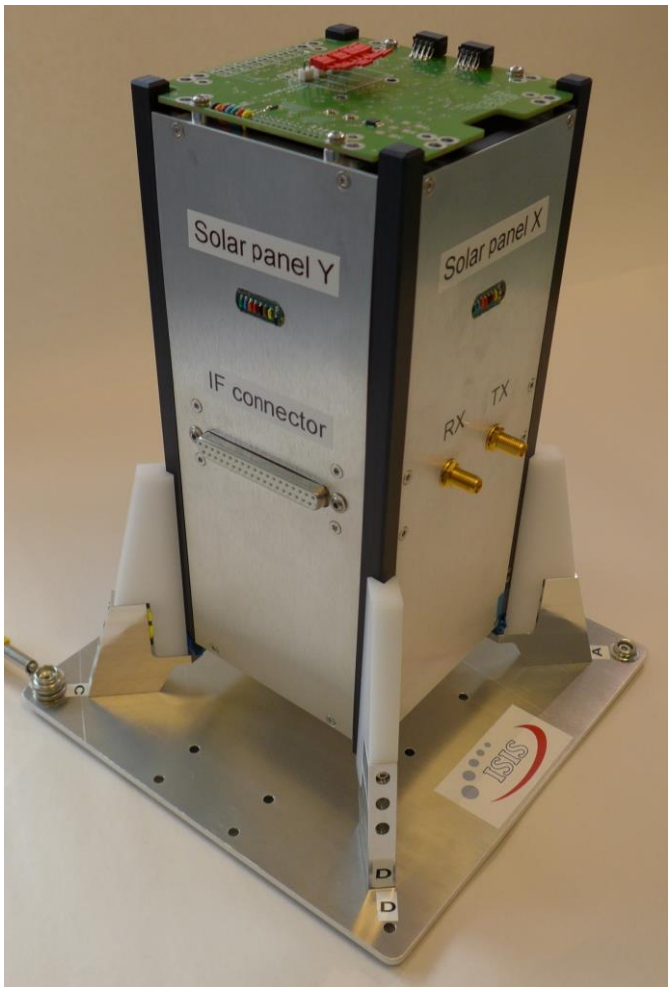
GEM - Generic Engineering Model Overview



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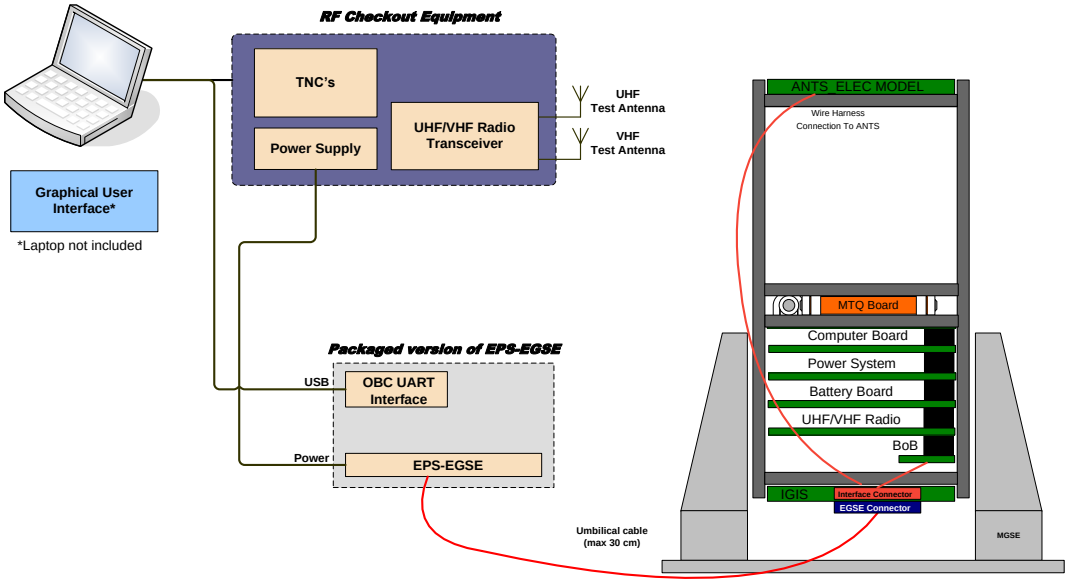
Introduction

The GEM has been developed by ISIS with the ambition to offer a starting point for new nanosatellite missions. The system allows satellite developers to get familiar with the design approach and the typical components used for such project.

System Overview

The GEM consists of standard electronics systems, support equipment and interfaces that are virtually identical to the systems used in an actual satellite flight model.



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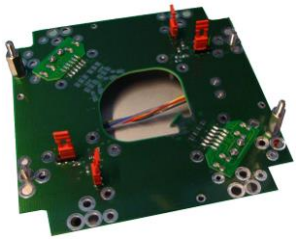
GEM satellite components

The hardware components integrated in the GEM are described hereafter.

