

System-on-Module ZSOM™-F01

ver.0.1N_25

Radiation-Tolerant System-on-Module with FPGA

AMD Zynq™ UltraScale+™ MPSoC ZU3EG C784

Enabling Advanced Commercial-Off-The-Shelf (COTS) to 'Space-Grade'

Product Overview

ZSOM™ is a family of ZES' Radiation Tolerant System-on-Modules (SoM) for processing platforms that leverage Power-reliability and Data-integrity solutions to protect commercial-off-the-shelf (COTS) components from radiation effects.

ZSOM™-F01 is a Rad. Tol. System-on-Module embodying FPGA AMD Zynq™ UltraScale+™ MPSoC ZU3EG C784 with Single-Event-Latchup (SEL) and Single-Event-Upset (SEU) mitigations. ZSOM™-F01 enables a quick and reliable payload development platform for data-intensive high-performance computing Space applications.

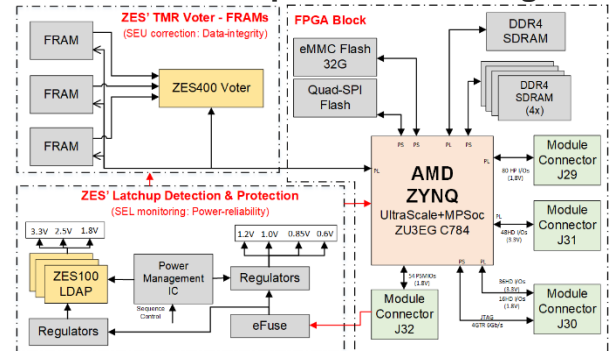
Key Features

- **FPGA-based SoM is integrated with SEL and SEU protections:**
 - SEL protection enabled by **ZES100 Radiation-Hardened Latchup Detection and Protection (LDAP-IC) x 3pcs**
 - SEU protection enabled by Triple-Modular-Redundancy (TMR) **ZES400 Radiation-Hardened Voter-IC** with external FRAMs (3pcs) and proprietary Error-Detection-And-Correction (**EDAC**) C-code for detecting/correcting multi-bit soft errors, suitable for BRAMs (within FPGA), Flash, eMMC, and DDR memories
 - **2,000x lesser soft-errors** than Single-Event-Correction-Double-Error-Detection (SECDED)
- High Reliability Manufacturing PCB (Class III)
- Operating temperature: -40°C to 85°C
- Power Input: 12V@2A (max.)
- Small Formfactor (90.17mm x 81.70mm)

Target Applications

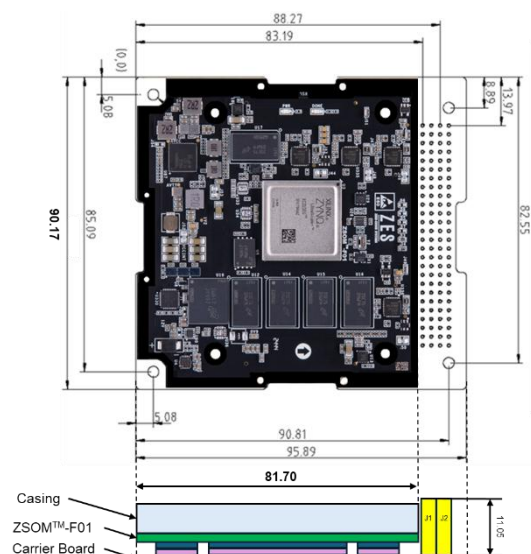
- Payload designs for Space missions for VLEO, LEO, MEO, GEO with **radiation protection against SEL/SEU**
- Earth Observation (EO) payloads
- Telemetry, scientific data processing payloads (Image-sensing, AI and/or edge-computing)
- Navigation, instrumentation payloads (e.g., star trackers, gyroscopes, accelerometers, etc.)
- Application-specific software-enabled payloads (e.g. security codes/protocols, etc.)
- **Low error-rate data protection** applications

ZSOM™-F01 Simplified Block Diagram



ZSOM™-F01 Specifications

- **AMD Zynq™ UltraScale+™ MPSoC device XCZU3EG-1SFVC784I**
 - Arm Quad-core Cortex™-A53 1.2GHz
 - Arm Dual-core Cortex™-R5 500MHz
 - Mali™-400MP2 GPU 667MHz
- DDR4 SDRAM (4GB for PS, 1GB for PL)
- QSPI Flash (256Mbit)
- I²C EEPROM (4Kbit)
- eMMC Flash (32GB)
- 180 user PL I/O pins and 26 user PS MIO pins (one full MIO bank) via 4 connectors
- Supports 10/100/1000Mbps Gigabit Ethernet (1x PS, 1x PL)
- Supports SATA3.1, USB2.0, USB3.0, PCIe2.0/1.0 x4, and Display Port (Shared GTx)
- Supports integration with PC104 LibreCube standard board



