**802.15.4 FRAMES**

**PHY Frame**

|  |  |  |
| --- | --- | --- |
| Number of bytes | Field Name | Explanation |
| 4 | Synch Header | Preamble (All zeros ) |
| 1 | PHY Header | Least significant 7 bits frame length |
|  | PHY Payload (PSDU) | |

**MAC Frame**

|  |  |  |
| --- | --- | --- |
| Number of bytes | Field Name | Explanation |
| 2 | Frame Control |  |
| 1 | Sequence Number |  |
| 0/2 | Destination PAN Identifier |  |
| 0/2/8 | Destination Address |  |
| 0/2 | Source PAN Identifier |  |
| 0/2/8 | Source Address |  |
| 0/5/6/10/14 | Auxiliary Security Header |  |
|  | PAYLOAD |  |
| 2 | FCS | Frame Check Sequence |
| 5 <=Header Length <=25 |  |  |

Frame Control

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Bits 0-2 | 3 | 4 | 5 | 6 | 7-9 | 10-11 | 12-13 | 14-15 |
| Frame Type | Security Enabled | Frame Pending | Ack Request | PAN ID Compression | Reserved | Dest. Addressing Mode | Frame Version | Source Addressing Mode |

Frame Type

|  |  |
| --- | --- |
| Frame Type Value | Description |
| 000 | Beacon |
| 001 | Data |
| 010 | Acknowledgement |
| 011 | MAC Command |
| 100-111 | Reserved |

Dest/Source Address Mode

|  |  |
| --- | --- |
| Destination Address Mode | Description |
| 00 | PAN Identifier and address fields are not present |
| 01 | Reserved |
| 10 | Address field contains 16 bit short address |
| 11 | Address field contains 64 bit extended address |

**FCS**

16 bits

ITU-T CRC computed over MHR and Payload

G16(x) = x16+x12+x5+1

Computation

1. Given M(x) = b0 xk-1+ b1 xk-2+ b2 xk-3+ b3 xk-4+ b4 xk-5+………..
2. Multiply M(x) by x16
3. Divide M(x).x16  by the generator polynomial G16(x) using modula 2 division
4. Compute the remainder R(x)
5. The FCS field is given by the remainder coefficients

Four Frame Types

* Beacon
* Data
* Acknowledgement
* MAC Command

**Beacon Frame Format**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Octets: 2 | 1 | 4/10 | 2 | variable | variable | variable | 2 |
| Frame Control | Sequence Number | Addressing Fields (only source) | Superframe specification | GTS fields | Pending address fields | Beacon Payload | FCS |
| MAC Header | | | MAC Payload | | | | MAC Footer |

GTS Fields (Guaranteed Time Slot)

|  |  |  |
| --- | --- | --- |
| Octets : 1 | 0/1 | Variable |
| GTS Specification | GTS Directions | GTS List |
| Bits 0-2 : GTS Descriptor count  Bits 3-6 : Reserved  Bit 7 : GTS Permit |  | Each GTS descriptor is 4 bytes |

GTS Decriptor

|  |  |  |
| --- | --- | --- |
| Bits 0-15 | 16-19 | 20-23 |
| Device short address | GTS Starting slot | GTS Length |
|  | The superframe slot at which GTS is to begin | Number of contiguos superframe slots over which GTS is active |

Pending Address Specification

|  |  |
| --- | --- |
| Octets 1 | Variable |
| Pending address specification | Address list |
| Bits : 0-2 Number of short addresses pending  Bit 3 reserved  Bits 4-6 Number of extended addresses pending  Bit 7 Reserved | List of addresses of devices that currently have messages pending with the coordinator  Maximim number of addresses pending is limited to 7  Pending short addresses will appear first followed by extended addresses |

Superframe Specification

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Bits 0-3 | 4-7 | 8-11 | 12 | 13 | 14 | 15 |
| Beacon Order | Superframe Order | Final CAP slot | Battery life extension | Reserved | PAN Coordinator | Association Permit |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Tramission interval of beacon  BI= SuperframeDuration \* 2BO  If BO = 15 , coordinator will not transmit frames except when requested |  |  |  |  |  |  |