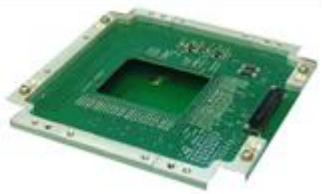
The **ISIS OBC** is a flight qualified, high performance processing unit that can be used as main flight computer on-board of the platform. The system is based around an ARM9 processor with a speed of 400 MHz, which makes it substantially more capable than other OTS components available in the market in the same price range. It has a wide range of interfaces and a robust design. This product has been used in orbit on several missions since 2014.

The **ISIS VHF/UHF Transceiver** enables the CubeSat to have a full duplex system with telemetry, telecommand & beacon capabilities on a single board. The BPSK downlink modulation scheme and flexible receiver make it easy to communicate with your CubeSat. The radio is connected via the I2C bus to the rest of the spacecraft. For the GEM the receiver and transmitter connectors are routed to two MMCX connectors on the side of the structure for easy connection to attenuators, test antennas and test equipment.

The **NanoPower P31U** power supply is designed for small, low-cost satellites with power demands from 1-30W. Employing a strictly KISS design philosophy, the NanoPower interfaces to triple junction photo-voltaic cells and uses a highly efficient boost-converter to condition their output power in order to charge the provided lithium-ion batteries. The NanoPower is connected via the I2C bus to the rest of the spacecraft.



The **ISIS AntS Electrical model** is identical to a conventional AntS system with the exception that no mechanical or RF parts are integrated and that the system can therefore be reused as many times as required for testing and development purposes. LED indicators are used to simulate the deployed state of the antenna(s) and simple test jumpers are used to as inputs for the state of the deployed antennas. The AntS Electrical model is connected via the I2C bus to the rest of the spacecraft.



The **ISIS Generic interface system (IGIS)** is intended to be a standard set of hardware interfaces between integrated satellites and electronic ground support equipment. Its supports satellite operation during ground based testing and for the flight mode of the hardware. On the satellite side it is made up by a breakout board (BOB), An Interface PCB and an ABF connector.

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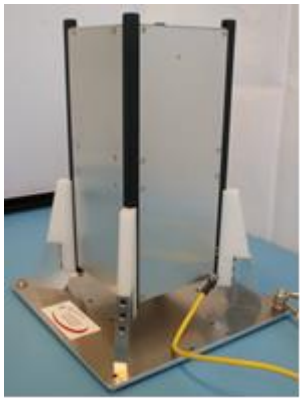
iMTQ Board
Attitude Control Board with 2 magnetic torque rods, a magnetic torque air-coil and a magnetometer implemented onto and in the board. The ISIS MagneTorQuer (iMTQ) is a PCB based 3-axis magnetic system. It is designed to provide maximum flexibility in placing actuators in a CubeSat structure. Providing actuation of 0.2Am^2, the system can be placed in a stack or in between stacks in ISIS structures. The system can be controlled over I2C or analog interface, and provides telemetry over I2C.



The **ISIS 2U CubeSat Structure** is developed as a generic, modular nanosatellite structure concept, compliant with the CubeSat standard. The design created by ISIS allows CubeSat developers a high level of freedom in their spacecraft configuration. Avionics or payload modules are built up as single 1-Unit form factor building blocks that are mounted onto the primary load carrying elements. This design concept, together with the accessibility of the internal subsystems even after assembly, creates an open structure which is easy and straightforward to use.

Sidepanels with integrated AOCS
The side panels and top panel will be installed with 3 panels containing a coarse sun sensor for 3-axis sun presence information.

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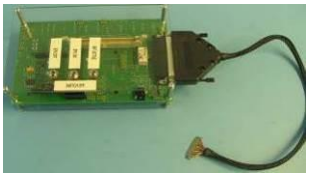
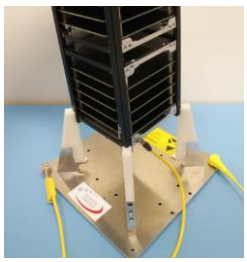
Ground Support Equipment

The following components are required to operate and are included with the GEM.

The RF Checkout system consists of an equipment rack connected to a PC running dedicated software for the control and monitoring of the entire setup using a dedicated RF link.



The EPS-EGSE and umbilical cord forms the ground side of the IGIS. It connects directly to the interface board on the satellite and allows testing and monitoring of the satellite hardware with basic laboratory equipment. It also allows battery management of the integrated satellite battery.



The MGSE Vertical Integration Jig supports an integrated platform during lab testing.

The MGSE Stack Integration Support Jig allows the vertical integration of a stack of cubesat components.

The MGSE tooling set provides a basic set of tools required to integrate and test the test platform.

