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# AEROSPACE & DEFENCE



# We are a cross-sectoral tech corporation supplier of cutting-edge products and services.

We operate in five business segments:

AEROSPACEINDUSTRIALAGROTECHHEALTHCAREFINTECH& DEFENCESERVICESAGROTECHHEALTHCAREFINTECH

# WHO ARE WE?

ARQUIMEA GROUP

**FIGURES** 2020

Clients 25+ countries

# 400+ employees

Incomes € 73M EBIT

€ 11M

# **ARQUIMEA Aerospace & Defence**

#### Engineering company specialized in parts and systems for Space, Aeronautics, Defence, Hi-Rel Industrial and Science

Suppliers of electronics, microelectronics, mechanisms, software, robotics and drones

End-to-end engineering capabilities. In-house mechanisms workshop, labs and clean room facilities

Strong **R&D** activity and **product-oriented** strategy

HQ in Madrid (Spain)

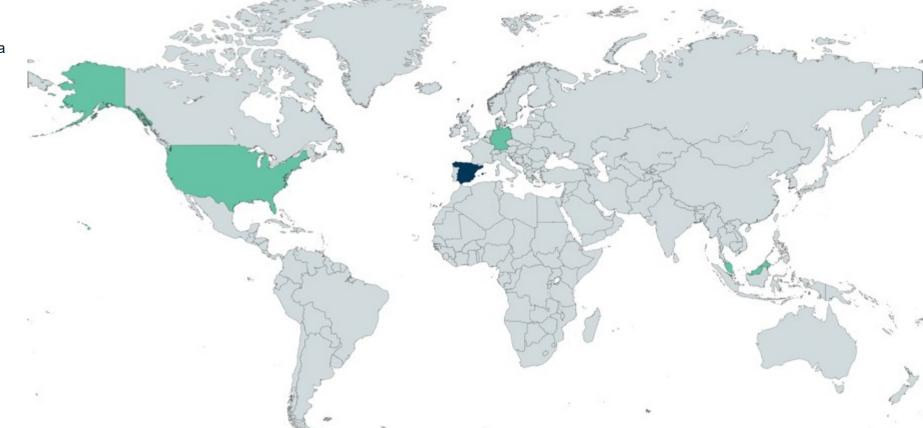
Commercial offices in Germany, USA and Malaysia





80 employees







# **SPACE & HI-REL**



# **Aerospace & Hi-Rel**



• 60+ years' experience in manufacturing and integration of complex mechanisms and electromechanical equipment for aeronautics, space, defence, science and industry

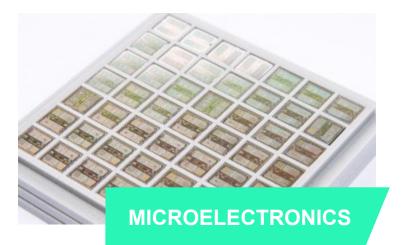


# Areas of activity





Space-qualified actuators and mechanisms MGSE, tooling and test jigs In-house MAIT capabilities Custom and off-the-shelf Own-proprietary high-temp. SMA material HDRMs, DMs, pin pullers, valves, rotary actuators...



Fabless Design House Analog, digital and mixed-signal Own-proprietary rad-hard IPs and libraries Rad-hard IP, ASIC and FPGA design Rad-hard IC products: transceivers, converters... Microelectronics-related services



Flight electronics and EGSEs Sensing systems and sensor networks Electromechanical equipment Custom and off-the-shelf EEE parts radiation characterization Space science. R&D activities

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One-stop-shop for space-qualified mechanisms and ground support equipment

#### SHAPE MEMORY ALLOYS

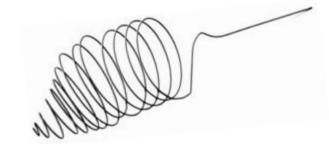
Own-proprietary high-temperature shape memory material  $\rightarrow$  **SMARQ** 

SMAs are **artificial muscles** commonly used as force, linear and rotary actuators, springs and valves

# Lightweight, solid-state alternative to pyro-actuators, hydraulic and pneumatic systems

Typically used in automotive, industrial, healthcare, aeronautics...

Stable operation in harsh thermal environments from - 40 to +150°C



#### **OFF-THE-SHELF ACTUATORS**

#### HDRMs, Valves & Pin Pullers

**Hold-down and release** of solar arrays, antennas, cover doors, booms, heat shields, scientific instruments, etc. in spacecraft

Low-shock, non-explosive, resettable

Extended operation temperature range

#### **Solar Array Deployment Mechanisms**

HDRM + deployment mechanism for small satellite platforms



#### **MECHANISMS MAIT**

**Full manufacturing capabilities**: precision machining, mechano-welding, milling, lathes, EDM, robotic cell

**90sqm clean room** with thermal vacuum chamber (under construction)

Turnkey solutions. Custom design of equipment, tools and GSE

**60+ years' experience in aerospace**. Over 30,000 devices supplied.





Manufacturing – Assembly – Integration – Test



Manufacturing – Assembly – Integration – Test

# Millings, lathes, EDM, grinding

Over 30,000 different parts supplied since 1958















# Manufacturing – Assembly – Integration – Test



Optical bench - COPERNICUS Sentinel 5 (ESA)



Environmental monitoring station - InSight (NASA)



REMS – MSL Curiosity (NASA)



Mechanical parts for antennas



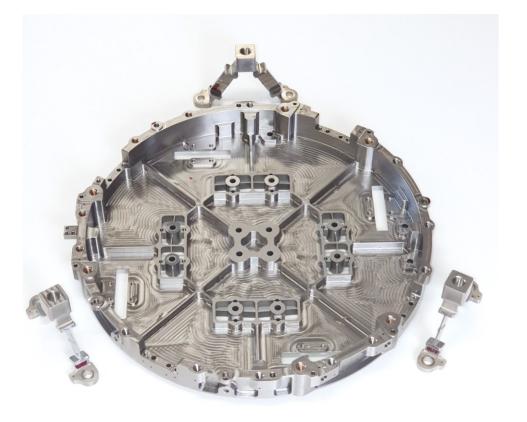
Antenna pointing mechanism - ENVISAT (ESA)

Manufacturing – Assembly – Integration – Test

**PLATO – PLAnetary Transits and Oscillations of stars** 

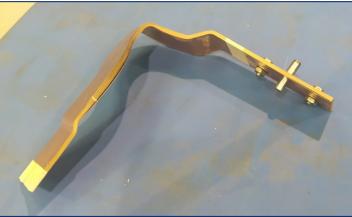
Optical instrument







esa







# Off-the-shelf Actuators – REACT HDRM

REACT are low-shock Hold-Down & Release Actuators which function is to firmly fix a payload during transportation or launch and later release it by electrical activation.

