

Pixel/SCT data format memo

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1 S-Link Package

Word	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
F	0xBOF00000																															
H1	0xEE1234EE (ROD Header Marker)																															
H2	0x00000009 (Header size)																															
H3	0x30100000 (format version 3.01)																															
H4	0x00								Sub Detector ID								Module ID															
H5	Run Type (0x00 for Physics)								Run Number																							
H6	ECR ID								Level 1 ID																							
H7	0x000000																Bunch Crossing ID															
H8	0x00000000																Trigger Type															
H9	Detector Event Type (Not used yet)																															
	ROD Data Word																															
T1	Error Status 1																															
T2	Error Status 2																															
T3	0x00000002 (Number of Status Words)																															
T4	ROD Data Word Count																															
T5	0x00000001 (Status Block Word)																															
F	0xEEF00000																															

Figure 1: 32 bits S-Link package.

Region	Layer	ID
Barrel	0	0x13
Barrel	1, 2	0x11
Endcap	0, 1, 2	0x12

(a)

Region	Side	ID
Barrel	A	0x21
Barrel	C	0x22
Endcap	A	0x23
Endcap	C	0x24

(b)

Figure 2: Sub-Detector ID definition for (a) Pixel and (b) SCT readout.

- Two frame words of S-Link, which are at the beginning of and the end of the sent data-set, are not recorded to files. They are used only for the S-Link communication.

- Number of S-Link Header words and Trailer words are fixed as shown in Figure 1, 9 words for Header and 5 words for Trailer.
- Definition of Sub-Detector IDs in H4 for Pixel and SCT readout is summarized in Figure 2.
- ROD Data words, which are discussed in Section 2 and Section 3, are located between S-Link Header and Trailer without any additional words.
- The total number of the ROD Data words are stored in T4 so that it can be cross-checked in decoding.

2 Pixel-ROD Data

The Pixel-ROD output words consist of series of data for individual FE readout modules that are connected to the ROD. As defined in Figure 3, the data consist of Header words ($[31 : 29] = 001$), Trailer words ($[31 : 29] = 010$), Hit words ($[31 : 29] = 100$), Error Words ($[31 : 29] = 000$), Raw Data ($[31 : 29] = 011$), and Timeout words ($[31 : 29] = 011$) [1]. In the most case, series of (1) Header words, (2) several Hit words, and (3) Trailer words are recorded, while Error words will be added only in case that errors are detected. The number of the Hit words depends on the read detector response after zero-suppression.

Word	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Header	001			P	0x00								BCID Offset				Skipped MMC				Level1 ID				BC ID							
Triler	010			Z	H	V	-																									
Hit	100			-	FE Number				Time over threshold value								-				Column				Row							
Error	000			1	FE Number				-		1	1	1	1	1	MCC Error Code								FE Error Code								
Raw data	011			28 bits Raw Data																												
Timeout	001			0																												

Figure 3: Data format for Pixel readout. The P, Z, H, and V in the tables represent error bits. The details of the error bit definition can be found in the Users Manual [1]. The “-” in the table represents bits are not defined (i.e. not taken care in encoding and decoding). “0” is set by RODs for these bits. **Note: differently from S-Link case, the ROD data word are not recorded in the order shown in the Table.**

- The highest-3 bits are used to identify types of words (Fragment ID).
- The Pixel hit information may be completed with a combination of the following information: Sub-Detector ID, Module ID (See Section 1), FE Number, Pixel Column, and Pixel Row.
- In the Users Manual [1], another error word that is named “Error Words Old” is defined, but not used in the 2011 data-taking (PROBABLY to be confirmed). Note that the additional error words is not shown in the table above.
- Raw Data words are not stored in data taken in 2011.

3 SCT-ROD Data

As Pixel-ROD, the SCT-ROD output words consist of series of data for individual FE readout modules that connected to the ROD. As define in Figure 4, the data consist of Header words ([15 : 13] = 001), Trailer words ([31 : 29] = 010), three Hit words ([15] = 1), Error words ([15 : 13] = 011), and Raw Data words ([15, 13] = 001). In decoding procedure, the hit words are separated from the other data words first by checking the highest-1 bits, and then the other words can be categorized by checking the highest-3 bits in decoding, since the fragment word length is different only for Hit words. The Hits words consists of three types, which are so-called “1st hit cluster expanded word” ([3] = 0), “1 hit cluster expanded word” ([3] = 1&[7] = 0), and “2 hit cluster expanded word” ([3] = 1&[7] = 1). The fist cluster data are given by the “1st hit cluster expanded word”, and the other are by “2 hit cluster expanded word” or “1 hit cluster expanded word”, which depends on number of remained clusters. So-called “Strip ID” is defined to be

$$\text{Strip} = \text{Chip ID} \times 128 + \text{Cluster Base Address}$$

for the fist cluster, and **it is incremented one by one for the following clusters**. The three Bunch Crossing SCT hit data are recorded around the Bunch Crossing pointed by the Level1 Trigger, and the Bunch Crossing occupancy for individual clusters are stored in three bits named Hit BC in the figure (BX−1, BX±0, BX+1).

Word	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Header	001			P	Level1 ID			ROB Link Number								
Triler	010			Z	H	V	-									
1st Hit	1	sid	Chip ID			Cluster Base Address						0	Hit BC			
Neighbering hit (1)	1	-						0	-			1	Hit BC (1)			
Neighbering hit (2)	1	-						1	Hit BC (2)			1	Hit BC (1)			
Error	011			-						FE Number			Error Code			
Raw Data	001			#bits			-		Raw Data							

Figure 4: Data format for SCT readout. The P, Z, H, and V in the tables represent error bits. The details of definition can be found in the Users Manual [1]. **Note: differently from S-Link case, the ROD data word are not recorded in the order shown in the Table.**

- The SCT has two type of readout, “condensed mode” and “expanded mode”, and **one of the two** is used. In the data taking 2012, the “expanded mode” is used. Note only words for the “expanded modes” are shown in the figure.
- In the offline calculation, the “Link Number” defined to be $((\text{ROB Link Number} \gg 4) \& 0x7) + (\text{ROB Link Number} \& 0xf)$ are used in offline decoding.
- **The highest bit of ROB Link Number are used to show the “Masked Off” states.** If the bits are asserted, it implies an error in the readout.
- Side bits ([14] bit in Hits words) represent for which of the two sub layers of SCT (with stereo angles) the cluster belongs to. The bits are used in searching the redundancy of

readout as well with respect to Link Number defined above. (Redundancy : In case one of the side loses the link between FE module and ROD, one of the other side will send data of both sides to the ROD.)

- Different from Pixel-Readout case, **the Trailer words may not follow all the Header, but only a part of them.** The rules for this is to be checked (probably due to hierarchy structure of readout).
- Raw Data words are not stored in data taken in 2011.

References

- [1] *ATLAS Silicon Readout Driver (ROD) Users Manual*
<http://www-eng.lbl.gov/~jmjoseph/Atlas-SiROD/Manuals/usersManual-v164.pdf>
- [2] *Pixel ROD Decoder*
<https://svnweb.cern.ch/trac/atlasoff/browser/InnerDetector/InDetEventCnv/PixelRawDataByteStreamCnv/trunk/src/PixelRodDecoder.cxx>
- [3] *SCT ROD Decoder*
https://svnweb.cern.ch/trac/atlasoff/browser/InnerDetector/InDetEventCnv/SCT_RawDataByteStreamCnv/trunk/src/SCT_RodDecoder.cxx