

DHE/DHC Data Formats

v. 0.4.38

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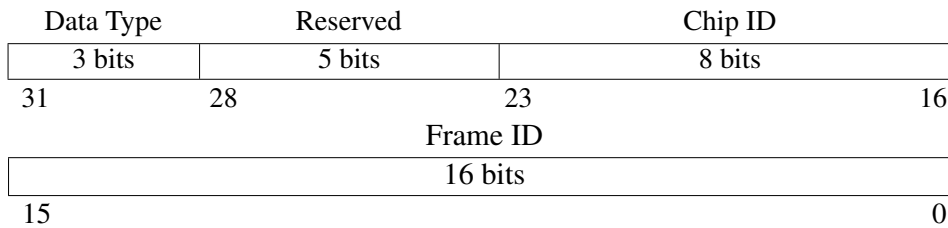
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1 DHP Data Formats[1]

1.1 Frame Header

- Frame Header(32 bit):



– Data Type:

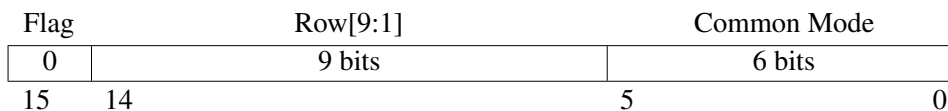
- * "000": raw data
- * "101": zero suppressed data

– Chip ID: Global chip ID

- * [7:2]: DHE ID
- * [1:0]: DHP ID

1.2 Zero Suppressed Format

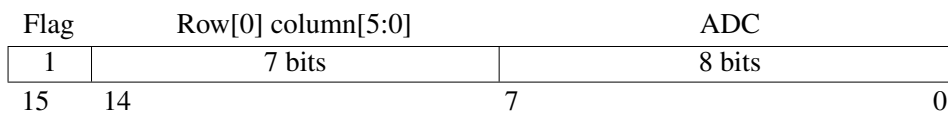
- Frame Header
- Start of Row(SOR, Row Header):



– Flag:

- * "0": Row header

- Data Word:

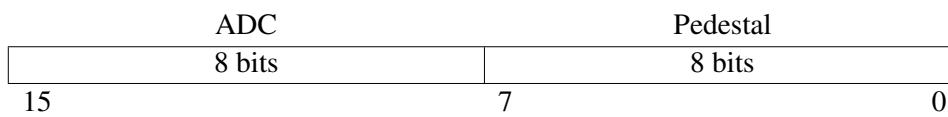


– Flag:

- * "1": Data word

1.3 Raw Data Format

- Frame Header
- Data Word (Format depends on the value of the **send_buf_data_only** register):
 - **send_buf_data_only = "0"**: Total memory content of the DHP is read. Data words contain information on the pedestal and the ADC.



- **send_buf_data_only = "1"**: Only ADC values are read.



2 DHC Data Formats

2.1 Overview

In following the sequence of the frames in a DHC sub-event will be described. Payload data that belongs to the same trigger is encapsulated by the DHE into Start-of-Event (SOE) frame and DHE End-of-Event (EOE) first. Then the frames from several DHE (up to five) is used to build sub-events in the DHC. This sub-event are still encapsulated into Start-of-Sub-Event (SOSE) and End-of-Sub-Event (EOSE) frames in the DHC and are ready to be transmitted to the ONSSEN hardware. The number of the payload frames is defined by the type of the payload and the configuration of the read-out hardware. The order of the DHE events in a sub-event is fixed.

An example of a sub-event is given below:

DHC SOSE
DHE 0 SOE
Payload Frame 0
...
Payload Frame N
DHE 0 EOE
...
DHE M SOE
Payload Frame 0
...
Payload Frame N
DHE M EOE
DHC EOSE

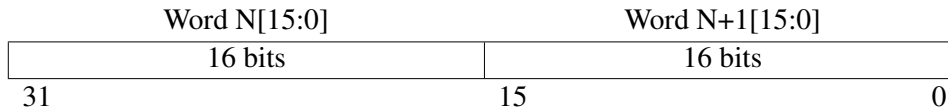
2.2 Data Transmission Protocol

Data is transmitted over 4 bytes Aurora 8b/10b protocol with framing interface and immediate native flow control(NFC). Frame boundaries are indicated by the SOF_N and EOF_N signals of the aurora interface.