#### Typical applications:

Solar arrays, antennas, booms and masts, reflectors, cover doors, scientific instruments, shutter mechanisms, large structures, launch locks for gimbals, thrusters, stage separation, caging mechanisms, etc.

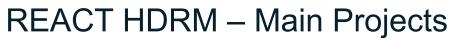
- Qualified to TRL9 (flight proven). Selected for several flight missions
- Low shock
- · Manually field resettable by the end user. No refurbishment required
- Redundant SMA trigger (two independent initiators)
- Compatible with pyro electrical interface
- Near simultaneous release of multiple hold-down points
- Three standard mechanical interfaces available
- Space-qualified parts and materials
- · Custom configurations available under request
- Full solar array deployment system available: HDRM + deployment mechanism
- ITAR/EAR free



REACT	REAC.053.V2.XX	REAC.153.V2.XX	REAC.153.V2.XX
Hold-Down Load [N]	5,000	15,000	35,000



YEAR



PROJECT

2012	Resettable SMA Hold Down and Release Actuator for General Use in Satellite Systems (REACT)	ESA	HDRA development and qualification
2014	REACT 15KN extended temp. for magnetometer experiment of ESA JUICE Mission	Serenum (CZ)	Devices for on-ground system validation
2014	REACT 2.5KN extended temp. for MetOp Mission	Kongsberg (NO)	Devices for on-ground system validation
2015	REACT 2.5KN extended temp. for picosat launcher	BISEE (CN)	Devices for on-ground system validation
2016	REACT 5KN standard temp. for low-shock release of antenna	CAST Xi'an (CN)	Devices for on-ground system validation
2017	HDRM 5KN extended temp. and solar array deployment mechanism for ESA-µHETSAT	Sitael (IT)	Launch foreseen 2022
2017	REACT 5KN standard temp. for solar array release in ESA-ESAIL Sat	LuxSpace (LX)	2020: Successful operation in orbit
2017	REACT 5KN extended temp. for antenna release	CASC (CN)	2019: Successful operation in orbit
2018	REACT 5KN and release control electronics for space launch system for LEO small sats	GTD (ES) / ONERA (FR)	2018: Successful operation in atmospheric flight
2018	REACT 15KN extended temp. for magnetometer boom release in ESA JUICE Mission	Frentech (CZ)	Devices for on-ground system validation
2018	REACT 15KN extended temp. for large deployable antenna, including a deployable boom and reflector	RUAG Space GmbH (DE)	Devices for on-ground system validation
2019	REACT 5KN standard temp. for cubesat dispenser	ICEYE (FI)	Launch foreseen 2022
2020	REACT 15KN extended temp. + custom HDRA for satellite constellation	Confidential (US)	Devices for on-ground system validation
2020	REACT 15KN extended temp. for ESA Copernicus Imaging Microwave Radiometer (CIMR) mission	RUAG Space GmbH (DE)	Launch foreseen 2025
2020	REACT 5KN extended temp. for ESA ADEO Passive Deorbit Subsystem	HPS GmbH (DE)	Launch foreseen 2022
2021	REACT 15KN extended temp. for space debris removal system	ClearSpace (CH)	Launch foreseen 2024

CUSTOMER



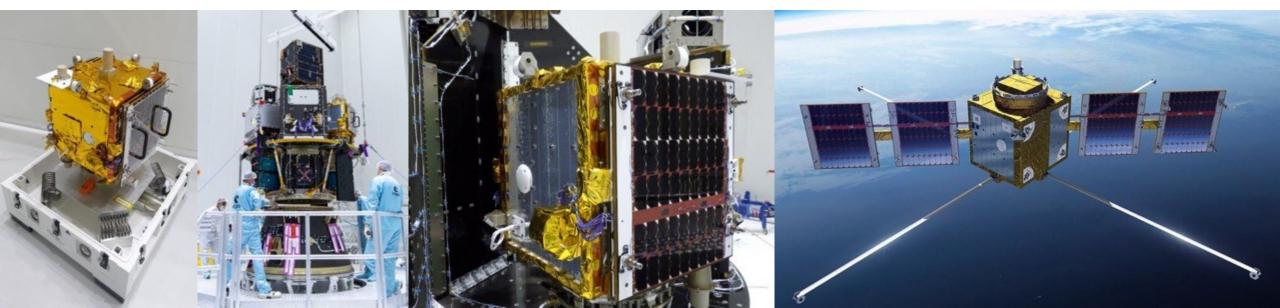
**FLIGHT HERITAGE** 

# REACT HDRM – Flight Heritage

MISSION	ESA ESAIL-Sat AIS
PRIME CONTRACTOR	LuxSpace (OHB Group)
LAUNCH	Launched in 2020
MISSION DESCRIPTION	ESAIL satellite is part of the projects promoted by ESA to improve the next generation of space services for the maritime sector. The objectives will be the control of navigation and the detection and tracking of ships throughout the Earth.
	The satellite weighs 110 kilograms and has an improved configuration of multiple antenna-receiver for the global detection of AIS (Automatic Identification System) messages and the capture of high-resolution spectrum.
ARQUIMEA CONTRIBUTION	8x REACT 5KN standard temperature for the release of the solar panels





