



# Tech Notes

## Modem Bit Delays

Two sets of bit delay data are presented below.  
 The first is for the M5 Class modems and the second is for the M4 Class modems.

### M5: PSM-4900/4900H & M5000 Bit Delays

#### Transmit Path

- PSM-4900 Modulator ----- 1 User Rate Bit
- Viterbi Rate 1/2 ----- 12 Channel Rate Bits
- Viterbi Rate 3/4 ----- 15 Channel Rate Bits
- Viterbi Rate 7/8 ----- 17 Channel Rate Bits
- TPC Full Rate 1/2 ----- 1094 User Rate Bits
- TPC Full Rate 3/4 ----- 573 User Rate Bits
- TPC Full Rate 7/8 ----- 482 User Rate Bits
- TPC Short Rate 3/4 ----- 208 User Rate Bits
- TPC Short Rate 7/8 ----- 164 User Rate Bits
- Reed-Solomon Encoder -----  $8 \cdot k + 10$  User/IBS Mux Output Rate Bits + Fixed 500us Delay
- IBS Mux ----- 12 User Rate Bits

#### Receive Path

- PSM-4900 Demodulator ----- 1 User Rate Bit
- Viterbi Rate 1/2 ----- 184 Channel Rate Bits
- Viterbi Rate 3/4 ----- 186 to 188 Channel Rate Bits
- Viterbi Rate 7/8 ----- 186 to 190 Channel Rate Bits
- TPC Full Rate 1/2 ----- 2025 User Rate Bits + Fixed 751us Delay
- TPC Full Rate 3/4 ----- 2196 User Rate Bits + Fixed 446us Delay
- TPC Full Rate 7/8 ----- 3593 User Rate Bits + Fixed 447us Delay
- TPC Short Rate 3/4 ----- 729 User Rate Bits + Fixed 218us Delay
- TPC Short Rate 7/8 ----- 1087 User Rate Bits + Fixed 290us Delay
- Reed-Solomon Decoder
- Depth=4 --  $32 \cdot k + (24 \cdot k \cdot (4 \cdot D - n)) / n + 11$  User/IBS Demux Input Rate Bits + Fixed 500us Delay  
           where D is the smallest integer  $\geq (n-1)/4$
- Depth=8 --  $64 \cdot k + (24 \cdot k \cdot (4 \cdot D - n)) / n + 11$  User/IBS Demux Input Rate Bits + Fixed 500us Delay  
           where D is the smallest integer  $\geq (n-1)/8$
- IBS Demux ----- 4 User Rate Bits
- FIFO Buffer (Enabled) ----- 3 + Buffer Fill User Rate Bits

Note, Channel Rate is the Convolutional Encoder Input Data Rate for the Modulator.  
 Channel Rate is the Viterbi Decoder Output Data Rate for the Demodulator.

*Reed-Solomon Example 1*, if  $n=126$ ,  $k=112$  and Depth=4 then

- Total R-S Encoder Delay=906 User/IBS Mux Output Bits + Fixed 500us Delay
- D=32, Total R-S Decoder Delay=3,638 User/IBS Demux Input Bits + Fixed 500us Delay

*Reed-Solomon Example 2*, if  $n=201$ ,  $k=219$  and Depth=4 then

- Total R-S Encoder Delay=1,618 User/IBS Mux Output Bits + Fixed 500us Delay
- D=55, The Total R-S Decoder Delay=6,465 User/IBS Demux Bits + Fixed 500us Delay

Reed-Solomon Example 3, if  $n=205$ ,  $k=225$  and  $\text{Depth}=4$  then

Total R-S Encoder Delay= $1,650$  User/IBS Mux Output Bits + Fixed  $500\mu\text{s}$  Delay

$D=56$ , The Total R-S Decoder Delay= $6,549$  User/IBS Demux Bits + Fixed  $500\mu\text{s}$  Delay

#### **M4: PSM-512/2100/2100L & M4000 Bit Delays**

##### **Transmit Path**

Modulator ----- 8 Channel Rate Bits

Q1650/1900 Convolutional Encoder (Qualcomm Data Sheet)

Rate 1/2 ----- 11 Channel Rate Bits

Rate 3/4 ----- 11 to 19 Channel Rate Bits

Rate 7/8 ----- 11 to 19 Channel Rate Bits

Scrambler Enabled ----- 1 Channel Rate Bit

Reed-Solomon Encoder ----- 910 User/IBS Mux Rate Bits + Fixed  $300\mu\text{s}$  Delay

IBS Mux ----- 8 User Rate Bits

RS/IBS Option Installed -- 5 User Rate Bits

##### **Receive Path**

Demodulator ----- 1 Channel Rate Bit

Q1650/1900 Viterbi Decoder (Qualcomm Data Sheet)

Rate 1/2 ----- 183 Channel Rate Bits

Rate 3/4 ----- 183 to 191 Channel Rate Bits

Rate 7/8 ----- 183 to 191 Channel Rate Bits

Descrambler Enabled ----- 1 Channel Rate Bit

FIFO Buffer (Enabled) ----- 1 Additional User Rate Bit + number of bits set.

Reed-Solomon Decoder ----- 3598 User/IBS Demux Rate Bits + Fixed  $300\mu\text{s}$  Delay

IBS Demux ----- 0 User Rate Bits

RS/IBS Option Installed -- 4 User Rate Bits

Notes:

"User" bit rate = "Terrestrial" interface rate

"Channel" bit rate =

User bit rate X (1/FEC rate) X 16/15 (if mux enabled) X 9/8 (if R-S enabled)

Example: A modem with R-S and IBS mux is running at a user rate of 128 kbps.

The Channel bit rate is then =  $128 \text{ kbps} \times 2 \times 9/8 \times 16/15 = 307.2 \text{ kbps}$ .

The time/channel bit is  $3.3 \mu\text{s}$ . The time/user bit is  $7.8 \mu\text{s}$ .

The modulator delay is 20 channel rate bits x  $3.3 \mu\text{s}$  plus 923 user rate bits x  $7.8 \mu\text{s}$  plus  $300 \mu\text{s}$ , for a total delay of  $7,565.4 \mu\text{s}$  or  $7.565 \text{ mS}$ .

Notice that the majority of delay is due to the Reed-Solomon codec.