

# Selecting Guides on Compression Parameters in KOMPSAT-2 MSC

Jong Tae Lee, Sang Gyu Lee, Sang Taek Lee  
 KARI PDTS Engineer  
 45 Eoeun-dong Yusung-gu, Deajeon 305-333, Korea  
 jtlee@kari.re.kr

**Abstract:** KOMPSAT-2 provides two different imaging methods, direct imaging and playback imaging. For playback imaging operation KOMPSAT-2 has a storage device called DCSU (Data Compression & Storage Unit) to hold images taken before. Compression function is necessary to save memory space and data transmission time to ground station. There are several parameters for compression like compression ratio. Due to DCSU architectural characteristics and KOMPSAT-2 operational limitations, there are some restrictions on selecting compression parameters. This paper will provide selecting guides on compression parameters.

**Keywords:** KOMPSAT-2, MSC, PDTS, DCSU.

## 1. Introduction

KOMPSAT-2 has compression and storage device called DCSU, which is under development. Storage function is needed for later data transmission to ground station after imaging the land of outside of the contact. Compression function is required for saving transmission time to ground station and storage space on the satellite memory. To perform imaging with compression function, compression parameters must be selected before the operation. Due to DCSU architectural characteristics and KOMPSAT-2 operational limitations, there are several restrictions on selecting compression parameters.

## 2. DCSU Characteristics

### 1) Functions

The DCSU is a part of the PDTS(Payload Data Transmission Subsystem), which is included in the MSC payload of KOMPSAT-2. The DCSU performs storage of compressed or uncompress video data coming from CEU(Camera Electric Unit), storage of telemetry house keeping data from OBC(On-Board Computer), direct acquisition with and without compression, with and without storage of video data coming from CEU, playback and transfer to DLS(Down Link System) of the stored data and direct transfer to DLS of video data received from CEU during direct operation.

### 2) Data Input

The MSC has two types of camera. One is PAN(panchromatic) camera and the other is MS(multi-spectral) camera. Fig. 1. illustrates how video data come

to the DCSU. The PAN camera consists of 3 detectors which have physically 3 lines of detecting band. The first band is the primary band, the second one is the redundant band and last one is not used. The 3 bands of the first band make one line of panchromatic image. The MS camera consists of 2 detectors which is the same as PAN camera. The first and second band is for color A and B, and the third band is not used. The MS camera has 4 color bands with 4 different filters. The PAN camera has 6 lines of output channel and the MS camera has only 2 lines of output channel due to its difference of output rate. Color A and B, color C and D will be merged by SPU(Signal Processing Unit) of MS camera.

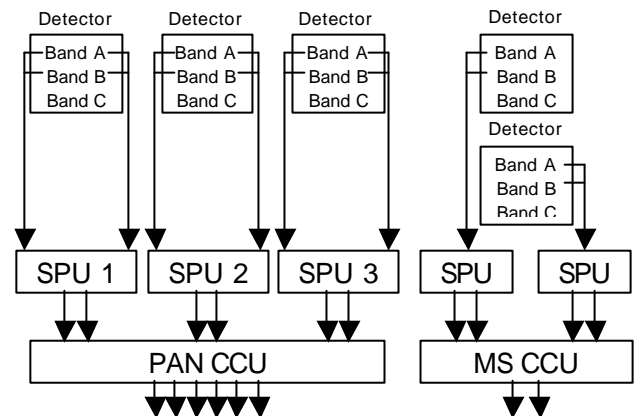


Fig. 1. PAN & MS Camera Electronics & Data Flow

Because the PAN and MS camera are using same optic system and imaging in push-bloom manner(PAN 1m, MS 4m resolution), the PAN video data and the MS video data are synchronized. Each four PAN video lines the SOL(Start of Line) maker of PAN channel shall be synchronized with MS video lines SOL marker.

Table 1. PAN and MS channel synchronization mechanism

| Time |   |            |   |   |            |   |   |   |            |   |   |            |   |   |   |
|------|---|------------|---|---|------------|---|---|---|------------|---|---|------------|---|---|---|
| PAN  | S | L          | S | L | S          | L | S | L | S          | L | S | L          | S | L |   |
|      | O | 1          | O | 2 | O          | 3 | O | 4 | O          | 5 | O | 6          | O | 7 |   |
|      | F | L          | L | L | L          | L | L | L | L          | L | L | L          | L | L |   |
| MS   | S | Color A/L1 |   |   | Color B/L1 |   |   | S | Color A/L2 |   |   | Color B/L2 |   |   | S |
|      | O | L          |   |   | L          |   |   | O | L          |   |   | L          |   |   | O |
|      | F | L          |   |   | L          |   |   | F | L          |   |   | L          |   |   | F |

There is an addition input channel to back-up OBC-

AUX house keeping data from OBC into DCSU. But normally OBC-AUX data will be transmitted through S-band and while OBC-AUX write operation there will be no imaging operation.