SEL and SEU mitigations

SEL Detection & Protection by LDAP:

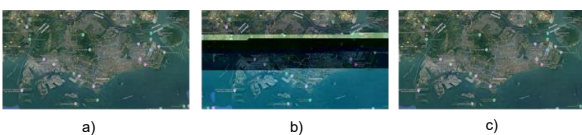
ZES' LDAP IC, **ZES100** detects **Single-Event-Latchup (SEL)** and **μ-SEL** in COTS devices (MCU/FPGA/ ASIC) and subsequently provides a command output for recovery (Power-cycling). ZSOM™-F01 is integrated with 3pcs of ZES100 (on 3.3V, 2.5V, 1.8V power-rails to FPGA) that can **detect the early onset of SEL/μ-SEL occurrence and remove SEL** by appropriate power-cycling.

SEU Soft-errors Detection & Correction by TMR Voter, FRAM and EDAC Algorithm:

ZES' Quad-Channel Voter-IC **ZES400** is a radiation-hardened monolithic microchip, **embodying 4 channels of 3-input majority voters** – each channel consists of a majority gate and an error indicator. ZES400 is used to mitigate soft-errors by Triple-Modular-Redundancy (TMR) system, for data in the embedded and high-speed memories of the ZSOM™-F01.

Data Protection with EDAC algorithm example:

An image is stored inside the SRAMs of the ZSOM™-F01, and the data is protected by ZES EDAC code. Hypothetically the data is then randomly corrupted with 14 errors (14 bits flipped out of 284kB). The **corrupted data would be recovered by the ZES EDAC**. Figs. (a) – (c) depict the original picture (a), the corrupted picture (b) with 14 bits flipped, and the corrected picture (c).



Data protection demo (picture data) in SRAMs:

- (a) Original data,
- (b) Corrupted Data
- (c) Corrected data **(with ZES EDAC)**

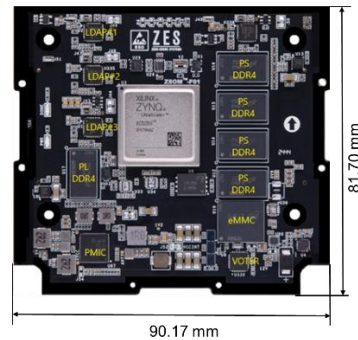
ZES100 and ZES400 feature high radiation hardness against Total Ionizing Dose (TID), Single-Event-Latchup (SEL), and Single-Event-Transient (SET).

Part ordering information

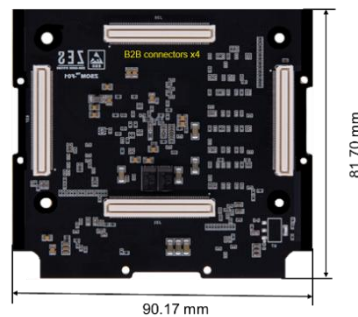
PART Code	Size (mm)
ZSOM-F01	90.17 x 81.70

ZSOM™-F01 Mechanical Interface

ZSOM™-F01 has compact size (90.17mm x 81.70mm) with 4pcs of the board-to-board (B2B) connectors to integrate into various application carrier-boards.



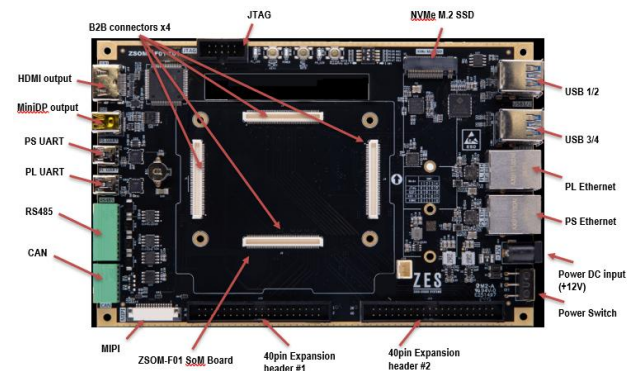
ZSOM™-F01 (PCB top view)



ZSOM™-F01 (PCB bottom view)

Evaluation Board for Supporting Application Development

The evaluation board **ZSOM™-F01-T01** is available to connect the ZSOM™-F01 for an application development and/ or debugging/ testing. The integration between the evaluation board and the ZSOM™-F01 is based on the B2B connectors at the bottom of the PCB.



ZSOM™-F01-T01 Evaluation Board

Note: The above specifications are subject to change, please refer to ZES for further information: sales@zero-errorsystems.com