**DATA Frame**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Octets : 2 | 1 |  | 0/5/6/10/14 | Variable | 2 |
| Frame Control | Sequence Number | Addressing Fields | Auxiliary Security Header |  | FCS |
|  |  |  |  | Mac Payload | MFR |

**Ack Frame Format**

|  |  |  |
| --- | --- | --- |
| Octets : 2 | 1 | 2 |
| Frame Control | Sequence Number | FCS |
| MHR | | MFR |

**MAC Command Frames**

While FFD is capable of receiving and transmitting all frame types, RFD is capable of certain frame types as indicated below.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Command Frame ID | Command Name | RFD | |  |
| Tx | Rx |
| 0x01 | Association Request | X |  |  |
| 0x02 | Association Response |  | X |  |
| 0x03 | Disassociation Notification | X | X |  |
| 0x04 | Data Request | X |  |  |
| 0x05 | PAN ID conflict notification | X |  |  |
| 0x06 | Orphan notification | X |  |  |
| 0x07 | Beacon Request |  |  |  |
| 0x08 | Coordinator realignment |  | X |  |
| 0x09 | GTS Request |  |  |  |
| 0x0a-0xff | Reserved |  |  |  |
|  |  |  |  |  |

**Association Request**

|  |  |  |
| --- | --- | --- |
| Octets | 1 | 1 |
| MHR Fields | Command Frame Identifier | Capability Information |
| Source addressing field set to extended (64 bit)  Dest addressing set to mode indicated in beacon  Frame pending set to zero  Ack request set to 1  Dest PAN Identifier contains the PAN ID or the network  Source PAN ID will contain 0xffff  Source address shall contain the value of aExtendedAddress |  | Bit 0: Alternate PAN coordinator  Bit 1 : Device type  Bit 2: Power source (1 is device connected to power source)  Bit 3: Receiver on when idle  Bits 4-5 : reserved  Bit 6 : Security capability  Bit 7 : allocate address (will be set to one if the device would like to have a 16 bit address allocated upon association) |

**Association Response**

|  |  |  |  |
| --- | --- | --- | --- |
| Octets | 1 | 2 | 1 |
| MHR fields | Command frame identifier | Short address | Association status |
| Source and dest addressing modes set to extended addressing  PAN ID compression field will be set to 1. |  |  | 0x00 association successful  0x01 PAN at capacity  0x02 PAN access denied  0x03 – 0x7f reserved  0x80 – 0xff reserved |

**Disassociation notification**

|  |  |  |
| --- | --- | --- |
| Octets | 1 | 1 |
| MHR Fields | Command Frame identifier | Disassociation Reason |
|  |  | 0x00 Reserved  0x01 The coordinator wishes the device to leave the PAN  0x02 The device wishes to leave PAN  0x03 - 0x7F reserved  0x80 – 0xFF Reserved |

**Data Request Command**

|  |  |
| --- | --- |
| Octets | 1 |
| MHR Fields | Command Frame Identifier |

**PAN ID Conflict Notification**

|  |  |
| --- | --- |
| Octets | 1 |
| MHR Fields | Command Frame Identifier |

**Orphan Notification**

|  |  |
| --- | --- |
| Octets | 1 |
| MHR Fields | Command Frame Identifier |

**Beacon Request Command**

|  |  |
| --- | --- |
| Octets | 1 |
| MHR Fields | Command Frame Identifier |

**Coordinator Realignment Command**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Octets | 1 | 2 | 2 | 1 | 2 | 0/1 |
| MHR Fields | Command Frame Identifier | PAN Identifier | Coordinator short address | Logical channel | Short address | Channel Page |

**GTS Request Command**

|  |  |  |
| --- | --- | --- |
| Octets : 7 | 1 | 1 |
| MHR Fields | Command frame identifier | GTS Characteristics |
|  |  | Bits 0-3 : GTS length  Bit 4 : GTS Direction  Bit 5 : Characteristic type  Bits 6-7 : Reserved |

