Mode Adaptation Input and Output Interfaces for DVB-S2 equipment

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1 Scope and Objectives

The SatLabs Group is an international, not-for-profit association whose members are committed to bringing the DVB-RCS standard [1] to large-scale deployment by ensuring interoperability between DVB-RCS products.

The Group implements qualification and certification programme aimed at verifying compliance and interoperability of DVB-RCS terminals. Testing equipment was developed for this purpose, under the denomination CTB (Common Test Bed).

The present specification defines mode adaptation interfaces with signalling of the MODCOD changes for DVB-S2 [2] based equipment.

The protocols defined for these interfaces allow a cost-effective implementation of VCM/ACM for:

- modulator control (L.1 and L.2): the mode adaptation interface lies between the Mode adaptation and the Stream adaptation functions. It allows to transport VCM/ACM commands (defining the dynamic transmission parameters) associated to each Data Field through either a separate signaling circuit (L.1) or in-band signaling (L.2).
- verification of the air interface by receiving decoded air interface frames (L.3 and L.4): the mode adaptation interface lies between the demodulation/decoding and the baseband processing devices. It allows to transport the received VCM/ACM commands and SNR measurements associated to each Data Field through either a serial (L.3) or a parallel output interface (L.4).

SatLabs intends to use these interfaces within the CTB in order to facilitate verification of the air interface. SatLabs will propose this specification to the DVB Forum.

2 References

[1] ETSI EN 301 790 v.1.4.1, “Digital Video Broadcasting (DVB); Interaction channel for satellite distribution systems” (2005-09)

[2] ETSI EN 302 307 v1.1.2: "Digital Video Broadcasting (DVB); Second generation framing structure, channel coding and modulation systems for Broadcasting, Interactive Services, News Gathering and other broadband satellite applications" (2006-06)

3 Abbreviations

8PSK	8-ary Phase Shift Keying
16APSK	16-ary Amplitude and Phase Shift Keying
32APSK	32-ary Amplitude and Phase Shift Keying
ACM	Adaptive Coding and Modulation
ASI	Asynchronous Serial Interface
ASIC	Application Specific Integrated Circuit
BB	BaseBand
BBF	BaseBand Frame
BCH	Bose-Chaudhuri-Hocquenghem multiple error correction binary block code
BER	Bit Error Rate
CCM	Constant Coding and Modulation
CNI	Carrier to Noise plus Interference ratio
CRC	Cyclic Redundancy Check
CTB	Common Test Bed for DVB-RCS Terminals
DFL	Data Field Length
DVB	Digital Video Broadcast
DVB-S2	Digital Video Broadcast via Satellite, 2nd Generation, as specified in EN 302 307
EN	European Norm
FEC	Forward Error Correction
GS	Generic Stream
IF	Intermediate Frequency
IRD	Integrated Receiver and Demodulator
LDPC	Low Density Parity Check (codes)
LNB	Low Noise Block
LP	Low Priority
LSB	Least Significant Bit
MA	Mode Adaptation
MCT	MODCOD and frame Type
MPEG	Motion Pictures Expert Group
MSB	Most Significant Bit
NCR	Network Clock Reference
ODU	Outdoor Unit
PCR	Program Clock Reference
PID	Packet Identifier
PL	Physical Layer
QPSK	Quadrature Phase Shift Keying
RCS	Return Channel via Satellite
RCST	Return Channel via Satellite Terminal
RF	Radio Frequency
RX	Reception
SA	Stream Adaptation
SNR	Signal to Noise Ratio
SOF	Start Of Frame
TS	Transport Stream
UP	User Packet
UPL	User Packet Length
VCM	Variable Coding and Modulation

4 System architecture

According to [2] and Figure 4-1 (modified from [2]), the DVB-S2 System shall be composed of a sequence of functional blocks as described below.

Mode Adaptation shall be application dependent. It shall provide input stream interfacing, Input Stream Synchronisation (optional), null-packet deletion (for ACM and Transport Stream input format only), CRC-8 coding for error detection at packet level in the receiver (for packetised input streams only), merging of input streams (for Multiple Input Stream modes only) and slicing into DATA FIELDs. For Constant Coding and Modulation (CCM) and single input Transport Stream, Mode Adaptation shall consist of a “transparent” DVB-ASI (or DVB-parallel) to logical-bit conversion and CRC-8 coding. For Adaptive Coding and Modulation (ACM), Mode Adaptation shall be according to [2]-annex D.
A Base-Band Header shall be appended in front of the Data Field, to notify the receiver of the input stream format and Mode Adaptation type. To be noted that the MPEG multiplex transport packets may be asynchronously mapped to the Base-Band Frames.

