

Format of the read-out data of the DIF

Version **0.7**

The DIF developers

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1.1 Topology

A DIF is connected to **Nc** “ROC chains” each including **Nr** read-out chips (ROC). The data from the chips are sent in series. The TransmitON edges allow to separate the data from two different chips.

1.2 Amount of data

The maximum packet size sent to LDA is set to **DIF_MaxROPacket_Size** = 1 kB (512 x 16bits words).

For a chip version 2, the amount of raw data is $1 + \text{Nevt} + [1,2] * \text{Nch} * \text{Nevt}$ words.

Chip	Nevt	Nch	Size (words)
SKIROC 2	16	64	1 to 2065
SPIROC 2	16	36	
HARDROC 2	128	64	10

With full zero suppression the size would be a factor 5 to 10 less.

Case for ECAL	Nchip/DIF	Amount of DIF	Amount of packets (1 packet / chip / train)	Amount of packets (concatenated data, expectations)
EUDET	4 (112 long slab)	30	~150	~150
MODULE 0	128	150	~20000	~150 (one tower always hit)

ILD	128	7800	1 000 000	50 000 (0.04 occupancy), 10 000 (with full zero suppression)
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This table does not take the noise into account.

1.3 Data buffering

For each ROC chain, a FIFO in the DIF buffers the data coming from the chain: the data from all the ROC chips on any given chain is seen by its associated DIF buffer as a single flow of words.

For each of its ROC chains, the DIF slices that flow into so-called “DIF packets” that are sent to the upper level of the DAQ system (eg. LDA, DCC). Each of these DIF packets can be up to **DIF_MaxROPacket_Size** bytes in size. In particular, they can be shorter: for example, if the read-out of chips on the chain is finished before **DIF_MaxROPacket_Size** is reached, a smaller packet is sent.

The flow of ROC read-out data will be sliced regardless of the location where the packet split occurs: the split can happen between 2 words describing an event stored in a ROC for example.

The transmitON signal from the ROC chips allows to identify the correct data and to filter the Z state on the data bus as well as the switching from a chip to the next. This allows the DIF to recognize the basic structure of the flow of ROC read-out data on a chain, so that the DIF packets can have the format described hereafter.

A DIF packet is associated with a ROC chain, reported in the DIF packet header. Since a DIF manages several ROC chains, it generates several streams of DIF packets, which may be interleaved on the wire.

1.4 Packet content

1.4.1 Header

A read-out data signature (**packettype** field).

A **DifID** identifying the DIF on the LDA link (there might be more than 1 DIF per LDA link if a concentrator card is used), coded on 6 bits.

A **ChainID** encoded on 3 bits.

A **ROSequenceID** which counts the number of read-out sequences and uniquely identifies a batch of packets from the same acquisition period, on 12b. This ID periodically saturates and restarts from 0.

A **ROPacketID** which identifies a packet for a given chain, on 10 bits. The ROPacketID is reset to 0 each time a read-out sequence is started (ie. ROSequenceID incremented). This counter should not saturate for any given read-out sequence. **To be verified: 10b enough ?**

Option 1 (encapsulated):

Field	SubField	Comments
PACKETTYE (16b)		DIFBT_PKT_DATA = 0x"0001"
PACKETID (16b)		Arbitrary ID (automatic increment)
TYPEMODIFIER (16b)		0x0001
DATALENGTH (16b)		Number of 16b words in the DATA field
DATA	localDIFID (6b)+ ROPacketID (10b)	16b
	"0" + CHAINID (3b) + ROSequenceID (12b)	16b
	ROCDATA 1 to 505 x 16b words	Data block from ROC, w or w/o empty chips (a slice of DIF_MaxROPacket_Size – 7 words max)
CRC	16b	Inserted by 8b/10b itf

Option 2 (specific):

Field	Width	Comments
PACKETTYE	16 bits	DIFBT_PKT_DATA = 0x"0001"
localDIFID (6b)+ ROpacketID (10b)	16 bits	
"0" + CHAINID (3b)+ ROSequenceID (12b)	16 bits	
DATALENGTH	16 bits	Number of 16b words in the ROCDATA section
ROCDATA	1 to 507 x 16 bit words	Data block from ROC, w or w/o empty chips (a slice of DIF_MaxROPacket_Size - 5 words max)
CRC	16 bits	

1.4.2 Data

The ROCDATA field carries a slice of the read-out data flow coming from a ROC chain. By design, in each DIF packet, the maximum number of words dedicated to the ROCDATA field is **Choose option:** 505 for option 1, and 507 for option 2.