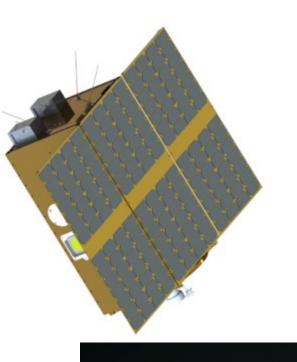




# HDRM & Deployment Mech. – Flight Heritage

MISSION	ESA μHETsat	
PRIME CONTRACTOR	SITAEL S.p.A.	
LAUNCH	2022	
MISSION DESCRIPTION	In-Orbit Validation (IOV) mission of a Mini-Hall Effect Thruster (HET) onboard SITAEL's S-75 micro-satellite class platform (60 kg) in the frame of an GSTP 6.3 (IOV-IOD) programme.	
ARQUIMEA CONTRIBUTION	HDRM + Solar Array Deployment Mechanism	
	(REACT 5KN extended temperature + cup-cone + bolt-catcher + hinges)	

TECHNICAL SPECIFICATIONS	SADM (REACT + cup-cone catcher + hinges)	
Application	1m x 1m Solar panel hold-down & deployment mechanism	
Overall mass	560 g (including screws and harness)	
Temperature range	-40/+100°C	
Life Cycles (min)	10 cycles on ground + 1 in orbit	
Solar panel separation (Stowed)	20mm from S/C to panel	
Deployment sensor	Able to detect start and end of deployment	
Other properties	2 Spring motorized hinges with latch on deployed position Includes catcher for the hold-down bolt after release Safety tooling to avoid deployment during AIV	



# 

SITAEL

esa

#### H2020 ALTAIR – Cost effective and reliable space launch system for small sats access to LEO

- Development and validation of a space launch system based on an unmanned aircraft carrier releasing a micro-launcher.
- ARQUIMEA implemented the HDRM for the release of the launcher, consisting of 2x REACT and the electronic control unit for synchronized activation (<25ms) of the REACTs.</li>
- Successful flight test carried out in September 2019



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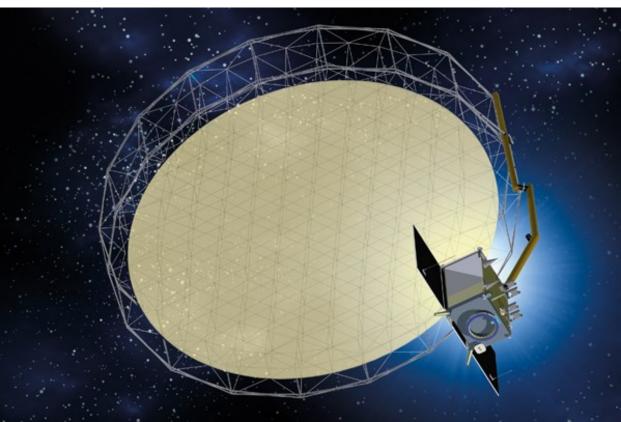
# **Mechanisms** REACT HDRM – Projects

#### H2020 LEA – Large European Antenna – Large Deployable Reflector (LDRS)

- Development of a 6m diameter PFM of a large deployable reflector subsystem (reflector, arm, HDRMs, etc.)
- Until April 2021, a 7m diameter EM will be designed, built and tested by the consortium, led by HPS, for the ESA Copernicus Mission CIMR
- ARQUIMEA is supplier of the HDRM release nuts for the arm and the reflector
- Further cooperation between the consortium ongoing for new related projects.

# Together ahead. RUAG

Copyright HPS GmbH





# **Mechanisms** REACT HDRM – Projects

#### ADEO – Passive Deorbit Subsystem. Deployable Drag Sail

- Drag sail subsystem constituted by a boom and a membrane for passive deorbiting of satellites. It recognizes when the satellite has come to the end of its mission or has failed and then slowly unfurls a large aluminum-coated polyamide membrane, attached to four carbon-fibre reinforced booms.
- The membrane acts as a sail, to create a drag effect causing the spacecraft to decrease its orbit much faster, catching at the atmosphere to slow the worn-out spacecraft enough that it will burn up entirely.
- ARQUIMEA is supplier of the HDRM release nuts for the demonstration model.





Copyright HPS GmbH





# **REACT HDRM** Electronic Ground Support Equipment



EGSE specifically designed to **support REACT operations during on-ground activities** such as validation/acceptance test at device and system level.

Three main operating modes:

- Monitorization: for long tests
- Preload: enables the accurate preload of the HDRM
- Actuation: associated to the electric pulse enabled per channel and the actuation measurements done in real time.

Capable to **control the actuation of up to eight REACTs**, acquiring the preload and temperature signals for each REACT.

- Load cell monitoring
- Temperature monitoring
- REACT actuation controlling the maximum pulse duration, current and voltage
- Actuation logs for a comprehensive feedback of the actuations performed
- Prevents voltage losses due to the use of long wires during operation
- LCD display available for control and operation
- · USB interface and SD memory card for data recording and loading.



# **HDRA: Pin Puller**

Pin pullers are **linear actuators** in which a pin or piston initially remains firmly locked in extended position and, when activated, usually against a **side load**. In the extended position, the pin blocks a mobile/deployable element in a spacecraft before it is released for regular operation.

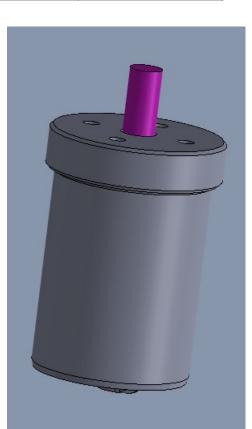
#### Typical applications:

Solar arrays, antennas, booms and masts, reflectors, cover doors, scientific instruments, shutter mechanisms, large structures, launch locks for gimbals, thrusters, stage separation, caging mechanisms, etc.

