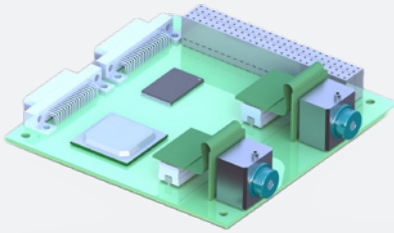# SAPPHIRERUBY^{FEE}
Imaging Sensors | NewSpace Flexible Imaging System

KEY FEATURES
- Cubesat-compatible camera solution for 2-year lifetime in LEO
- NewSpace approach to component selection
- FPGA for data handling and processing
- Embedded processor for TMTC interface and board control
- Memory enabling fast real time data handling and processing
- Memory for radiometric correction coefficients
- I2C interface for TMTC
- SPI over LVDS for data
- SpaceWire for TMTC and data interface as an option
- LVDS external timing triggers available
- Full configuration control of either Teledyne e2v Sapphire or Ruby sensor
- Different sensor operating modes supported
- 5V, 3.3V power input
- Power consumption <5W; with two image sensors

TYPICAL APPLICATIONS
- Earth observation
- Remote sensing
- Space Situational Awareness
- Rendezvous and docking
- In-orbit servicing

Teledyne has extensive heritage in providing customised image sensing solutions for space applications. Please discuss any requirements for customised variants to meet your needs.

SapphireRuby Flexible Imaging System for Space Applications

The SapphireRuby front-end electronics (FEE) solution, developed in conjunction with XCAM Ltd, is designed to operate up to two Teledyne e2v COTS Sapphire or Ruby imaging sensors*, offering unprecedented performance and choice of applications from a cubesat-compatible single-board system. Further information on the Sapphire and Ruby image sensors is available upon request.

Benefits:
- Single-board PC104 ¼U format
- FEE provides flexible control, interface and data processing operations
- Powerful and versatile electronics architecture
- Data processing and memory capacity to enable use as a simple data pipeline or to incorporate higher levels of data processing
- Embedded processor operation, detector and on-board functionality configuration, telemetry and telecommand (TMTC)
- Flexible for different applications

Considerations:
- System consists of high reliability COTS and radiation tolerant components
- Space-radiation mitigation techniques have been implemented
- Suitable for short duration low-Earth orbit (LEO) (typical 2-years)
- SPI over LVDS (SoL) can be utilised to optimise data throughput with I2C for TMTC; SpaceWire is available as an option for data output and TMTC
- TRL9 9.6 mm F/3.0 wide field camera optics are available as standard

Thermal interface:
- Up to two detector headboards mechanically and thermally decoupled from main front-end electronics via a flexible circuit
- Interface provided to allow user to control the detector temperature
- Detector(s) temperature sensors electrically connected through the system
- Temperature read out when the system is powered
- Operational range is -30°C to +65°C, non-operational range of -40°C to +85°C

Different geometries of flexible circuits can also be accommodated allowing easy integration into various optical solutions. The system can easily be adapted to accommodate different optical interfaces, enabling the system to support a wide range of space imaging applications. A flexible daughterboard solution enables certain other image sensors to be incorporated. More details available on request.

	2023	2024	2025
Demo systems	TRL6	TRL7	—
Flight systems	—	TRL8	TRL9

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*Teledyne does not offer specific space heritage or space qualification data for COTS imaging sensors. Qualification programmes available upon request.

ARCHITECTURE
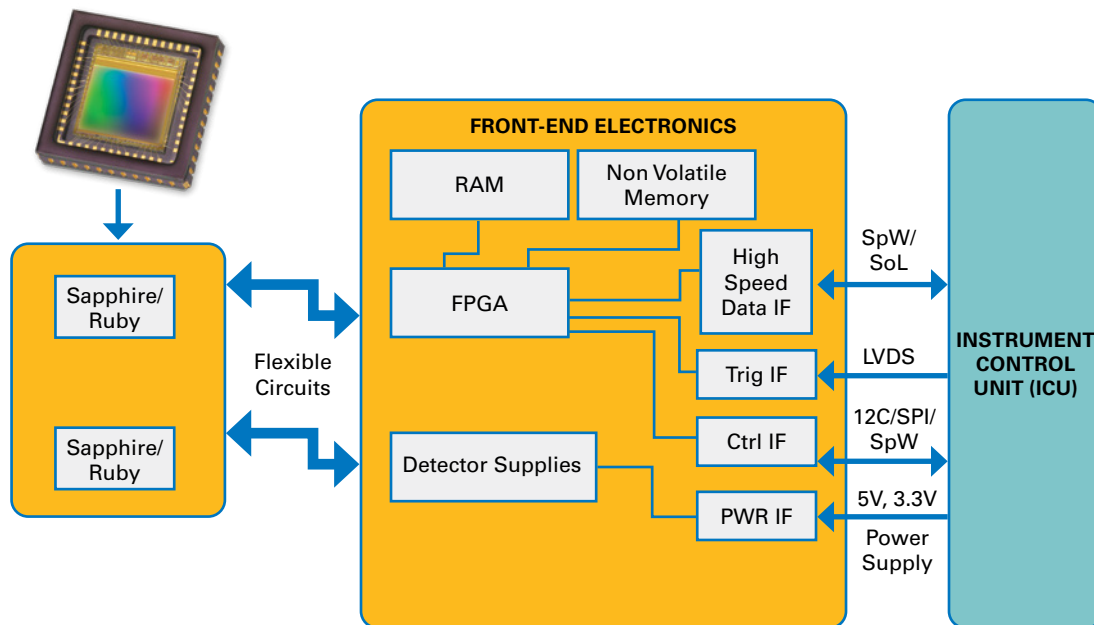
KEY DATA

Imaging (Sapphire)	
Spatial resolution @ 650km	300 m GSD (with standard TRL9 COTS lens 9.6 mm F/3.0)
Image sensor (Sapphire)	2.0 MP CMOS, 5/4 aspect ratio, RGB or B&W
Pixels	4.5 µm (1600 x 1200)
Wavelength Range	400 – 650 nm (RGB, extended with B&W)
Exposure	Auto or fixed

Imaging (Ruby)	
Spatial resolution @ 650km	360m GSD (with standard TRL9 COTS lens 9.6 mm F/3.0)
Image sensor (Sapphire)	1.3 MP CMOS, 5/4 aspect ratio, RGB or B&W
Pixels	5.3 µm (1280 x 1024)
Wavelength Range	400 – 1000 nm (enhanced NIR sensitivity)
Exposure	Auto or fixed

Mechanical & Environmental		Data	
Dimensions of board	9.5 x 9.1 x 2.7 cm	**Data format**	10-bit raw and thumbnail (1:10)
Mass with two imagers	< 160 g	**On board memory**	128 Gb
Peak power consumption	5 W	**Image compression**	50% JPEG-LS (Lossless)
Operating temperature	-30 to +65 °C	**Data Interfaces**	I2C/SoL/SpW
Survival temperature	-40 to +85 °C		

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