For applications requiring sophisticated merging policies, in accordance with specific service requirements (e.g. Quality of Service), Mode Adaptation may optionally be performed by a separate device, respecting all the rules of the DVB-S2 specification. To allow standard interfacing between Mode and Stream Adaptation functions, an optional modulator interface (Mode adaptation input interface) is defined in the following sections, as L.1 (separate signalling circuit) in 5.1 or L.2 (in-band signalling) in 5.2.

Mode Adaptation shall be a sequence of Data Fields (according to clause [2]-5.1.5), where each individual Data Field is preceded by a BBHEADER, according to clause [2]-5.1.6 and to [2]-Figure 3, and Stream Adaptation Command, according to 5.1, to allow setting, by an external “mode adaptation unit”, of the transmission parameters to be adopted by the DVB-S2 modulator, for each specific MA Packet. Mode Adaptation shall be according to 5.1 (separate signalling circuit) or 5.2 (in-band signalling).

For receiver systems the Receiver Adaptation protocols, L.3 (serial) or L.4 (parallel) are specified in sections 5.3 and 5.4 respectively, as optional interfaces between the receiver/demodulator and the baseband subsystem.

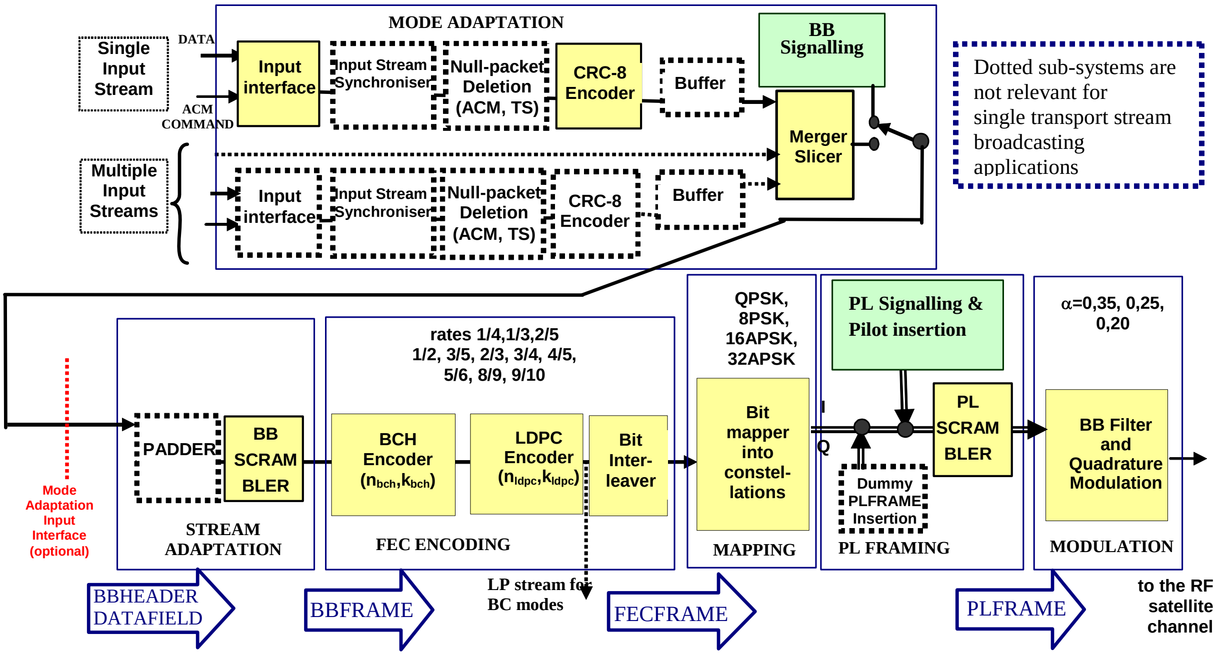

Figure 4-1: Functional block diagram of the DVB-S2 System

5 Mode Adaptation Interfaces Definition

5.1 L.1: Mode Adaptation input interface with separate signalling circuit

Mode Adaptation optional input interface (see Figure 4-1) shall allow implementing the merging of multiple input streams by an external “Mode Adaptation Unit”, respecting all the rules of the DVB-S2 specification. To allow to vary the transmission parameters to be adopted by the DVB-S2 modulator, it shall also transport the ACM command associated to each specific Data Field.

