Interrogators certified for operation in dense-Interrogator environments shall have a frequency accuracy of +/– 10 ppm over the nominal temperature range (–25°C to +40°C) and +/– 20 ppm over the extended temperature range (–40°C to +65°C). Interrogators rated by the manufacturer to have a temperature range wider than nominal but different from extended shall have a frequency accuracy of +/– 10 ppm over the nominal temperature range and +/– 20 ppm to the extent of their rated range. If the local regulations specify tighter frequency accuracy then the Interrogator shall meet the local regulations.

9.3.1.2.2 Modulation

Interrogators shall communicate using DSB-ASK, SSB-ASK, or PR-ASK modulation, detailed in Annex J. Tags shall demodulate all three modulation types.

9.3.1.2.3 Data encoding

The R=>T link shall use PIE, shown in Figure 35. Tari is the reference time interval for interrogator-to-tag signalling, and is the duration of a data-0. High values represent transmitted CW; low values represent attenuated CW. Pulse modulation depth, rise time, fall time, and PW shall be as specified in Table 185, and shall be the same for a data-0 and a data-1. Interrogators shall use a fixed modulation depth, rise time, fall time, PW, Tari, data-0 length, and data-1 length for the duration of an inventory round. The RF envelope shall be as specified in Figure 36.

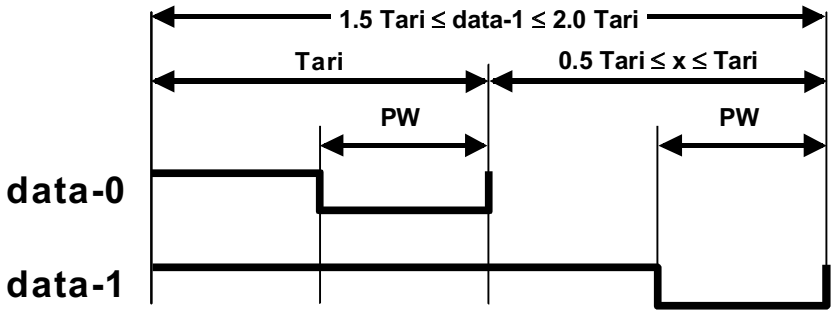

Figure 35 — PIE Symbols

9.3.1.2.4 Tari values

Interrogators shall communicate using Tari values in the range of 6.25µs to 25µs. Interrogator compliance shall be evaluated using at least one Tari value between 6.25µs and 25µs with at least one value of the parameter *x*. The tolerance on all parameters specified in units of Tari shall be +/–1%. The choice of Tari value and *x* shall be in accordance with local radio regulations.

9.3.1.2.5 R=>T RF envelope

The R=>T RF envelope shall comply with Figure 36 and Table 185. The electric or magnetic field strength A (as appropriate) is the maximum amplitude of the RF envelope, measured in units of V/m or A/m, respectively. Tari is defined in Figure 35. The pulsewidth is measured at the 50% point on the pulse. An interrogator shall not change the R=>T modulation type (i.e. shall not switch between DSB-ASK, SSB-ASK, or PR-ASK) without first powering down its RF waveform (see 9.3.1.2.7).