- Version V1 developed and qualified to TRL6 in the frame of an ESA project
- V2 under development, improving some key features: actuation time, electrical interfaces.
  - Phase I on going
  - BB in manufacturing
- Low-shock, non-explosive
- Operation temperature up to +125°C
- Very light and small volume
- Redundant **SMA trigger** (two independent initiators)
- Resettable by end user (manual reset)
- COTS and custom configurations available

PIN PULLER	PPLL.051.V2.XX	PPLL.012.V2.XX	PPLL.052.V2.XX
Pull Force (min) [N]	50	100	500





# 

# **SMA Valve**

# Development and Qualification of a Shape Memory Alloy Valve for Propulsion Passivation (ESA Contract No. 4000126106/18/NL/LvH)

- Suitable for Propellants (N<sub>2</sub>H<sub>4</sub>, MON, MMH, LPM-103s), Inert gases (Kr, Xe, He, Ar) and all propellant vapors
- Environmental operating temp.: -30 to +60°C (gas application), 0°C to +60°C (liquid storable propellant application)
- Environmental nonoperating temp.: -50°C to +90°C (gas application), -2°C to +90°C (liquid storable propellant application)
- Inlet operating pressure: MEOP = 310 bar
- External leak: < 1x10<sup>-6</sup> scc/sec GHe at worst-case conditions (during min and max non-op temperature)
- Mass < Pyrovalve (410g not including harness)
- Lifetime on ground + on orbit = 25years





# Off-the-shelf Actuators – Mini HDRA

# Low-shock small-size Hold-Down & Release Actuator

- Two different shapes: compact and finger
- Nominal Load > 600 N
- Mass < 60g (< 40 g for compact)
- Dimensions: 60 x 25 x 17 mm (finger) Ø 25 mm x h 18 mm (compact)
- Low-shock, non-explosive
- Operation temperature up to +125°C
- Redundant SMA trigger (two independent initiators)
- Field manually resettable by end user
- Lifetime on ground + on orbit = 25 years
- Under development
  - EQM available and validated. Formal qualification ongoing
  - FM available in Q1-2022









**Competitive Advantages** 

- 1. Aerospace and Hi-Rel specialization
- 2. End-to-end capabilities: in-house design, analysis, MAIT and qualification
- 3. Off-the-shelf and custom: space-qualified actuators and mechanisms, tooling and MGSE
- 4. Experts in Shape Memory Alloys. Exclusive high-temperature SMA
- 5. Most mature and reliable **European source for resettable HDRMs**
- 6. Turnkey projects. Direct control and management of the entire development flow
- 7. ITAR-free products

# **Microelectronics**



Miniaturized systems and improved performances using Integrated Circuits

#### **ARQUIMEA VALUE PROPOSAL**

- **Fabless Design House**. We select the right technology for each application and apply the suitable Radiation-Hardening technics.
- 2 Design Centers: Spain and Germany
- Application area: Mixed-signal, Digital, Analog & Power
- **Turnkey solutions**, from requirements consolidation to full-space qualification per ESCC/MIL standards.
- **Space-grade FPGA to ASIC conversion** to reduce costs in constellations and other recurring applications.
- **Own electronic labs**, with automated measurement instruments, PCB design and test setup development.
- Flexible procurement flow from Hi-rel plastic to class 1
  Ceramic

#### **ARQUIMEA HERITAGE**

- 15 years experience
- 1500+ Flight Models delivered to date.
- Main Customers: Cesa AIRBUS
- **Trusted partners and supply chain** for rad-hardened digital libraries and technology access, IP integration and backend services, granting the design integrity and confidentiality.
- Own proprietary rad-hard IP cores (converters, regulators, drivers/receivers, references, PLL etc).
- **Off-the-shelf solutions** for specific applications as telemetries & telecommand, housekeeping, Read-out electronic, Low power, High precision or High-speed conversion and data transmission (PHY Layer).
- Products listed under EPPL Part 1 (Soon)

#### **TECHNOLOGIES & TOOLs**

Technology nodes from 0.35µm to 22nm
 SFAB
 MICROCHIP

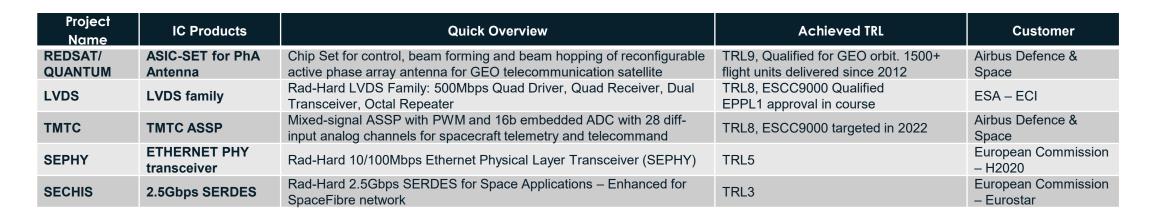


- Reliable design flow and EDA tools
- In-house radiation simulation tools, from SET injection to SEU Mitigation
- Dedicated radiation test instruments for SEE
  cross section and LET threshold determination





# **Microelectronics – IC & IP Products**



Project Name	IPs	Description	Achieved TRL	Technology node
COSMIC VISION	HF & MF ADC, DAC Bessel Filter, LNAs	Reconfigurable mixed-signal ASICs. (12b to 18b resolution, 100kSps to 10MSps)	TRL8 for MF ADC targeted 2022 TRL6 for the rest of IPs	180nm bulk Si
CARTU	13b, 100kSps ADC & DAC	ADC and DAC IPs for Avionics (OBC+PCDU) control in low-cost satellites	TRL5	250nm SiGe
BiCMOS	14b, 15MSps ADC	$\Delta\Sigma$ ADC IP with Scalable architecture & good trade-off performance vs power (compared to pipeline and SAR architectures)	TRL5 targeted in 2022	130nm SiGe
GENESIS	6.25Gbps SERDES 6.25GHz PLL	Rad-Hard 6.25Gbps SERDES for Space Applications – Enhanced for SpaceFibre, Ethernet, JESD204A/B network	TRL6 targeted in 2023	65nm bulk Si
EFESOS	9b 1-2GSps ADC & DAC	Rad-Hard High-speed ADC and DAC IP (9b, >1-2GSps)	TRL6 targeted in 2023	22nm FDSOI
MEDITC	TRACE Checker for ARM uP COTS	Low latency error detection and diagnosis approach trough TRACE interface of ARM COTS microprocessors	TRL5 targeted in 2022	Technology Agnostic

