MODULAR INTEGRATED DATA HANDLING SUBSYSTEM

Image data compression, storage formatting and ciphering

Applications

♦ Optical satellite telemetry payload
♦ SAR satellite telemetry payload
♦ Data collection satellite payload

Main features

♦ Modular architecture based on functional building blocks, physically isolated on dedicated boards
♦ Integrated and easy reconfigurable design that allow to include the following functions in one single equipment
  - Customized capacity Storage
  - Data compression compliant to JPEG like standard with Programmable compression rate regulation
  - Formatting compliant to CCSDS standard (packet or transport level)
  - DES 2-3 ciphering
♦ Compatible to a large scale of input/output data rate
♦ Standard video input/output interface based on off the shelf components either CYPRESS hot links or parallel LVDS bus
♦ Standard Telecommand/Telemetry interface of RS422 type or MIL 1553B

Production

♦ Off-the-shelf building blocks that allow short delivery schedule : 12 months
♦ Integrated technology and namely use of a lot of ASIC that allow to support very high data rates

Background

♦ Spot 5 satellite
♦ IRSP5 satellite
♦ On going Commercial Earth Observation Program
♦ ESA and CNES R&D
COMPRESSION MODULE / DATA COMPRESSION SYSTEM

Main features

♦ Compression function :
  ➢ JPEG like standard
  ➢ Programmable compression ratio (1.2 to 40)
  ➢ Non uniform quantization
  ➢ Run length encoder and AC/DC Huffman tables
  ➢ High accuracy (up to 10 bit per pixel)

♦ Rate regulation
  ➢ Precise and robust rate regulation
  ➢ High image quality
  ➢ Patented rate regulation based on the theoretical model of Mallat & Falzon
  ➢ Possible extension to rate regulation on image quality

♦ Input data format :
  ➢ pixels embedded into frames with auxiliary data header and synchro marker
  ➢ Serial interface based on hot links (parallel interface as an option)

♦ Output data format
  ➢ Source formatted data including synchro marker and header
  ➢ Parallel interface based on LVDS driver (serial interface as an option)

♦ 3 independent data compression chains per module

♦ Full space qualified and latch up free components

♦ Optional bit to bit simulator delivery for test purpose and parameter optimization versus image quality

♦ Optional engineering support and end to end simulations for performances optimization

Technical description

♦ High integration : integration of the whole data compression chain in one ASIC

♦ Customized Huffman tables and weighting tables that enable optimized performances whatever the characteristics of the images are and the compression rate that is applied

♦ Rate regulation by software

Performances

♦ High data throughput : 75 Mpixels/s per module with pixels coded on up to 10 bit

♦ Modules can be stacked up to 3 to increase the throughput

♦ Low power consumption : 6 W per compression chain

♦ Radiation tolerance better than 35 kRad

♦ Reliability:
  ➢ 0.99 with cold redundancy
  ➢ 0.97 with a redundancy of one among 9 with a duty cycle of 10 %

Example of 1.6 Gb/s data compression system

TYPICAL PERFORMANCES

♦ Input rate up to 1.6 Gb/s on 8 input channels

♦ Output format: bursts which length depend on the compression ratio applied

♦ Telemetry/Telecommand interface : RS 422

♦ JPEG data compression with software rate regulation implemented on up to 8 active chains in parallel

♦ Programmable compression ratio from 1.2 to 40

♦ Hot redundancy of 1 among 8

♦ Partial OFF/NFF are available

♦ Mass : < 13 Kg

♦ Volume : LxDxH= 290x296x70 mm³

♦ Power consumption :

♦ Radiation tolerance >35 krad

OPERATING MODES

♦ OFF

♦ INIT (Transient State)

♦ STANDBY (Waiting Mode)

♦ OPERATIO N
  ➢ Number of active chains
  ➢ Compression ratio applied
  ➢ Reference of the Huffman table and weighting tables used
SOLID STATE RECORDER/MEMORY STACK