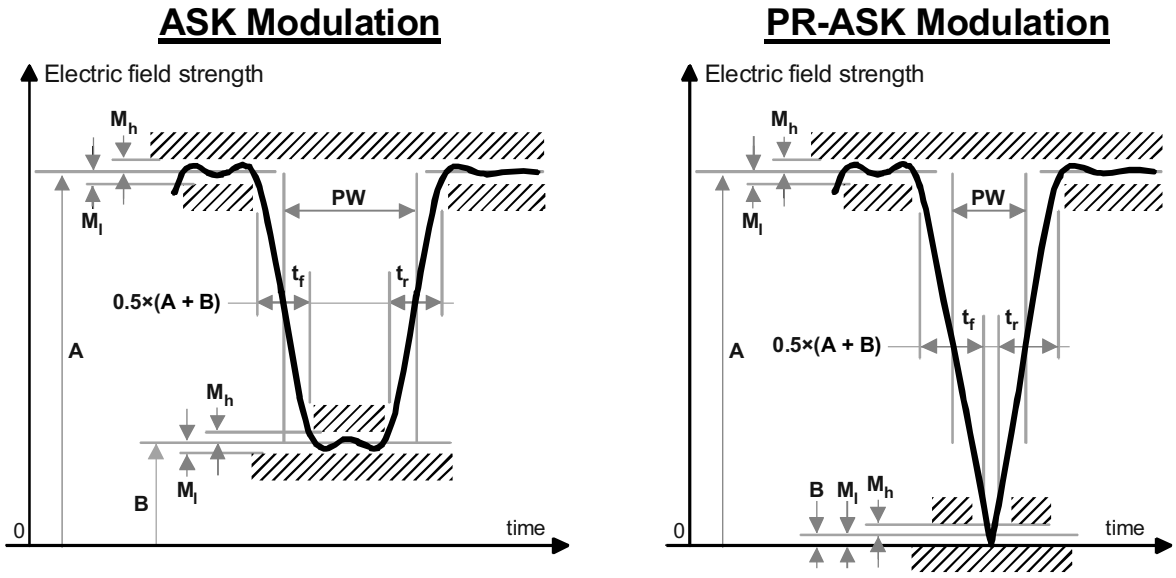

Figure 36 — Interrogator-to-tag RF envelope

Table 185 — RF envelope parameters

Tari	Parameter	Symbol	Minimum	Nominal	Maximum	Units
6.25 µs to 25 µs	Modulation Depth	(A–B)/A	80	90	100	%
	RF Envelope Ripple	$M_h = M_l$	0		0.05(A–B)	V/m
	RF Envelope Rise Time	$t_{r,10–90\%}$	0		0.33Tari	µs
	RF Envelope Fall Time	$t_{f,10–90\%}$	0		0.33Tari	µs
	RF Pulsewidth	PW	MAX(0.265Tari, 2)		0.525Tari	µs

9.3.1.2.6 Interrogator power-up waveform

The interrogator power-up RF envelope shall comply with Figure 37 and Table 186. Once the carrier level has risen above the 10% level, the power-up envelope shall rise monotonically until at least the ripple limit M_l. The RF envelope shall not fall below the 90% point in Figure 37 during interval T_s. Interrogators shall not issue commands before the end of the maximum settling-time interval in Table 186 (i.e. before the end of T_s). Interrogators shall meet the frequency-accuracy requirement specified in 9.3.1.2.1 by the end of interval T_s in Figure 37.

9.3.1.2.7 Interrogator power-down waveform

The interrogator power-down RF envelope shall comply with Figure 37 and Table 187. Once the carrier level has fallen below the 90% level, the power-down envelope shall fall monotonically until the power-off limit M_s. Once powered off, an interrogator shall remain powered off for a least 1ms before powering up again.

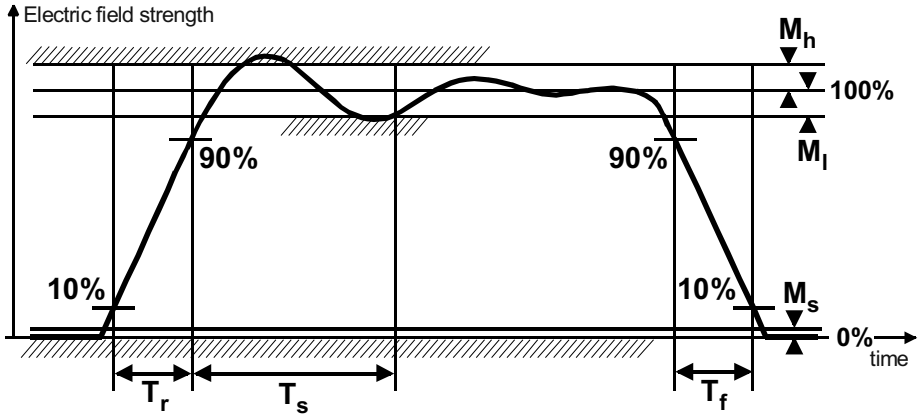

Figure 37 — Interrogator power-up and power-down RF envelope

Table 186 — Interrogator power-up waveform parameters

Parameter	Definition	Minimum	Nominal	Maximum	Units
T_r	Rise time	1		500	µs
T_s	Settling time			1500	µs
M_s	Signal level when OFF			1	% full scale
M_l	Undershoot			5	% full scale
M_h	Overshoot			5	% full scale

Table 187 — Interrogator power-down waveform parameters

Parameter	Definition	Minimum	Nominal	Maximum	Units
T_f	Fall time	1		500	µs
M_s	Signal level when OFF			1	% full scale
M_l	Undershoot			5	% full scale
M_h	Overshoot			5	% full scale

9.3.1.2.8 R=>T preamble and frame-sync

An interrogator shall begin all R=>T signalling with either a preamble or a frame-sync, both of which are shown in Figure 38. A preamble shall precede a *Query* command (see 9.3.2.11.2.1) and denotes the start of an inventory round. All other signalling shall begin with a frame-sync. The tolerance on all parameters specified in units of Tari shall be +/–1%. PW shall be as specified in Table 185. The RF envelope shall be as specified in Figure 36.