# **Microelectronic – ASICs for PhA Antenna**

# Vision/Goal

- ASIC-SET for In-orbit reconfigurability for active Electronically Steerable Antennas (coverage, frequency and power)
- · Beam hopping in Ku bands for GEO satellites communications
- RF signals conditioning under a Multi-Chip Module
- ESA ARTES program

# Target

# Spacecraft Equipment that requires:

- Beam-forming & beam-hopping
- Control and monitoring of RF MMICs elements
- Rad Hardened devices in die form

#### **Typical applications:**

- Control electronic for Phase Array Antennas
- Housekeeping

#### **Distribution:**

Europe: **Protec GmbH** Worldwide: TBD

#### Phase Shifters **Digital ASIC Digital ASIC I SPI PROTOCOL** ANTENNA ARQ-RSB02 ARQ-RSB02 MOSI INTERFACE CONTROL UNIT Shift Register Shift Register Mode Mode Clk Digital ASIC nCS ARQ-RSB02 nDBUFF Sensing BH-Clk Control Mode Tº/I . . . . $\downarrow$ $\downarrow$ $\downarrow$ **Digital ASIC Digital ASIC** Limits ARQ-RSB02 ARQ-RSB02 /Control Analog ASIC ARQ-RSA02 Shift Register Shift Register MISO POWER Mode Mode LNA MMIC Attenuators

## Status

- TRL9, Qualified and Flight heritage
- Lead-time: 1 year
- Quote on request

# **Product Name & description**

- ARQ-RSA02 Analog ASIC (Read telemetries of the active elements, LNA Control)
- ARQ-RSB02 Digital ASIC for Beam forming and control (embedded SRAM, Configuration of the RF MMICs Phase shifter & Attenuators)
- Nominal and Redundant Communication

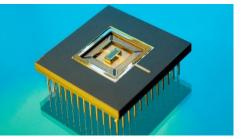
**Competitive advantages** 

Configurable solution

• Fully European, ITAR free

• Thousands of flighting units (Hispasat 36W-1)

MMIC



#### **Product Features** ANALOG ASIC (ARQ-RSA02)

- Current and T<sup>o</sup> sensing
- Over-current detector
- 8.6V switch (200mΩ Rds ON)
- 8b embedded SAR ADC
- Power on reset
- TID >50 Krad(Si), SEL free

#### **DIGITAL ASIC (ARQ-RSB01)**

- Dual Mode ASIC (A/B pin)
- Mode A: Control ASIC mode
- Mode B: Shift Register 24b/48b
- 32 SRAM locations
- <0.5ms dwell time</p>
- TID>120 Krad(Si), SEL/SEU free

#### Available options

Hard dice/wafer for MCM CPGA100





ARQ-RSA02 ARQ-RSB02 DSH Case Study

PDF

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# **Microelectronic – LVDS Family**

LVDS Octal Repeater

## Vision/Goal

- European alternative for LVDS transceivers ITAR/EAR free
- Improved compatibility with SpaceWire standard
- Specific Features for space (Cold spare, Extended Common Mode, Fail-Safe, etc..)

ENCK

CLKIN+¢

CLKIN-

END

IN[1..8]+ 0

IN[1..8]

ENG

FN/G

IN[1..4]

- High data transfer rate
- European Component Initiative program (ESA-ECI)

# Target

#### Any spacecraft Equipment that Requires:

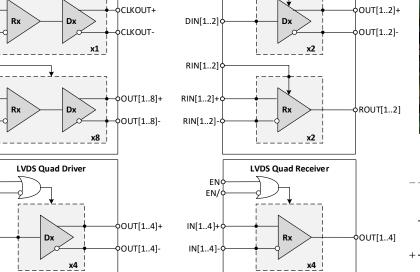
- Noise tolerant transmission along twisted pair cables at high data-rates (500Mbps)
- · Low EMI and low power
- Maturity of LVDS Standard
- Rad-Hardened devices

#### **Typical applications:**

- SpaceWire network
- Clock distribution networks
- Coldspare buffer
- Command & Data Handling

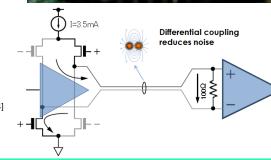
#### Distribution:

Protec GmbH Europe: Worldwide: TBD



DEN[1..2]

# RadHard 500Mbps LVDS Octal Repeater



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# **Product Features**

- ANSI EIA/TIA644A standard
- 500Mbps Channel data rate
- · Low Channel skew and jitter
- Extended CMI [-4V to +5V]
- · Cold-spare in all pins
- Fail Safe protection
- LVDS Input hysteresis
- TID: 300 kRad(Si)
- SEL immune
- BER <10-13 err/bit (GEO Orbit)
- 8kV ESD protection
- [-55 to 125°C]

#### Available options

- Soft IP /Hard Dice/Wafer
- Space-grade Ceramic
- Hi-rel Plastic

#### **Related Documentation**



LVDS Driver LVDS receiver

# Status

- TRL8 ESCC9000 Qualified
- EPPL1 Approval for LVDS Driver and Receiver
- Lead time: 12 weeks
- Quote on request

# **Competitive advantages**

**Product Name & description** 

• RadHard 500Mbps LVDS Quad Driver

RadHard 500Mbps LVDS Quad Receiver

RadHard 500Mbps LVDS Dual Transceiver

- I ow cost and lead time for ceramic
- High performances (speed, cold-spare, extended input common mode, Hysteresis, fail-safe)
- Fully European, ITAR free





LVDS Dual Transceiver

# 

# Microelectronic – TMTC ASSP (16b ADC)

## Vision/Goal

- Need for improved integration of satellite RIU/RTU and ICU equipment's
- No other full-integrated TMTC alternative for space ITAR/EAR free
- ESA GSTP program