2.2.1 Words Order

Data inside of DHE is converted from 16b wide interface for data received from the DHP to the 32b wide interface for further data processing. Since there are two ways of arranging 16b words inside of the 32b words the clear order of the 16b words has to be defined. The natural way of defining the word arrangement in the

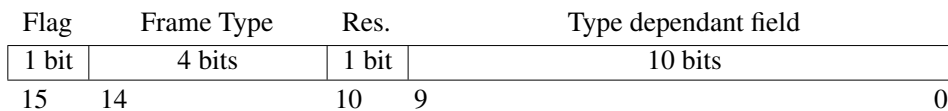
transmitted data is to take the byte ordering of the Aurora 8b/10b protocol. In this protocol bytes are arranged in the order MSB first.



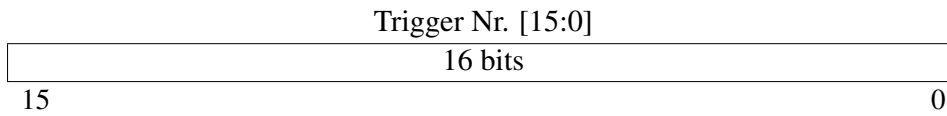
2.3 Frame Formats

2.3.1 Frame Header

- Word 0:



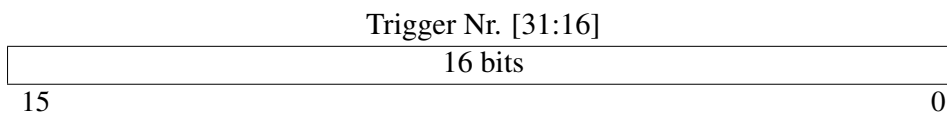
- **Flag:** Error flag
 - **Data Type:** Format of the data in the frame body
 - * "0000": DHE frame in DHP raw data format
 - * "0101": DHE frame in zero suppressed DHP data format
 - * "0001": DHE FCE output data format
 - * "0110": DHE Common mode frame format
 - * "0010": DHE "Ghost" data frame
 - * "0011": DHE Start of Event frame format
 - * "0100": DHE End of Event frame format
 - * "1011": DHC Start of Event frame format
 - * "1100": DHC End of Event frame format
 - * "1101": Zero suppressed ONSSEN data format
 - * "1001": ONSSEN FCE format
 - * "1110": ONSSEN trigger format
 - * "1111": ONSSEN ROIs format
 - **Res.:** Reserved.
 - **Type dependant field:** field description varies depending on the frame type.
- Word 1, frame tag:



- **Trigger Nr. [15:0]:** Two lower bytes of the Trigger Nr. used for fast event identification

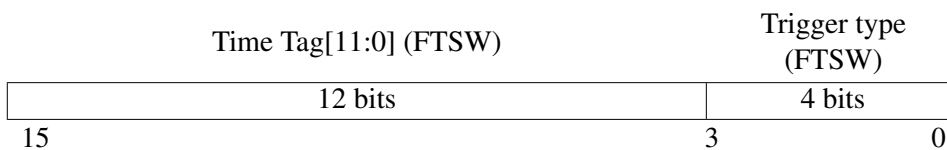
2.3.2 DHC Start of Sub-Event Frame

- Frame Header Word 0
 - **Data Type:** "1011"
 - **Type dependant field:**
 - * field[4:0]: Mask of the active DHE channels connected to this DHC.
 - * field[8:5]: DHC ID
 - * field[9]: Reserved
- Frame Header Word 1
- Trigger Nr. [31:16]:

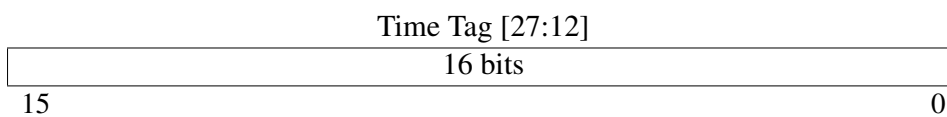


- **Trigger Nr. [31:16]:** Two upper bytes of the Trigger Nr.