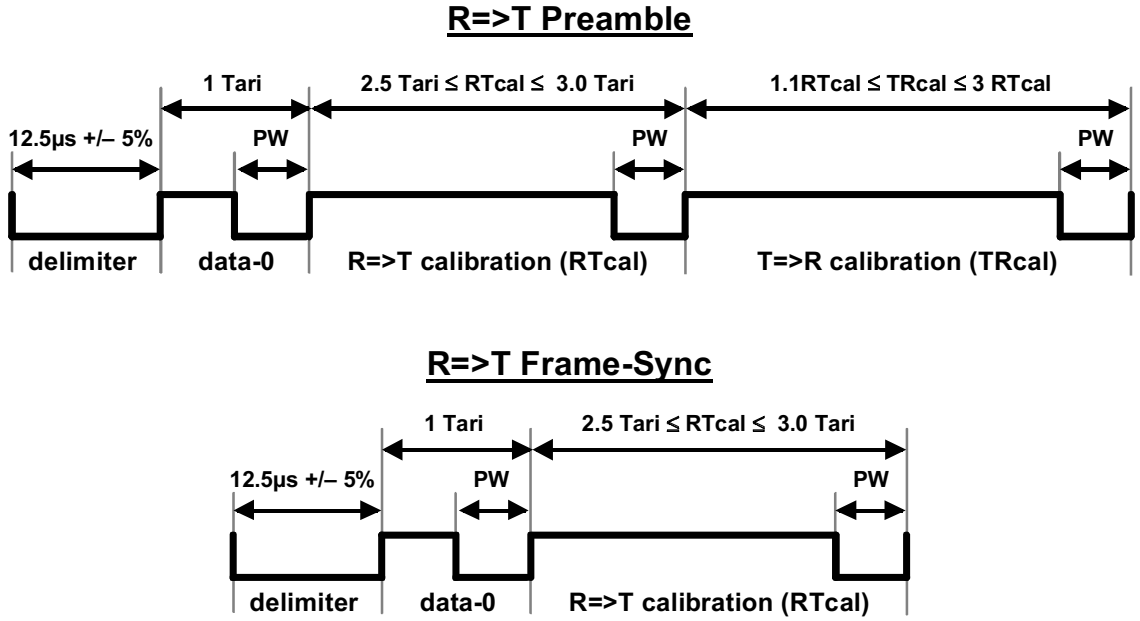

Figure 38 — R=>T preamble and frame-sync

A preamble shall comprise a fixed-length start delimiter, a data-0 symbol, an R=>T calibration (RTcal) symbol, and a T=>R calibration (TRcal) symbol.

RTcal: An interrogator shall set RTcal equal to the length of a data-0 symbol plus the length of a data-1 symbol (RTcal = 0_{length} + 1_{length}). A tag shall measure the length of RTcal and compute *pivot* = Rtcal / 2. A tag shall interpret subsequent interrogator symbols shorter than *pivot* to be data-0s, and subsequent interrogator symbols longer than *pivot* to be data-1s. A tag shall interpret symbols longer than 4 RTcal to be invalid. Prior to changing RTcal, an interrogator shall transmit CW for a minimum of 8 RTcal.

TRcal: An interrogator shall specify a tag's backscatter link frequency (its FM0 datarate or the frequency of its Miller subcarrier) using the TRcal and divide ratio (DR) in the preamble and payload, respectively, of a *Query* command that initiates an inventory round. Equation (1) specifies the relationship between the backscatter link frequency (BLF), TRcal, and DR. A tag shall measure the length of TRcal, compute BLF, and adjust its T=>R link rate to be equal to BLF (Table 189 shows BLF values and tolerances). The TRcal and RTcal that an interrogator uses in any inventory round shall meet the constraints in Equation (2):

$$BLF = \frac{DR}{TRcal} \quad (1)$$

$$1.1 \times RTcal \leq TRcal \leq 3 \times RTcal \quad (2)$$

A frame-sync is identical to a preamble, minus the TRcal symbol. An interrogator, for the duration of an inventory round, shall use the same length RTcal in a frame-sync as it used in the preamble that initiated the round.

9.3.1.2.9 Frequency-hopping spread-spectrum waveform

When an interrogator uses frequency-hopping spread spectrum (FHSS) signalling, the interrogator's RF envelope shall comply with Figure 39 and Table 188. The RF envelope shall not fall below the 90% point in Figure 39 during interval T_{hs}. Interrogators shall not issue commands before the end of the maximum settling-time interval in Table 188 (i.e. before T_{hs}). The maximum time between frequency hops and the minimum RF-off time during a hop shall meet local regulatory requirements. Interrogators shall meet the frequency-accuracy requirement specified in 9.3.1.2.1 by the end of interval T_{hs} in Figure 39.