Main features

♦ Standard functions
  ➢ Recording
  ➢ Playback
  ➢ Self test
♦ Optional functions
  ➢ Online processing capability
  ➢ Data formatting
  ➢ TM packet assembly
  ➢ Routing functions….
♦ Powerful memory management system
  ➢ Multi users and parallel access
  ➢ Storage with RAM disk type random access
  ➢ Flexibility of the storage capacity use, optimization of the available storage capacity
  ➢ Data storage either into files or free running buffers
  ➢ Flexible share of the total storage capacity between several users
  ➢ Recording while reproducing capability
♦ Flexibility of the input/output rate (from 50 Mb/s to 1.6 Gb/s in input from 50 to 600 Mb/s in output)
♦ No single point failure
  ➢ Hot and cold redundancy (of 1 between N) on the memory stack
  ➢ Cold redundancy on the interfaces and on the control unit
♦ All components are latch up free
♦ Fault detection and reconfiguration (internal self test)
♦ Fault tolerance

Technical description

♦ Architecture based on a standard kernel customized with dependent interfaces and software
  ➢ Basic architecture composed of standard building blocks :
    ➢ Memory boards
    ➢ Interface and frame generation
    ➢ Generic mechanisms for data collection
  ➢ Basic kernel designed for maximum flexibility in terms of capacity or data rate growth potential
  ➢ Integrated 3D non hermetic memory modules (1 or 2 Gbit)
  ➢ Optional hermetic memory modules of 1.28 or 5.12 Gbit

Performances

♦ Radiation tolerance better than 35 Krad
♦ Up to 600 Gbits in a single unit EOL
♦ Rate: up to 200 Mb/s in write and read mode per channel
♦ Reliability better than 0.97 over 5 years in 100% of time in retention mode
♦ Bit error rate less than $10^{-12}$ for 24 hours of storage thanks to REED SOLOMON error correcting code that protects the whole data transfer chain and not only the memory boards
♦ Power supply: primary bus 22V to 50V, adaptable to other standards

Example of 600 Gbit Integrated formatter and Solid State Recorder

TYPICAL PERFORMANCES

♦ Input rate up to 1.6 Gb/s split over 12 input channels
♦ Output rate up to 600 Mb/s split over 4 output channels
♦ Telemetry/Telecommand interface : MIL1553
♦ CCSDS packet format
♦ DES 2-3 encryption
♦ Mass : <22 Kg
♦ Volume : LxDxH = 633x296x250 mm$^3$
♦ Power consumption between 13 and 100 W depending on the selected mode
♦ Radiation tolerance > 35 krad

OPERATING MODES

♦ OFF
♦ INIT (Transient State)
♦ STANDBY (Waiting Mode)
♦ SELF TEST (for the memory stack only)
♦ RETENTION
♦ OPERATION
  ➢ Read Only, Record Only, Read while recording
  ➢ Pass through mode
TYPICAL PERFORMANCES

- Input rate up to 1.6 Gb/s on 8 input channels
- Output rate up to 300 Mb/s on 2 output channels
- Telemetry/telecommand interface: RS422
- Accuracy: pixels coded on 10 bits
- Storage capacity: 100 Gbits
- JPEG data compression with software rate regulation implemented on 8 active chains in parallel
- Programmable compression ratio from 1.2 to 40
- Formatter compliant to CCSDS standard
- DES 2-3 encryption
- Mass < 19 Kg
- Volume: LxWxH = 454x296x250 mm³
- Power consumption between 13 and 100W (depending on the selected mode)
- Radiation tolerance > 35 krad
- Space qualified and latch up free components

OPERATING MODES

- OFF
- INIT (Transient State)
- STANDBY (Wait Mode, Control Unit Powered On)
- AUTO TEST (for the memory stack only)
- RETENTION
- OPERATION
- Read Only, Record Only and Read and Record either:
  - With data compression
  - Or without data compression

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