The format of the whole sequence of slices, once reassembled, is made up of the following 2 parts:

- A sequence of **ROC read-out blocks**
- A **ROSummary** (16-bit word) which marks the end of this read-out sequence
- A series of optional **ROOptions** words, whose format is application-dependent

The ROSummary word is **always sent**, even when the sequence of ROC read-out blocks is empty (eg. in case of zero-suppression [if applicable], or early stop-readout command).

1.4.2.1 ROC read-out blocks

Each ROC read-out block in the sequence describes a variable number of events (Nevent), as recorded by the ROC. Its format is derived from, but not identical to, a raw read-out data sent by a ROC:

Field	Comments
ChipData Raw read-out data for the Chip Contains ENERGY + TDC [if applicable] + BXID values Format and size depends on the chip type size and Nevent, but <u>must be multiple of 16bits</u>	Derived from the read-out data block coming from the chip
"11" + ChipType(2b) + ChipAcqMode(2b) + ChipID (10b)	
"10" + DataSize(14b) To be verified:14b enough ?	Size in 16-bit words of the ChipData field
TransmitON edges on ROC control bus	
Next chip read-out block	
...	

Compared to the original ROC read-out data block format coming directly from a ROC, the leading bits for the ChipID field are modified and the DataSize field is added. Data from chips is taken in the same order as output by the chips (see ROC datasheet).

The contents of ChipData field is chip-dependent, and its size is Nevent & chip dependent. This ChipData field doesn't contain any marker allowing to differentiate it from the other fields (eg. ChipID, DataSize), and the value for Nevent is not explicitly reported. The online DAQ software processing the ROCData sequence has to identify the various ROC read-out blocks by recognizing the possible markers (ChipID, DataSize, ROSummary, ...) and making sure they are consistent with the value of the DataSize field.

The ROCData field in a DIF packet can include any fraction of the data described in the table above based on when the maximum size of the data block is reached.

The value of the ChipType and ChipAcqMode fields are not strictly necessary, as the DAQ online software has a configuration database which tells what kind of chips are connected to the DIFs, and what kind of read-out data they are supposed to send. But having this information in the read-out data flow allows to check a basic consistency of the whole setup.

ChipType field values

“01” - SKIROC

“10” - SPIROC

“11” - HARDROC

ChipAcqMode field values

For HardRoc chips:

“01” - Digital

“10” - Numeric

1.4.2.2 ROSummary word

The **ROSummary** field is a 16bit word appended after the sequence of ROC read-out blocks. It has the following format:

- when the last ROC in the chain has sent all of its data: 0100 0100 NumROCs(8 bits). The value of NumROCs corresponds to the number of ROCs that sent their data, even if this data was empty (ie. they only relayed the token).
- when a stop-read-out command has been received: 0100 0101 NumROCs(8 bits). In that case, the last read-out block may be truncated and, as such, invalid. NumROCs follows the same definition as previously.

1.4.2.3 ROOptions trailer

To be defined. Note: recommended to have a clear signature, so that ROSummary is easy to reach when analyzing the data from the end.

CRC

This pertains to each DIF packet. It is automatically added by the LDA-DIF 8b/10b interface.

2 To be discussed

Check that the max size of a read-out sequence of a ROC chain is less than 1024 packets (max ROPacketID). Check that DataSize is large enough for ChipData (max $2 \times 2^{14} = 32\text{kb}$).

Recommend the ROC people to send specific markers instead of 00/0000.

Add in DIF command specs: something to set the DIF ID programmatically ???

Tell that empty-read-out-data suppression is optional. Doesn't change the data format in any case.

Add DIF commands to set the ChipType and ChipAcqMode fields, or make sure that the chip configuration commands update these fields correctly.

DIF behavior when stop read-out cmd... In case a stop-read-out command is sent and, assuming ROSummary is seen correctly, the last data packet is pure garbage... it will be very approximate to lookup the previous valid packet.

Need a clear ROOptions format so that the DAQ software can see the ROSummary cleanly.

Revision History

Version/Date	By	Comments
0.1 (27/02/2009)	RC	First version
0.2 (02/03/2009)	DD	With comments from DD
0.3 (03/03/2009)	RC	Comments from RC
0.4 (03/03/2009)	DD	Comments from DD
0.5 (04/03/2009)	RC	Comments from RC
0.6 (05/03/2009)	DD	Comments from DD
0.7 (05/03/2009)	VB/RC/DD	Update after brainstorming