According to Figure 3 Mode Adaptation shall be a sequence of Data Fields (according to clause [2]-5.1.5), where each individual Data Field is preceded by a BBHEADER, according to clause [2]-5.1.6 and to [2]-Figure 3, and a Stream Adaptation command (SA command), transporting the transmission parameters to be adopted by the DVB-S2 modulator for each specific Data Field and corresponding BBHEADER.

“SA Command” (similar to the ACM command format, see clause [2]-D.1) shall carry the following information:

- MODCOD (5 bits, according to [2]-table 12)
- TYPE (2 bits, according to clause [2]-5.5.2.3)
- CVALID (Command Valid)
- SEND (end of MA Packet)

The CVALID=active indicates the start of a MA Packet (MSB of the BB Header).

The transmission format specified by MODCOD and TYPE shall be applied to MA Packet received after CVALID=active and before SEND=active. When SEND=active, the modulator shall deliver user data immediately, even if a FECFRAME is not completed, by inserting the PADDING field (see clause [2]-5.2.1). The user data included in the interval between CVALID=active and SEND=active shall not exceed the capacity of (K_{bch}-80) bits, K_{bch} being the transmittable bits associated with a specific MODCOD and TYPE.

An example temporisation of SA Command is given in Figure 5-1, using a single serial interface to convey MODCOD, TYPE, CVALID (active= high-to-low transition) and SEND (active= low-to-high transition).

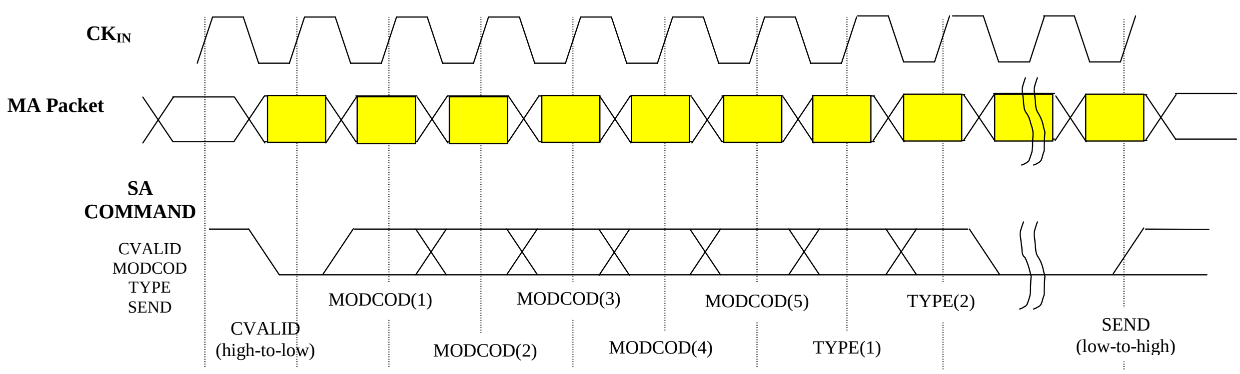

Figure 5-1: Example timing of SA Command (serial format)

5.2 L.2: Mode Adaptation input interface with in-band signalling

Alternatively to L.1, the SA command can be mapped into a Transport Header to be prepended to the data generated by the external Mode Adaptation Unit. As shown on Figure 5-2, Mode Adaptation shall be a sequence of Data Fields (according to clause [2]-5.1.5), where each individual Data Field is preceded by a BBHEADER, according to clause [2]-5.1.6, and a Transport Header.

The Transport Header shall consist of 2 bytes as illustrated in Figure 5-2 and defined in Table 5-1. The first byte identifies the start of the Mode Adaptation packet and shall contain the sequence 0xB8. The second byte shall indicate the ACM command, defining the dynamic transmission parameters (MODCOD, TYPE) for the BBFRAME, according to Table 5-2.

The BBFRAME shall consist of a valid BBHEADER, followed by the payload with length DFL, without padding bytes.

Stream Adaptation shall synchronise to the baseband frames (using the 0xB8 sync marker and the DFL field inside the BBHEADER.