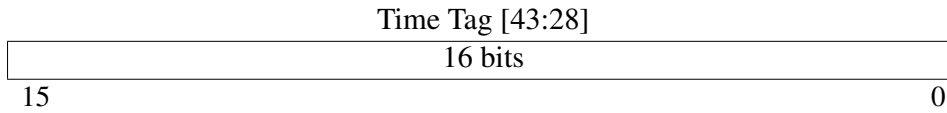
- Time Tag[11:0] (FTSW) and Trigger type (FTSW)



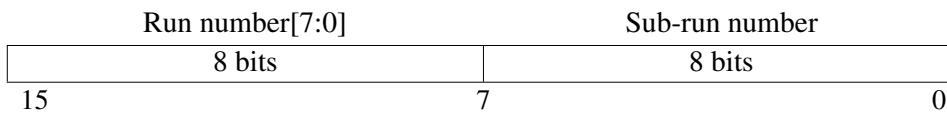
- Time Tag [27:12] (FTSW):



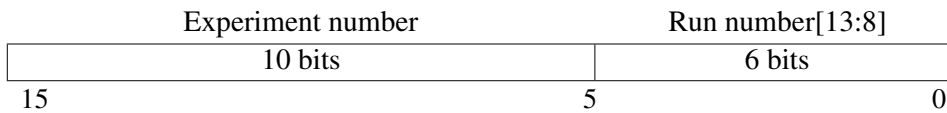
- Time Tag [43:28] (FTSW):



- 32b Experiment Run
 - ExpRun[7:0]: Sub-run number
 - ExpRun[21:8]: Run number
 - ExpRun[31:22]: Experiment number
 - Experiment Run [15:0]



- Experiment Run [31:16]



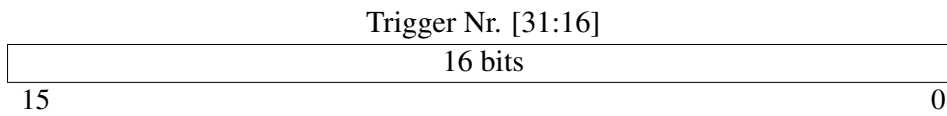
- 32b CRC16 Ethernet/AAL5 Hash

2.3.3 DHE Start of Event Frame

- Frame Header Word 0
 - **Reformatted** Flag
 - * **0**: Pixel coordinates not changed
 - * **1**: Pixel coordinates changed
 - **Data Type**: "0011"
 - **Type dependant field**:
 - * field[3:0]: Mask of the active DHP channels connected to this DHE.
 - * field[9:4]: DHE ID

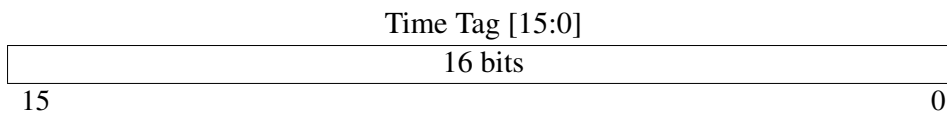
- DHEID[5] - layer (1 for inner (**b"0"**), 2 for outer (**b"1"**))
- DHEID[4-1] - ladder number (1-8 for inner, 1-12 for outer)
- DHEID[0] - sensor (1 for forward (**b"0"**), 2 for backward (**b"1"**))

- Frame Header Word 1
- Trigger Nr. [31:16]:

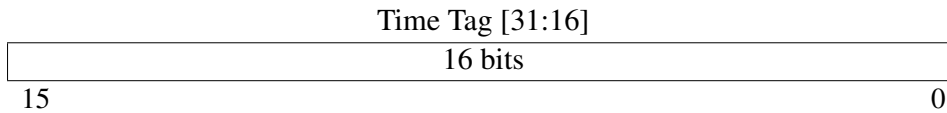


– **Trigger Nr. [31:16]**: Two upper bytes of the Trigger Nr.

