversals of the carrier at designated times. The first phase reversal in the P_6 pulse is the sync phase reversal and is always present. The presence or absence of a subsequent phase reversal indicates a one or zero in the transmitted code respectively.

Note 1: The sync phase reversal is the timing reference provided to identify chip positions to Mode S interrogation decoders.

The duration of a phase reversal in P_6 shall be less than 0.08 microsecond as measured between the 10-degree and 170-degree points of the phase transition. The interval between the 80-percent points of the amplitude transient associated with the phase reversal shall be less than 0.08 microsecond.

The tolerance on the 0- and 180-degree phase relationships in P_6 shall be ± 5 degrees. The 90-degree point of each data phase reversal in P_6 shall occur only at a time $(N \times 0.25) \pm 0.02$ microsecond ($N \geq 2$) after the 90-degree point of the sync phase reversal.

Note 2: 56 or 112 data phase reversals can occur in the 16.25 and 30.25-microsecond P_6 pulses respectively. This results in a 4 Mbit/sec data rate within the P_6 pulses.

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The spacing from P_1 to P_2 shall be 2 ± 0.04 microseconds between leading edges. The spacing from the leading edge of P_2 to the 90-degree point of the sync phase reversal of P_6 shall be 2.75 ± 0.04 microseconds. The leading edge of P_6 shall occur 1.25 ± 0.04 microseconds before the sync phase reversal.

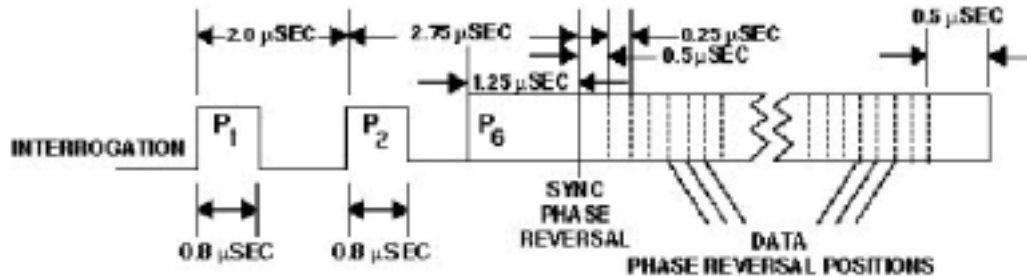


Figure 2-2 Mode-S Interrogation Pulse Sequence For TCAS.

Note 3: The P_1 - P_2 pair preceding P_6 suppresses replies from ATCRBS transponders to avoid synchronous garble due to random triggering of ATCRBS transponders by Mode S interrogations. A series of "chips" containing the information within P_6 starts 0.5 microsecond after the sync phase reversal. Each chip is of 0.25 microsecond duration and is preceded by a possible phase reversal. If preceded by a phase reversal, a chip represents a logic "1". There are either 56 or 112 chips. The last chip is followed by a 0.5 microsecond guard interval which prevents the trailing edge of P_6 from interfering with the demodulation process.

The radiated amplitudes of P_2 and the initial first microsecond of P_6 shall be greater than the radiated amplitude of P_1 minus 0.25 dB. The maximum envelope amplitude variation between successive phase modulation chips in P_6 shall be less than 0.25 dB.

Note 4: The tolerance values on these pulse widths and spacings and the location of the sync phase reversal are smaller than the signal-in-space tolerance values defined in Ref. B in order to provide margin for waveform distortion due to multipath reflections.