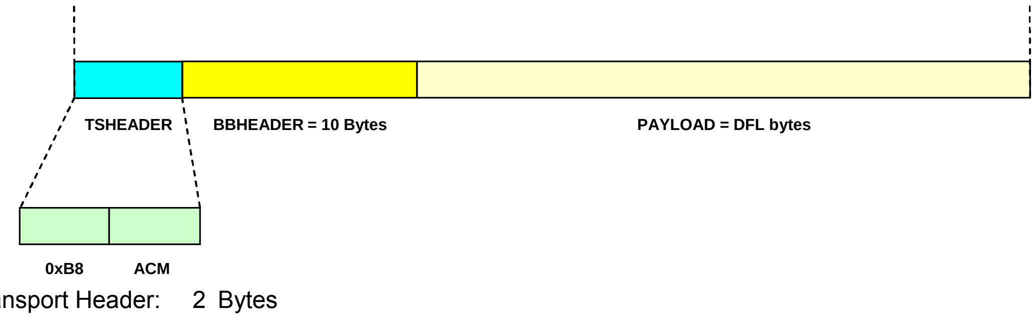

Figure 5-2: Mode Adaptation format at the Mode Adaptation input interface

Table 5-1: Transport Header format

Byte	Contents	Description
Byte 0	0xB8 sync marker	For BBF synchronisation
Byte 1	ACM command byte	Defines modcod, frametype and pilot insertion

Table 5-2: ACM command byte definition (acm[0] is the least significant bit)

Bit fields	Description
Acm[4:0]	MODCOD (as defined in [2]-Table 12)
Acm[5]	pilots configuration (0 = no pilots, 1 = pilots)
Acm[6]	FECFRAME sizes (0 = normal: 64 800 bits; 1 = short: 16 200 bits)
Acm[7]	reserved bit (set to 0)

5.3 L.3: Receiver Adaptation serial output interface with in-band signalling

For VCM/ACM applications it may be useful to divide a receiver implementation into a demodulation/decoding device and a baseband processing device. This section defines an interface between these two elements by including the frame header and ACM quality measurement information as in-band signalling information.

The protocol is intended for DVB ASI or Ethernet interfaces.

The received and demodulated data can be mapped into a Receiver Header to be prepended to the data demodulated and decoded by the Integrated Receiver and Demodulator (IRD). As shown on Figure 5-3, Receiver Mode Adaptation according to this section shall be a sequence of Data Fields (according to clause [2]-5.1.5), where each individual Data Field is preceded by a BBHEADER, according to clause [2]-5.1.6, and a Receiver Header.

The Receiver Header shall consist of 4 bytes as illustrated in Figure 5-3 and defined in Table 5-3. The first byte identifies the start of the Receiver Adaptation packet and shall contain the sequence 0xB8. The second byte shall indicate the received ACM command, defining the dynamic transmission parameters (MODCOD, TYPE) for the BBFRAME. The third byte shall contain the SNR measurement. The fourth byte shall contain a frame number which identifies the pairing of the frame content and its corresponding SOF marker, as described in [2]-Annex G.5.

The BBFRAME shall consist of a valid BBHEADER, followed by the payload with length DFL, without padding bytes.

The Receiver Adaptation shall synchronise to the baseband frames by using the 0xB6 sync marker and the DFL field inside the BBHEADER.