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Software

Typically, although drivers for individual subsystems are available, basic operating software for the satellite platform is generally not included with the training kit, as the software implementation highly depends on the payloads and sensors to be used with the setup and the customer preferences and experience with software development.

This basic platform functionality included in the training kit are:

- Boot up functionality of the OBC and other systems
- Collection of basic telemetry data (i.e. temperatures, switch statuses)
- Transmission of telemetry data over RF
- Receiving and processing basic telecommands over RF, for instance for:
    - Power on/off switching of on board systems
    - Specific polling for telemetry data
    - Perform antenna deployment on command

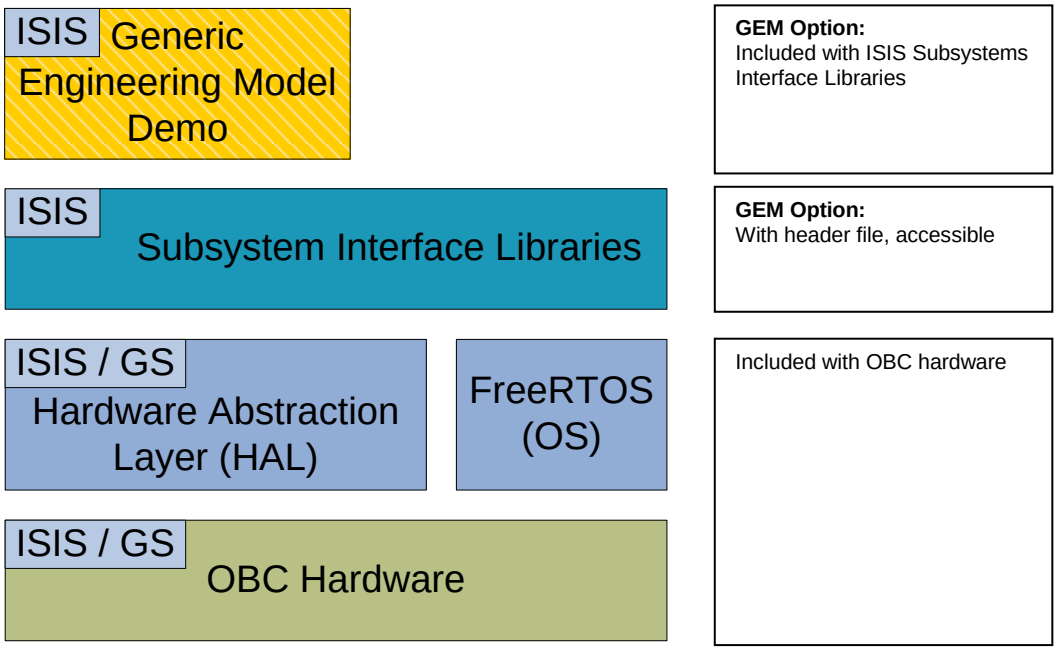
Basically the unit can be commanded through the radios. For enhanced development capability an option for adding software libraries is presented in the next section.

ISIS Software interface Libraries (ISIL)

An overview of the different software layers can be seen below. From this figure it can be seen that the basic level is the Hardware Abstraction Layer (HAL). This layer includes the drivers and rudimentary instructions to operate an electrical subsystem of the satellite. (e.g. “readout primary temperature sensor on the radio”)

On top of the HAL the ISIS library can be located. This is a library of standard instructions for the satellite subsystems that can be called and executed. These are typically a set/string of HAL commands (e.g. “Collect Housekeeping data set from System”). This layer is offered as an optional extra to the kit and provides a more advanced starting point of developing your own software.

The basic GEM Demo software is located on top of the software stack.



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Pricing

Item		Notes
ISIS Generic Engineering Model with GSE – 2U version		
CubeSat Standard Avionics Development kit	€49,950	Includes : - 2U Structure - TRXUV Communication System - Antenna System Electrical Model - Power System - On Board Computer - ISIS Generic Interface board - iMTQ Magnetorquer ADC system - Dummy Solar Panel set (no cells) - Integration harness - Flatsat Testing - Electrical GSE - JTAG programmer for the OBC - RF GSE for UHF and VHF
ISIS Subsystem Interface Libraries	€5,000	Libraries of standard instructions for ISIS Subsystems as starting point for Flight SW development. Includes the GEM Demo software.
Mechanical set of Ground Support Equipment	Complimentary	Includes: - Mechanical GSE - Tooling
Subtotal	**€54,950.00**	

All prices are based on the following conditions:

- No VAT included, whether VAT applies depends on customer's national legislation
- Delivery is subject to obtaining appropriate export licenses
- Delivery Ex Works - EXW (INCOTERMS 2010)

Payment Plan

The above price information is based on ISIS' standard payment plan:
Order confirmation: 50%
Delivery: 50%

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