## **Product Name & description**

- AQTMC01 RadHard TMTC device with embedded 16-bit ADC, 100kSps Nominal
- Acquire telemetries from sensors (thermistors, gauges, magnetometers, star trackers, sun sensors) in spacecraft subsystems

• Generate telecommands for actuators (reaction wheels, control moment gyroscopes, magnetorquers, flow control and latch valves, catalytic bed heaters)

# Target

#### Any spacecraft Equipment,

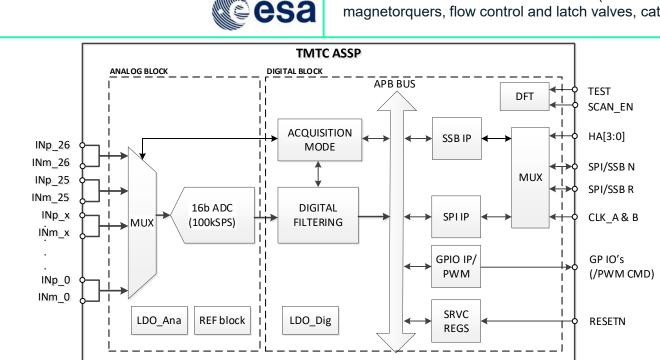
- specially concerning:
- Propulsion
- The AOCS (Altitude and Orbit Control System)
- The SADE (Solar Array Drive Electronics).

#### **Typical applications:**

- Remote Terminal Unit
- Remote Interface Unit
- Instrument Control Unit

#### **Distribution:**

Europe: Protec GmbH Worldwide: TBD



# **Competitive advantages**

- High integration
- Low cost compared to other solutions
- Configurability (channel sweep, latency, precision)
- European supply chain, ITAR free

## **Product Features**

• 54s.e./27diff. Acq. channels.

- 10µA /100µA /1mA biasing
- Continuous / sweep modes.
- Input common mode control
- Built-in 50 kHz anti-alias & Configurable digital filter
- 16-bit res., 100kSps Nom.
- LVCMOS/ LVTTL levels
- PWM & voltage monitoring
- functions [100Hz to 10MHz].
- 20MHz Dual SPI (N&R).
- Cold-spare & 2kV ESD HBM
- LDO with over-current protecto
- TID above 50 krad(Si).
- SEE free >37 MeV·cm2/mg.
- SEL immune

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#### Available options

CQFP-100 package.

#### **Related Documentation**



TMTC ASSP DSH AMICSA Paper 2021

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• Electrical Characterization PASS

Silicon ready

Status

- Radiation Characterization in course
- TRL8 by Q3 2022

# Microelectronic – 6.25Gb SERDES IP

## Vision/Goal

• High demand for High-speed Interfaces (dada handling, processing, digital payload building blocks)

Status

• Design phase on-course

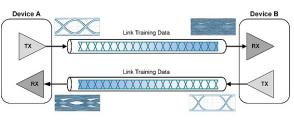
• TRL6 by Q4 2023

Licensing model

- RadHard SERDES IP for TSMC65 technology ITAR/EAR free
- Development in the frame of ESA GSTP program

## **Product Name & description**

- AQIPS6501 1 to 6.25 Gbps SERDES transceiver with embedded 8b/10b encoding (multiprotocol)
- Pre-emphasis and DFE Equalization
- Interfaces to backplane, copper cables or optical converters





## Target

Any spacecraft Equipment that Requires:

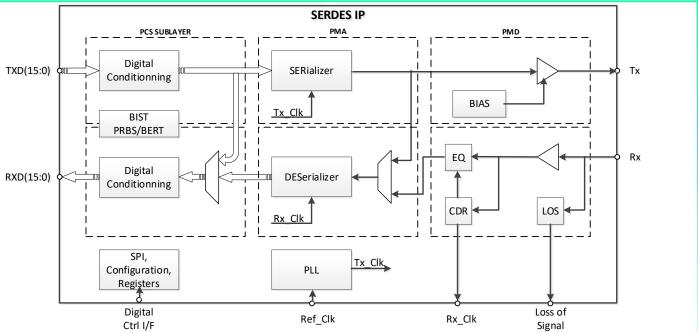
- Noise tolerant data transfer along twisted pair cables at very high data-rates
- Low EMI and low power
- Rad-Hardened devices

#### **Typical applications:**

- Spacefibre network
- Gb Ethernet network
- XAUI / RapidIO /JESD204B
- GNSS instruments

#### Distribution:

- IMEC DARE65 Library
- PROTEC



## **Competitive advantages**

- No alternative for RH SERDES IP under TSMC65nm technology
- Multiprotocol and programable speed
- Multilane

## **Product Features**

- 65nm CMOS process
- 1 to 6.25 Gbps Tx/Rx NRZ
- 8-Bit/10-Bit Encode/Decode & Comma Detect
- Low Power < 500mW
- Tristate Power < 5mW
- Multilane capability
- [-55°C to +125°C)]
- TID > 100 kRad
- BER<1E-12err/bit-day (GEO)
- SEL immune

#### Available options

CQFP-68 package
 Soft IP

#### **Related Documentation**





# Microelectronic – 6.25Gb PLL IP

# 

## Vision/Goal

- PLL are key elements of CMOS technologies.
- RadHard PLL IP for TSMC65 technology ITAR/EAR free
- Widely used for HSSL and Clock generation.
- State of the Art: 1.2GHz under TSMC65 technology.
- Development in the frame of ESA GSTP program

# Target

#### System-on-chip or ASIC that requires

- Precise High-frequency clock
- Low jitter

#### **Typical applications:**

- Synchronisation and clock multiplying purposes
- Clock recovery
- · Clock generation and distribution
- High-Speed Serial Links (Gb Ethernet, SpFi, RapidIO, JESD204B)

#### Distribution:

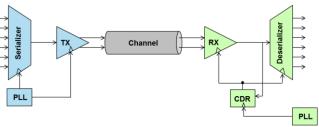
- IMEC DARE65 Library
- PROTEC

#### PROGRAMMABLE PLL IP LOW PASS PHASE CHARGE PUMP CLK Ref → CLK Out DETECTOR FILTER DW 2 GHz Frequency Divider (/4 /2 /1) **Competitive advantages** Rad-Hardened Compliant with most common HSSL standards

esa



- AQIPPLL0x programmable low-jitter PLL
- Compliant with most common space telecommunication standards



## **Product Features**

- 65nm CMOS process
- 312,5 MHz Input Clock
- Input Jitter > 70us
- Output frequencies:
- 1, 1.25, 1.5625, 2, 2.5, 3.125, 5,
- 6.25 GHz
  - Output jitter < 24ps peak-peak or 0.1UI (~1.7ps RMS).

