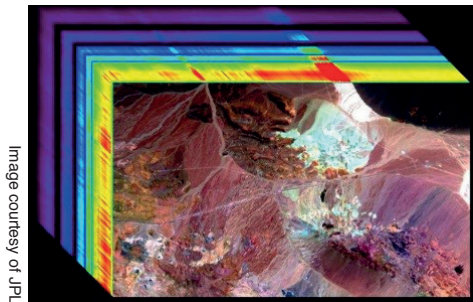# ALPHA DATA

# Hyperspectral Imaging and Compression Solutions

Image courtesy of JPL

JPL, in collaboration with Alpha Data Parallel Systems (Alpha Data), has developed a real-time capable FLEX compression core for Hyperspectral data - targeting various Alpha Data COTS and MCOTS products. Alpha Data now offer COTS and MCOTS FPGA based Hyperspectral acquisition and compression solutions licenced with the JPL FLEX compression core(s).

FLEX IP (CCSDS-123.0-B-2)

FLEX is the basis for the emerging Consultative Committee for Data Systems (CCSDS) CCSDS-123.0-B-2 standard for low-complexity lossless and near-lossless multispectral and hyperspectral image compression.

The FLEX data compression algorithm exploits dependencies in all three dimensions of hyperspectral data sets, which produces substantially more effective compression than two-dimensional approaches such as applying conventional two-dimensional image compression to each spectral image. FLEX is a predictive technique that uses an adaptive filtering method to achieve a state-of-the-art combination of low complexity and high compression effectiveness, making it well-suited for hardware implementation.
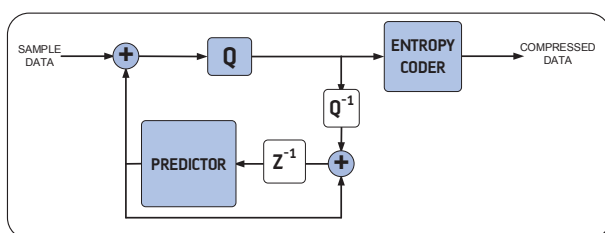
References

1. Lossless Multispectral & Hyperspectral Image Compression. Recommendation for Space Data System Standards, CCSDS 123.0-B-1. Blue Book. Issue 1. Washington, D.C.: CCSDS, May 2012 [Online] (http://public.ccsds.org/publications/BlueBooks.aspx)
2. Lossless Multispectral & Hyperspectral Image Compression. Report Concerning Space Data System Standards, CCSDS 120.2-G-1. Green Book. Issue 1. Washington, D.C.: CCSDS, December 2015 [Online] (http://public.ccsds.org/publications/GreenBooks.aspx)
3. D. Keymeulen, H. Luong, N. Aranki, C. Sarture, M. Eastwood, I. Mccubbin, A. Mazer, M. Klimesh, R. Green, D. Dolman , A. Bakhshi , "Real-time Airborne Demonstration of Fast Lossless Hyperspectral Data Compression System for AVIRIS-NG and PRISM", Proceedings of 2014 HyspIRI Science and Applications Workshop, 14 - 16 October 2014, California Institute of Technology, Pasadena, CA [Online] (http://hyspiri.jpl.nasa.gov/documents/2014-workshop)
4. D. Keymeulen et al. "High Performance Space Data Acquisition and Compression based on System-on-Chip Instrument Avionics for Space- based Imaging Spectrometers" Proceedings of 2017 HyspIRI Science and Applications Workshop, 17 - 19 October 2017, California Institute of Technology, Pasadena, CA [Online] (https://hyspiri.jpl.nasa.gov/documents/2017-workshop)
5. Presentation: https://hyspiri.jpl.nasa.gov/downloads/2017_Workshop/day3/23_HyspIRI2017_DidierKeymeulen_20180206_presentation.pdf

Usage and Deployment

Alpha Data has a history of working with Aerospace, Defence and other Industrial companies to provide robust FPGA based image acquisition solutions. This originated with Camera Link interfaces, supported by Alpha Data's Camera Link SDK on appropriate FPGA boards. This acquisition support has been extended to other interface protocols such as DVI, CoaXPress, GigE Vision and custom acquisition systems using LVDS interfaces to sensors including hyperspectral imagers.