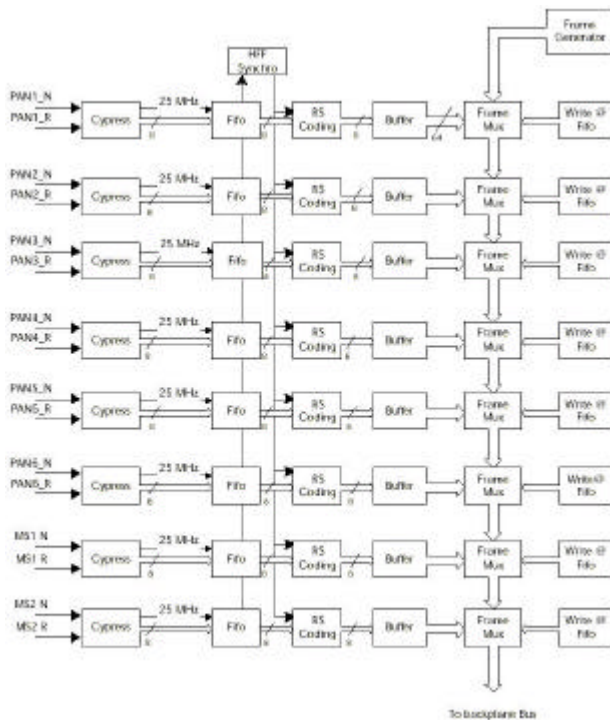
### 3) IFE Board Input Module

The IFE(Interface Equipment) board receive all the input and output electrical interfaces, the frame generation function and the read frame function. Input INOU module supports the video data interface and the data routing to the compression chains and to the storage unit. The minimum data unit to the memory storage is a frame which consists of file ID, video data, RS check symbols and frame CRC.

The data write operation in the memory stack is based on a collect loop principle, data in each INOU(ASIC for the Input/Output Interface) could be transferred in a transport frame following a time share(refer to Fig. 2). Upon the input configuration, each input function is allowed to insert data in a frame using a deterministic sequencing table. Table 2. shows the 3 different sequencing table that will be used by the DCSU.

**Table 2. PAN and MS channel synchronization mechanism**

| PAN Only | MS Only | PAN + MS |
|----------|---------|----------|
| PAN1     | MS1     | PAN1     |
| PAN2     | MS2     | PAN2     |
| PAN3     |         | PAN3     |
| PAN4     |         | PAN4     |
| PAN5     |         | PAN5     |
| PAN6     |         | PAN6     |
|          |         | MS1      |
|          |         | MS2      |



**Fig. 2. Write Frame Generation Scheme**

### 4) File System

All video data and OBC auxiliary data will be written by the file. A folder contains a set of file recorded during the same elementary operation execution. The DCSU is able to manage up to 1024 image files. Each file is internally cut into sectors which are the minimum read/write unit in DCSU and one file contains all the data coming from the same input channel and only these data. A folder can have maximum 9 files(6 for PAN, 2 for MS and 1 for OBC-AUX) depending on its operational mode. The DCSU is able to read back either complete folder, either complete file. And it's possible to read partial file.

A file can be erased by TC\_ERASE STC or setting an option in the playback operation LD\_READ\_OPS.

### 5) Operational Mode

There are 6 elementary operations which the DCSU provides to image and playback data. Write operation with compression, write operation without compression, direct operation with compression, direct operation without compression, OBC-AUX write operation and read operation are the elementary operation. One memory queue is given for each elementary operation. To perform any elementary operation, its mission command script must be uploaded to designated elementary operation list before, and the execution command must be sent when the operation is needed to start. Only top script of the elementary operation queue will be executed but will not be erased automatically. Ground station must send "TC\_RAZ" STC(Serial Telecommand) to erase queue. "TC\_RAZ" command will destroy entire script include unexecuted script.

## 3. Selecting Compression Parameters

### 1) Compression Ratio

The DCSU have total 64 indexes for compression operation. Index 0 to 31 are default values which were programmed in PROM before launch and the rest are programmable by the ground station on orbit.

In order to define the compression ratio, the ground station shall give to the DCSU the average number of byte to be generated by the compression function for each video line. Table 3. summarizes the various PAN and MS compression ratio.

Due to the difference between PAN input structure and MS input structure, operators must be careful that the calculation of compression ratio is different each other.

- PAN Ratio = (Header + Band A) / Navg
- MS Ratio = (Header + Color A + Color B) / 2 / Navg

**Table 3. Compression Ratio Range of PAN and MS**

|     |                   | Maximum Line Rate | Minimum Line Rate |
|-----|-------------------|-------------------|-------------------|
| PAN | Bytes per channel | 3250              | 3160              |
|     | Max. Navg(bytes)  | 2574              | 2503              |
|     | Min. Comp. Ratio  | 1.262626263       | 1.262485018       |
|     | Min. Navg(bytes)  | 56                | 56                |
|     | Max. Comp. Ratio  | 58.03571429       | 56.42857143       |
| MS  | Bytes per channel | 4810              | 4740              |
|     | Max. Navg(bytes)  | 3809              | 3754              |
|     | Min. Comp. Ratio  | 1.262798635       | 1.26265317        |
|     | Min. Navg(bytes)  | 69                | 69                |
|     | Max. Comp. Ratio  | 69.71014493       | 68.69565217       |

## 2) Beta, K, THL and THH

Whatever the compression ratio, K should be set to 10 for PAN video data and 5 for MS. Beta should be set to 9 for compression ratio within range 1 to 2 and 5 for compression ratio over 2.