#### Available options

Soft IP

#### **Related Documentation**

Design files (confidential)



- Design phase on-course
- TRL6 by Q4 2023



# Microelectronic – 9b, 1-2GSps ADC IP **EARQUIMEA**

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European Commission

## Vision/Goal

- High demand for Gigabit speed ADCs (and nearly 10b resolution)
- RadHard ADC IP for GF FDX 22nm FDSOI technology ITAR/EAR free
- DARE22 Digital library for critical applications.
- GF 22nm is extensively used in automotive sector and targets new-space.

Status

Design phase in-courseTRL6 by Q4 2023

• Development in the frame of H2020 program

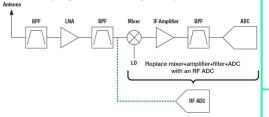
# Target

# Any spacecraft Equipment that Requires

- Front-end electronics for
  gamma-ray, Xray, visible
- gamma-ray, Xray, visible and infrared detection
- L-Band RF communication

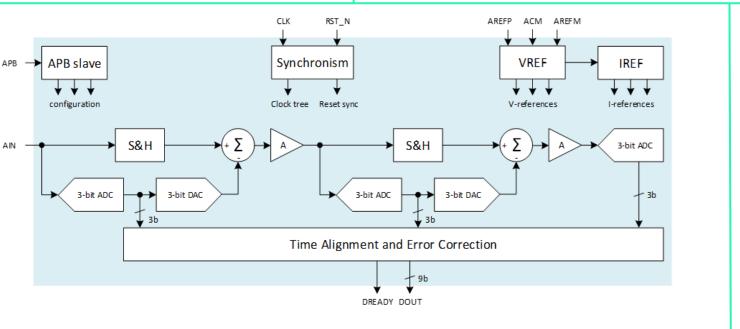
#### **Typical applications:**

- Radio, imager, spectrometer
- Earth Obs. SAR Radar
- L band Up/Down conversion (e.g. GNSS signals)



#### Distribution:

- IMEC DARE22 lib.
- GF FDX Accelerator



## **Product Name & description**

- AQIPADC0x 9b, 1-2Gsps RadHard ADC
- Pipelined Architecture
- Target mainly direct down conversion applications

## **Competitive Advantage**

- Reduces the parts count compared to former systems (avoid mixers, LO synthesizers, amplifiers, filters), the board size and power
- Better configurability

## **Product Features**

- 22nm FDSOI process
- 9b Resolution
- 6b ENOB
- INL=5LSB
- DNL=1LSB
- 1 to 2GHz sampling frequency
- Differential Inputs
- Input Full-scale>0.4mA
- Power consumption<1.5W
- VDDA=1,8V & 0,8V
- VDDD=0,8V
- Input clock jitter < 1ps rms</li>

#### Available options

Soft IP

#### **Related Documentation**

• Design files (confidential)

# Microelectronic – 9b, 1-2GSps DAC IP

## Vision/Goal

- High demand for Gigabit speed ADCs (and nearly 10b resolution)
- RadHard ADC IP for GF FDX 22nm FDSOI technology ITAR/EAR free
- DARE22 Digital library for critical applications.
- GF 22nm is extensively used in automotive sector and targets new-space.
- Development in the frame of H2020 program

# Target

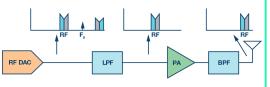
# Any spacecraft Equipment

that Requires:

• L-Band RF communication

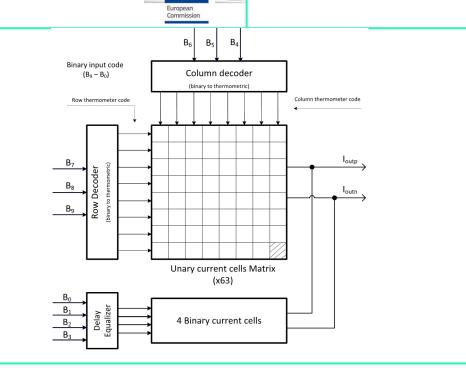
#### **Typical applications:**

• L band Up/Down conversion (e.g. GNSS signals)



Distribution:

- IMEC DARE22 lib.
- GF FDX Accelerator



## **Product Name & description**

- AQIPDAC0x 9b, 1-2Gsps RadHard DAC
- Segmented current steering Architecture
- Mainly target direct up-conversion applications

# **Product Features** 22nm FDSOI process 9b Resolution 6b ENOB • INL=0.5LSB • DNL=0.5LSB 1 to 2GHz sampling frequency Differential Outputs Power consumption<120mW</li> • VDDA=0.8V • VDDD=0.8V Available options Soft IP **Related Documentation** Design files (confidential)

# Status

- Design phase in-course
- TRL6 by Q4 2023

## Competitive Advantage

- Reduces the parts count compared to former systems (avoid mixers, LO synthesizers, amplifiers, filters), the board size and power
- Better configurability

# Microelectronic – 14b, 15Msps ADC IP

## Vision/Goal

- · High demand for precision ADCs for TMTC applications
- RadHard ADC IP for IHP 130nm BiCMOS technology ITAR/EAR free

Status

TRL4 - Silicon readv

• TRL6 by Q4 2022

• Elect. & Rad characterization at Test Chip Level

- Design platform of IHP's 130nm technology for space applications
- Scalable architecture

## **Product Name & description**

- AQIPADC0x 14b resolution, 15MSps RH ADC
- MASH 1-1  $\Delta\Sigma$  ADC Architecture
- Target mainly TMTC and video applications