The FLEX compression IP, licencesd from JPL, can be deployed with Alpha Data FPGA cards in several ways: for real-time applications or operating on buffered/stored data; in either Embedded or Workstation/Data-Center/HPC environments.
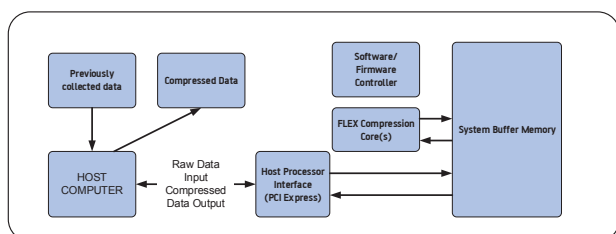
Offline Compression

To accelerate compression of stored raw, radiance or reflectance hyperspectral data where real-time compression is not required, or possible, Alpha Data can offer several suitable FPGA platforms for both Embedded and non-embedded deployment.
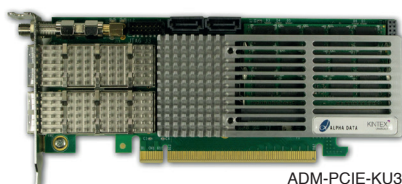
ADM-PCIE-KU3

These include PCIe form factor cards, such as the ADM-PCIE-KU3 which is suitable for workstation and HPC environments, and rugged embedded boards such as the ADM-XRC-KU1.

Real-Time with Embedded Host

Alpha Data offers several Xilinx Zynq based products suitable for deployment of the FLEX core.In this configuration flexible software can control a set of compression cores working in parallel, aware of the state of other system functionality chosen to be implemented on the board, such as imager configuration, geo-location integration, heater control and motor control.

ADM-VPX3-9Z2

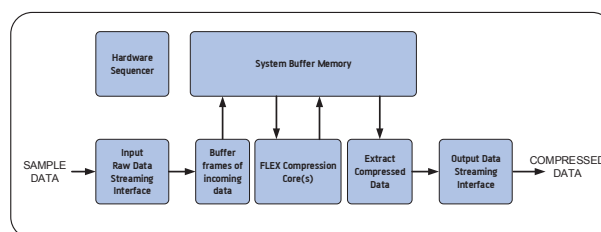Suitable boards include the ADM-VPX3-9Z2, and ADM-XRC-7Z1.

Embedded Standalone IP core without Host

Alpha Data can offer solutions implementing an RTL based sequencer (replaces the software control performed by the Host processor) to interface with a set of compression cores removing the need for a controlling host.
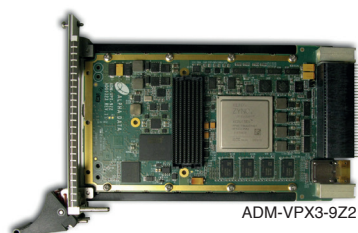
ADM-XRC-KU1

Such a configuration may be attractive when developing a standalone FPGA application that accepts streams of raw, radiance or reflectance data and transmits a compressed version of the data to another system.
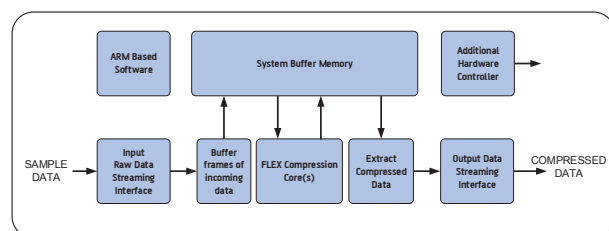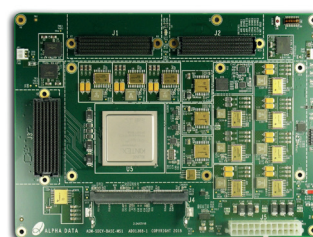
Space Development Board Deployment

The FLEX core is also suitable for deployment with Alpha Data's new Space Development Kit (ADA-SDEV-KIT). In this configuration a hyperspectral imager can be connected to the FPGA Board's FMC connectors, acquired data can be buffered on connected external memory. The compression core can then compress captured data, return it to a different region of the external memory where it can then be transmitted via a custom interface as a compressed file. This external interface would, in deployment, be the connection to the spacecraft bus, however during development this can be a connection to a commercial FPGA card emulating the spacecraft bus.

ADA-SDEV-KIT