

TECHNICAL DATA: Explanation of UHF RFID emissions and bandwidth

Wal-Mart will be evaluating the performance of UHF RFID Readers in our Bentonville, Arkansas laboratory. Readers destined for deployment at Wal*Mart sites in Europe, Japan and in other markets of potential interest to Wal-Mart will be tested.

The transmission characteristics of UHF RFID Readers are specified in the standard “Class-1 Generation-2 UHF RFID Protocol for Communications at 860 MHz – 960 MHz” (hereafter referred to as the Gen2 protocol). The Gen2 protocol has been ratified and is published by EPCglobal Inc. The Gen2 protocol will be used in connection with operations on all frequency ranges requested in this application.

The Gen2 protocol specifies three transmit modulation options for Readers, double sideband (DSB) ASK, single sideband (SSB) ASK, or PSK. Readers send digital commands to tags using one of these modulation formats then follows the command with a continuous wave (CW) transmission. Therefore, possible Reader emissions are DSB ASK, SSB ASK, PSK, and CW as indicated in 4(E) of the application.

Pulse Interval Encoding (PIE) is used to encode the digital bits (binary signaling scheme). Encoding of “data-0” and “data-1” bits is shown in Figure 1. A data-1 bit is distinguished from a data-0 by having a duration that is between 1.5 and 2.0 times the length of a data-0.

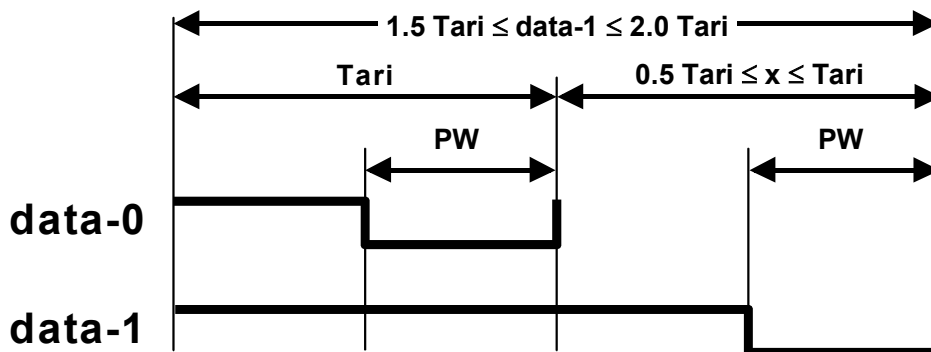


Figure 1: RFID Gen2 data encoding

The baseband data sequences are pulse shaped (filtered) to meet Japanese and European radiated emission regulatory requirements prior to modulation of the carrier. Figures 2, 3, and 4 show examples of typical pulse shaping and the resulting Power Spectral Density (PSD) of the transmitted DSB ASK, SSB ASK, and PSK signal, respectively. The examples show waveforms and spectra for a 32 kbps data rate signal.

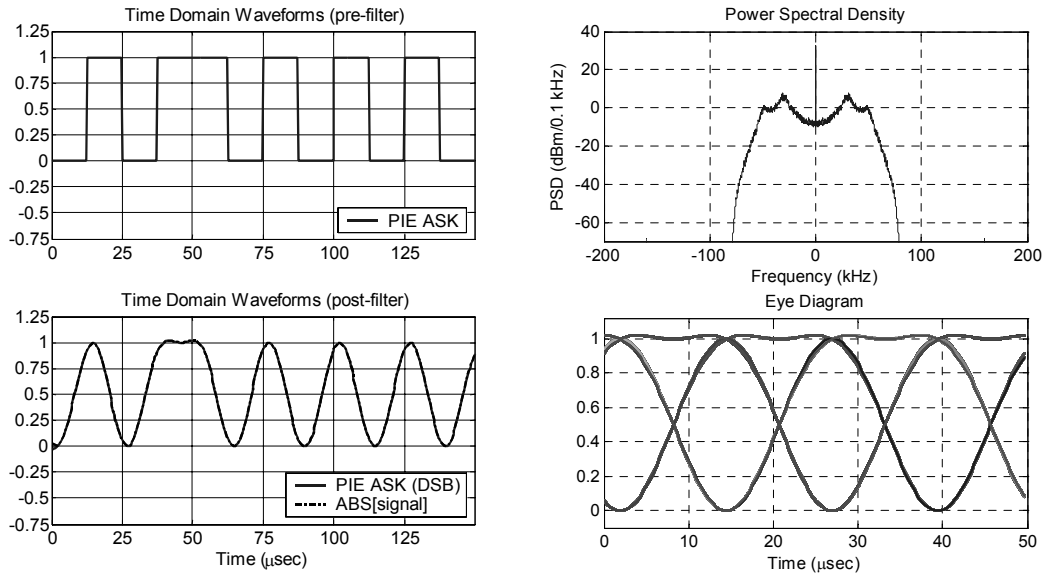


Figure 2: DSB ASK baseband time and frequency domain waveforms (32kbps data rate example)