THL and THH, which means lowest and highest level of compression regulation buffer threshold, are fixed to 64.

## 3) PAN + MS Direct Operation

In direct operation mode memory stack is used for temporally circular buffer and all channels have same buffer size and controls. Therefore MS Navg value must be double PAN Navg value.

Table 4. shows the possible combination of PAN and MS Navg in PAN + MS direct operation. Default compression parameters in the DCSU are shown in Table 5. In PAN + MS direct operation, operators must use index pair like (0,8), (1,9), and so on.

**Table 4. Valid Pair of Compression Ratio in PAN + MS Direct Mode at Typical Line Rate**

| PAN         |      | MS          |      |
|-------------|------|-------------|------|
| Comp. Ratio | Navg | Comp. Ratio | Navg |
| 10.07594937 | 316  | 7.51898734  | 632  |
| ...         | ...  | ...         | ...  |
| 5.08626198  | 626  | 3.79552716  | 1252 |
| ...         | ...  | ...         | ...  |
| 3.81317365  | 835  | 2.84550898  | 1670 |
| ...         | ...  | ...         | ...  |
| 1.67490794  | 1877 | 1.26584976  | 3754 |

**Table 5. Default Parameters**

| Index | NAV8/8 | Actual CR   | Beta | K  | Use Case   |
|-------|--------|-------------|------|----|--|
| 0     | 835    | 3.81317365  | 5    | 10 | Direct Mode PAN                                      |
| 1     | 626    | 5.08626198  | 5    | 10 |  |
| 2     | 316    | 10.07594937 | 5    | 10 |  |
| 3     | 600    | 5.30666667  | 5    | 10 |  |
| 4     | 1000   | 3.18400000  | 5    | 10 |  |
| 5     | 750    | 4.24533333  | 5    | 10 |  |
| 6     | 550    | 5.78909090  | 5    | 10 |  |
| 7     | 450    | 7.07555555  | 5    | 10 |  |
| 8     | 1670   | 2.84550898  | 5    | 5  | Direct Mode MS                                       |
| 9     | 1252   | 3.79552716  | 5    | 5  |  |
| 10    | 632    | 7.51898734  | 5    | 5  |  |
| 11    | 1200   | 3.96000000  | 5    | 5  |  |
| 12    | 2000   | 2.37600000  | 5    | 5  |  |
| 13    | 1500   | 3.16800000  | 5    | 5  |  |
| 14    | 1100   | 4.32000000  | 5    | 5  |  |
| 15    | 900    | 5.28000000  | 5    | 5  |  |
| 16    | 2503   | 1.27207351  | 9    | 10 | Play-back Mode or Direct Mode with only PAN channels |
| 17    | 835    | 3.81317365  | 5    | 10 |  |
| 18    | 626    | 5.08626198  | 5    | 10 |  |
| 19    | 316    | 10.07594937 | 5    | 10 |  |
| 20    | 1300   | 2.449230769 | 5    | 10 |  |
| 21    | 650    | 4.898461538 | 5    | 10 |  |
| 22    | 500    | 6.368000000 | 5    | 10 |  |
| 23    | 400    | 7.960000000 | 5    | 10 |  |
| 24    | 3754   | 1.26584976  | 9    | 5  | Playback Mode or Direct Mode with only MS channels   |
| 25    | 1252   | 3.79552716  | 5    | 5  |  |
| 26    | 939    | 5.06070288  | 5    | 5  |  |
| 27    | 474    | 10.02531646 | 5    | 5  |  |
| 28    | 1878   | 2.530351438 | 5    | 5  |  |
| 29    | 1800   | 2.640000000 | 5    | 5  |  |
| 30    | 1600   | 2.970000000 | 5    | 5  |  |
| 31    | 800    | 5.940000000 | 5    | 5  |  |

## 3. Conclusions

There are some restriction due to the DCSU characteristics and operational limitation. This paper describes several guide line on selecting compression parameters and will be helpful to operating compression function of the MSC the KOMPSAT-2 payload.

## Acknowledgement

This Paper is the result of MSC research and development supported by the Ministry of Science and Technology.

## References

- [1] L. Girard, 15/05/2003. DCSU Operational Handbook.
- [2] G. Salanie, 23/09/2003. DCSU Interface Data Sheet.
- [3] DCSU Design Team, 16/05/2003. DCSU Architectural & Technical Description.
- [4] F. Cazaban. 05/04/2002. DCSU Compression Algorithm Specification.
- [5] F. Cazaban. 05/04/2002. DCSU Decompression Algorithm Specification.