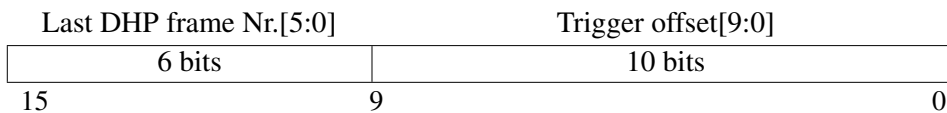
- Time Tag [15:0] (DHE timer):



- Time Tag [31:16] (DHE timer):



- Trigger position in respect to start of frame strobe (FCK) and 6 lower bits of the last DHP frame number before trigger



- 32b CRC16 Ethernet/AAL5 Hash

2.3.4 Common Mode Frame

- Frame Header Word 0
 - **Data Type:** "0110"
 - **Type dependant field:**
 - * field[3:0]: Reserved.
 - * field[9:4]: DHE ID
 - DHEID[5] - layer (1 for inner (**b"0"**), 2 for outer (**b"1"**))
 - DHEID[4-1] - ladder number (1-8 for inner, 1-12 for outer)
 - DHEID[0] - sensor (1 for forward (**b"0"**), 2 for backward (**b"1"**))
- Frame Header Word 1
- 96 Data Words:

Counter	Mask	CM1	CM0
2 bits	2 bits	6 bits	6 bits
15	13	11	5
			0

- **Counter:** 2 bit counter used for consistency checks
 - **Mask:** mask for the common mode words
- 32b CRC16 Ethernet/AAL5 Hash

2.3.5 FPGA Clustering Engine (FCE) Output Frame (New DHE Clustering Format)

- Frame Header Word 0
 - **Data Type:** "0001"
 - **Type dependant field:**
 - * field[3:0]: Reserved
 - * field[9:4]: DHE ID
 - DHEID[5] - layer (1 for inner (**b"0"**), 2 for outer (**b"1"**))
 - DHEID[4-1] - ladder number (1-8 for inner, 1-12 for outer)
 - DHEID[0] - sensor (1 for forward (**b"0"**), 2 for backward (**b"1"**))
- Frame Header Word 1

- Start Of Row
 - SOR[15]: '0' Start of Row flag
 - SOR[14]: Start of Cluster flag
 - SOR[13:12]: dE/dx information (to be filled by the Karlsruhe group)
 - SOR[11:10]: DHP index
 - SOR[9:0]: Row Address
- Pixel word
 - PW[15]: '1' Pixel word flag
 - PW[14]: Increment row flag. '1' - Increment row address, '0' - keep row address
 - PW[13:8]: Column address
 - PW[7:0]: ADC value

2.3.6 Direct Readout Frame

- Frame Header Word 0
 - **Data Type:**
 - * "0000": DHP raw data format
 - * "0101": zero suppressed DHP data format
 - **Type dependant field:**
 - * field[1:0]: DHP(T) Link ID
 - * field[3:2]: Reserved
 - * field[9:4]: DHE ID
 - DHEID[5] - layer (1 for inner (**b"0"**), 2 for outer (**b"1"**))
 - DHEID[4-1] - ladder number (1-8 for inner, 1-12 for outer)
 - DHEID[0] - sensor (1 for forward (**b"0"**), 2 for backward (**b"1"**))
- Frame Header Word 1
- DHP Frame
- if **data type == "0101"** and **frame is not aligned to 32b** then put last SOR as last data word
- 32b CRC16 Ethernet/AAL5 Hash

2.3.7 “Ghost” Frame

- Frame Header Word 0
 - **Error flag:** "1"
 - **Data Type:** "0010"
 - **Type dependant field:**
 - * field[1:0]: DHP port
 - * field[3:2]: Reserved
 - * field[9:4]: DHE ID
 - DHEID[5] - layer (1 for inner (**b"0"**), 2 for outer (**b"1"**))
 - DHEID[4-1] - ladder number (1-8 for inner, 1-12 for outer)
 - DHEID[0] - sensor (1 for forward (**b"0"**), 2 for backward (**b"1"**))
- Frame Header Word 1
- 32b CRC16 Ethernet/AAL5 Hash