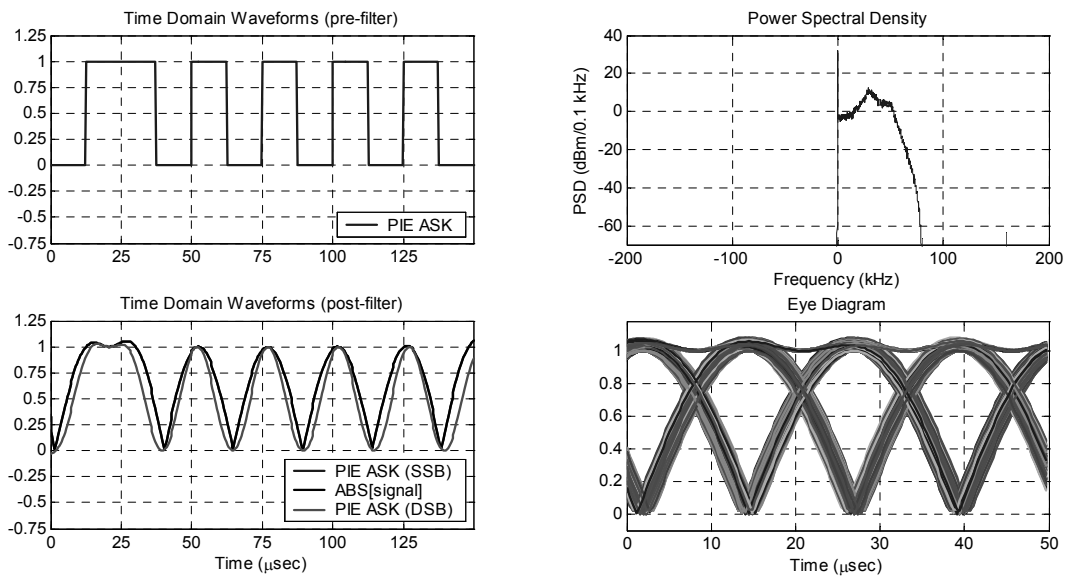


Figure 2: SSB ASK baseband time and frequency domain waveforms (32kbps data rate example)

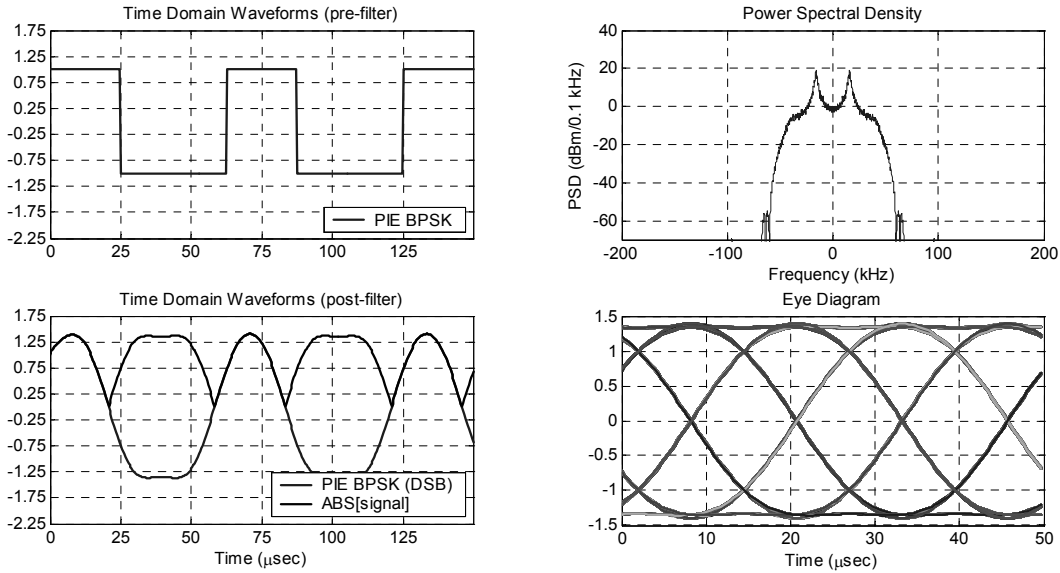


Figure 3: PSK baseband time and frequency domain waveforms (32kbps data rate example)

The bandwidth efficiency (bps/Hz) is used to relate the data rate to the 99% signal bandwidth for each emission type. Bandwidths are listed in Table 1 for typical and maximum data rates. Typical data rates correspond to modes prevalent in Readers designed for operation in Japanese and European markets. Applicant believes these data rates will apply in other countries, as well. Maximum bandwidths correspond to maximum data rates allowed by the Gen2 protocol.

Table 1: Typical and maximum bandwidths for each emission type

Emission Type	Bandwidth Efficiency (bps/Hz)	Typical Data Rate (kbps)	Maximum Data Rate (kbps)	Typical Bandwidth (kHz)	Maximum Bandwidth (kHz)
DSB ASK	0.20	48	128	240	640
SSB ASK	0.40	48	128	120	320
PSK	0.27	48	128	178	474

Baseband signals modulate an RF carrier at a frequency within the range listed in Technical Data section of the application. The carrier is constrained to fall on channel centers that are 200 kHz apart starting 100 kHz inside the frequency limits specified in this application. The peak radiated transmit power (power assuming no modulation, that is, a CW transmission) is listed in this application. The peak power is constrained by Japanese and European regulations.