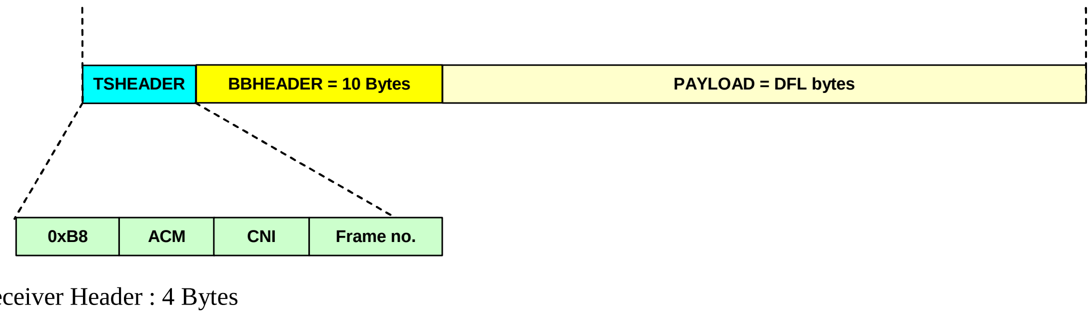

Figure 5-3: Mode Adaptation format at the Receiver Adaptation output interface

Table 5-3: Receiver Header format

Byte	Contents	Description
0	SYNC	**For BBFRAME synchronisation** 0xB8
1	ACM command byte (MCT)	**ACM command byte** Received MODCOD and frame type **Bit 0:** Not used, set to 0 **Bit 1:** TYPE(0) - pilots configuration (0 = no pilots, 1 = pilots) **Bit 2:** TYPE(1) - FECFRAME sizes (0 = normal; 1 = short) **Bit 3-7:** MODCOD
2	CNI (SNR)	**This 8-bit sub-field contains the measured Carrier to Noise plus Interference ratio for the frame as defined in clause 5 of [1].** The SNR estimate shall have the following performance: **Rate:** Once per RX frame **Size:** Unsigned byte **Resolution:** 0.125 dB/LSB **Accuracy:** σ<0.5 dB @ BER ≤ 10^{-6}, 16 kbit frame, static conditions **Range:** -1.0 … 30.75 dB **Coding:** 0: modem unlocked, SNR not available 1: -1.0 dB 2: -0.875 dB … 254: 30.625 dB 255: ≥ 30.75 dB **Bit 0:** LSB **Bit 7:** MSB
3	Frame number (PL FRAME ID)	Modulo-256 physical-layer frame counter. This counter increments each time a PLHEADER is received / detected. Bit 0: PL Frame ID(0) LSB Bit 1: PL Frame ID(1) Bit 2: PL Frame ID(2) Bit 3: PL Frame ID(3) Bit 4: PL Frame ID(4) Bit 5: PL Frame ID(5) Bit 6: PL Frame ID(6) Bit 7: PL Frame ID(7) MSB

5.4 L.4: Receiver Adaptation parallel output interface with in-band signalling

For VCM/ACM applications it may be useful divide a receiver implementation into a demodulation/decoding device and a baseband processing device. This section defines an interface between these two elements by including the frame header and ACM quality measurement information as in-band signalling information.

The protocol is intended for applications such as interfaces between boards within a receiver enclosure or for connecting the output from a demodulator ASIC to further processing devices.

The received and demodulated data can be mapped into a Receiver Header to be prepended to the data demodulated and decoded by the Integrated Receiver and Demodulator (IRD). According to Figure 5-4, Receiver Mode Adaptation according to this section shall be a sequence of Data Fields (according to clause [2]-5.1.5), where each individual Data Field is preceded by a BBHEADER, according to clause [2]-5.1.6, and a Receiver Header.

The Receiver Header shall consist of 3 bytes as illustrated in Figure 5-4 and defined in Table 5-4. The first byte shall indicate the received ACM command, defining the dynamic transmission parameters (MODCOD, TYPE) for the BBFRAME. The second byte shall contain the SNR measurement. The fourth byte shall contain a frame number which identifies the pairing of the frame content and its corresponding SOF marker, as described in [2]-Annex G.5.

The BBFRAME shall consist of a valid BBHEADER, followed by the payload with length DFL, without padding bytes.

Data and synchronisation information is carried on a number of parallel interface signals. The data itself can be bit-serial or bit-parallel, byte-serial. Additional interface signals include PACKET_SYNC, which marks the start of a delivered frame, ENABLE, which indicates when data are valid, and a clock signal. An example timing diagram is shown in Figure 5-5.