2.3.8 End of Event Frame

- Frame Header Word 0
 - **Error flag:**
 - * "1" error information is present
 - * "0" no errors in event
 - **Data Type:** "0100"
 - **Type dependant field:**
 - * field[3:0]: Reserved
 - * field[9:4]: DHE ID
 - DHEID[5] - layer (1 for inner (**b"0"**), 2 for outer (**b"1"**))
 - DHEID[4-1] - ladder number (1-8 for inner, 1-12 for outer)
 - DHEID[0] - sensor (1 for forward (**b"0"**), 2 for backward (**b"1"**))
- Frame Header Word 1
- Count of 16b words in previous frames of this event [31:0]
- Error information [31:0]
- 32b CRC16 Ethernet/AAL5 Hash

2.3.9 DHC End of Sub-Event Frame

- Frame Header Word 0
 - **Error Flag:**
 - * "1" error information is present
 - * "0" no errors in event
 - **Data Type:** "1100"
 - **Type dependant field:**
 - * field[4:0]: Reserved
 - * field[8:5]: DHC ID
 - * field[9]: Reserved
- Frame Header Word 1
- Count of 16b words in previous frames of this event [31:0]
- Error information [31:0]
- 32b CRC16 Ethernet/AAL5 Hash

2.4 Deprecated Frame Formats

2.4.1 FPGA Clustering Engine Input Frame (Preliminary)[2]

- Frame Header Word 0
 - **Data Type:** "101"
- Frame Header Word 1
- DHP Frames in zero suppressed mode without change
- 32b CRC16 Ethernet/AAL5 Hash

2.4.2 FPGA Clustering Engine (FCE) Output Frame with DHE Header(Preliminary)[2]

- Frame Header Word 0
 - **Data Type:** "0001"
 - **Type dependant field:**
 - * field[3:0]: Reserved

- * field[9:4]: DHE ID
 - DHEID[5] - layer (1 for inner (**b"0"**), 2 for outer (**b"1"**))
 - DHEID[4-1] - ladder number (1-8 for inner, 1-12 for outer)
 - DHEID[0] - sensor (1 for forward (**b"0"**), 2 for backward (**b"1"**))

- Frame Header Word 1
- Start of Cluster(SOC):

dE/dx	SOF SEL	Row Address	Column Address [7:4]
1 bit	0	10 bits	4 bits
15	14	13	3 0

- **dE/dx**: decision of the neuronal network, whether or not the cluster is produced by a slow pion
 - * **"1"**: Yes
 - * **"0"**: No
- Start of Frame / **Select (SOF SEL)**: "0"

- Cluster Member First(CM0):

Res.	SOF SEL	first next	column address [3:0]	Push	ADC
0	1	1	4 bits	1 bit	8 bits
15	14	13	12	8 7	0

- **Reserved**: "0"
- Start of Frame / **Select (SOF SEL)**: "1"
- **First/Next**: First cluster member: "1"
- **Push**: Push flag

- Cluster Member Next(CM1):

Res.	SOF SEL	first next	pop	rel2prev	Push	ADC
0	1	0	1 bit	3 bits	1 bit	8 bits
15	14	13	12	11	8 7	0

- **Reserved**: "0"

- Start of Frame / **Select (SOF SEL)**: "1"
 - First/**Next**: First cluster member: "0"
 - **Pop**: Pop flag
 - **Push**: Push flag
 - **Rel2prev**: relation to previous cluster member
- 32b CRC16 Ethernet/AAL5 Hash

References

- [1] M. Lemarenko, T. Kishishita, H. Kruger, and T. Hemperek, "DHP 0.2 manual."
- [2] D. Münchow, "PXD Data Formats and Status of Unpacker/Decoder."