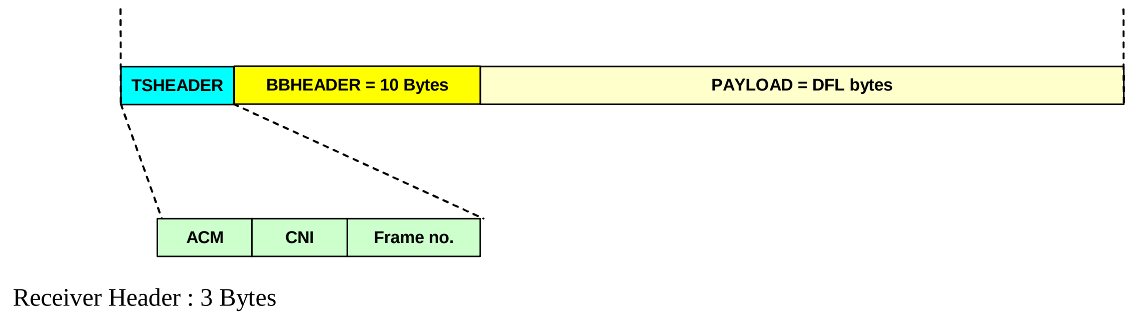

Figure 5-4: Mode Adaptation format at the Receiver Adaptation output interface

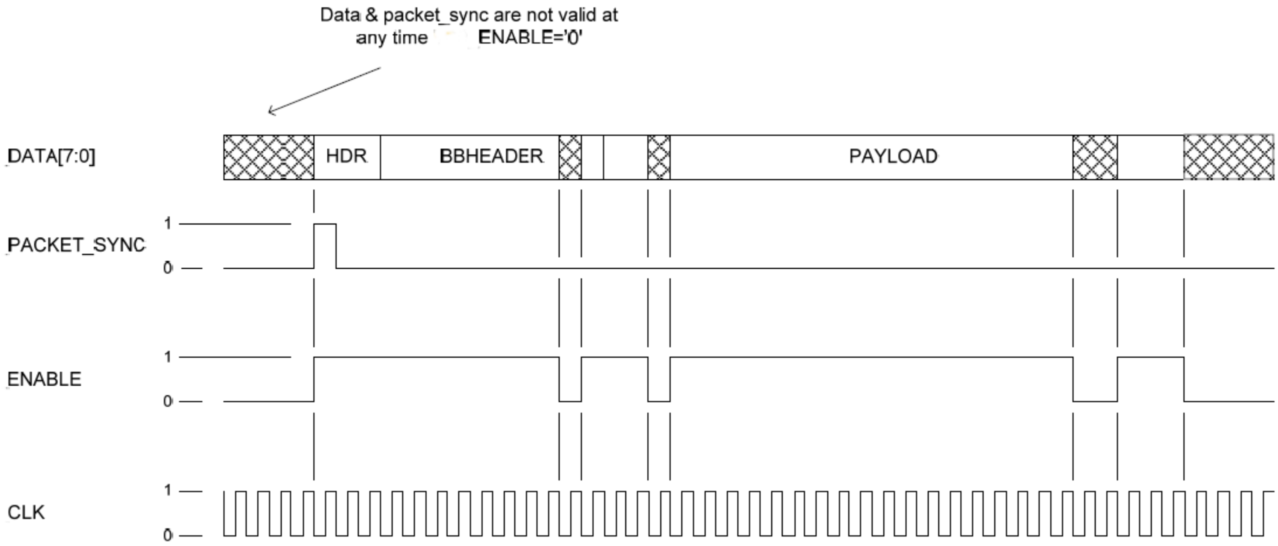

Figure 5-5: Example timing of parallel interface

Table 5-4: Receiver Header format

Byte	Contents	Description
0	ACM command byte (MCT)	**ACM command byte** **Received MODCOD and frame type** **Bit 0**: Not used, set to 0 **Bit 1**: TYPE(0) - pilots configuration (0 = no pilots, 1 = pilots) **Bit 2**: TYPE(1) - FECFRAME sizes (0 = normal; 1 = short) **Bit 3-7**: MODCOD
1	CNI (SNR)	**This 8-bit sub-field contains the measured Carrier to Noise plus Interference ratio for the frame as defined in clause 5 of [1].** The SNR estimate shall have the following performance: **Rate**: Once per RX frame **Size**: Unsigned byte **Resolution**: 0.125 dB/LSB **Accuracy**: σ<0.5 dB @ BER ≤ 10^{-6}, 16 kbit frame, static conditions **Range**: -1.0 … 30.75 dB **Coding**: 0: modem unlocked, SNR not available 1: -1.0 dB 2: -0.875 dB … 254: 30.625 dB 255: ≥ 30.75 dB **Bit 0**: LSB **Bit 7**: MSB
2	Frame number (PL FRAME ID)	Modulo-256 physical-layer frame counter. This counter increments each time a PLHEADER is received / detected. **Bit 0**: PL Frame ID(0) LSB **Bit 1**: PL Frame ID(1) **Bit 2**: PL Frame ID(2) **Bit 3**: PL Frame ID(3) **Bit 4**: PL Frame ID(4) **Bit 5**: PL Frame ID(5) **Bit 6**: PL Frame ID(6) **Bit 7**: PL Frame ID(7) MSB