**Competitive Advantage** 

 $\rightarrow$  Conversion speed of rad-hard pipeline ADCs  $\rightarrow$  Power consumption of rad-hard SAR ADCs

with good

Scalable architecture

performance vs power

## Target

#### Any spacecraft Equipment Specifically:

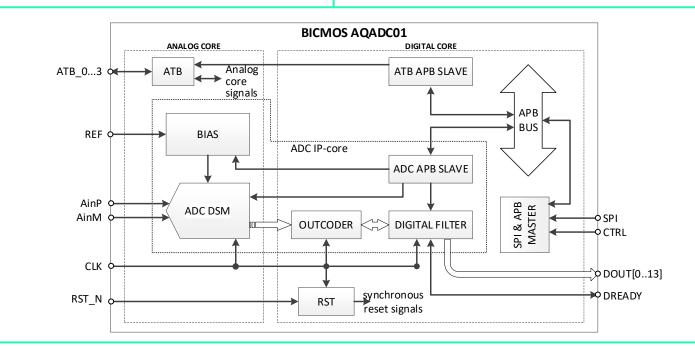
- Propulsion
- The AOCS (Altitude and Orbit Control System)
- The SADE (Solar Array Drive Electronics).

#### Typical applications:

- TT&C (telemetry, tracking and control)
- Mixed Signal IP for SoCs

#### Distribution:

IHP130 RH library



## **Product Features**

- 130 nm BiCMOS process
- 14b Resolution
- 13b ENOB
- INL=1 LSB
- DNL=0.5 LSB
- 10 to 15MHz sampling frequency
- Differential Inputs
- Input Full-scale=200mV
- Power consumption<100mW</li>
- VDDA=1,2V ; VDDD=1,2V
- TID above 500 krad(Si).
- SET free >20 MeV·cm2/mg.
- SEU/SEL immune

#### Available options

Soft IP/ Hard Dice

#### **Related Documentation**

یگر ₽DF

**BICMOSADC** 

paper

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trade-off

# Microelectronic – 16b, 100ksps ADC IP

## Vision/Goal

Target

Specifically:

Propulsion

Control System)

Electronics).

- · High demand for precision ADCs for TMTC applications
- RadHard ADC IP for UMC180L technology ITAR/EAR free
- DARE180U Design platform for space applications
- Configurable architecture
- Development in the frame of ESA COSMIC VISION program



# **Product Name & description**

- AQIPADC0x 16b resolution, 100ksps RH ADC
- Over-sampling  $\Delta\Sigma$  ADC Modulator
- Target mainly TMTC applications

#### Any spacecraft Equipment $\kappa_{ff}$ • The AOCS (Altitude and Orbit $\overline{Z}$ • The SADE (Solar Array Drive $V_{in}$ $\frac{1}{Z-1}$ $\frac{1}{Z}$ $\overline{Z-1}$

## Typical applications:

- TT&C (telemetry, tracking and control)
- Mixed Signal IP for SoCs

#### Distribution:

DARE180L library

# Status

• TRL6

Implemented in ARQUIMEA TMTC ASSP

## **Competitive Advantage**

- Scalable architecture with good trade-off performance vs power
  - $\rightarrow$  Conversion speed of rad-hard pipeline ADCs

 $\rightarrow$  Power consumption of rad-hard SAR ADCs

## **Product Features**

- 180 nm CMOS process
- 16b Resolution
- 15b ENOB at 100kSps (typ.)
- INL=0.5 LSB
- DNL=0.5 LSB
- 13,6MHz sampling frequency
- Differential Inputs
- 15mW Power consumption
- VDDA=1,2V ; VDDD=1,2V
- TID > 300 krad(Si).
- SER > 1E-10 Err/bit/dav
- SEL immune

 $d_{out}$ 

DAC

#### Available options

Soft IP/ Hard Dice

#### **Related Documentation**

PDF 16b 100ksps ADC paper



# **Microelectronic – MEDITC IP**

## Vision/Goal

Any spacecraft Equipment

SEU/SEFI radiation mitigations

• High performance ARM uP

**Typical applications:** 

→ Hyperspectral imaging

 $\rightarrow$  Data processing (FFT)

 $\rightarrow$  Image & SAR processing

Artificial Intelligence

 $\rightarrow$  Data filtering (FIR)

Signal treatment:

 $\rightarrow$  Data acquisition

that Requires:

• OBC

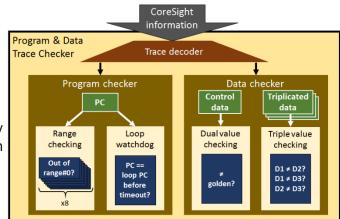
- COTS Microprocessors are being intensively used for space
- MEDITC offers a non-intrusive solution to mitigate SEE in ARM uP
- Development in the frame of IDEAS COTS campaign (ESA)

Target

# esa

## **Product Name & description**

- MEDITC IP core proposes a low latency error detection and diagnosis approach trough TRACE interface of ARM uP:
  - $\rightarrow$  Program checker (range, watchdog)
- $\rightarrow$  Data checker (Control, Consistency)



# **Product Features**

- Suitable for ARM microP
- Online operation in real-time
- detection
- Comprehensive error diagnosis

#### Available options

- Soft IP
- Space-grade Ceramic TBC
- Hi-rel Plastic TBC

#### **Related Documentation Design Files (Confidential)**

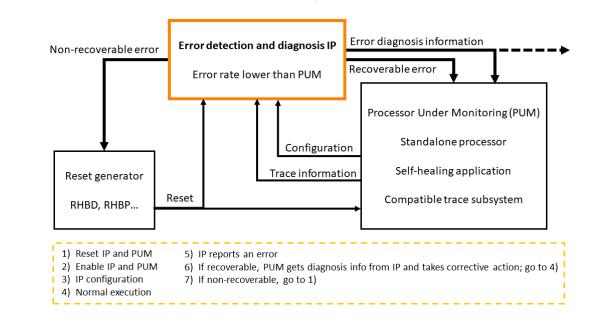


### **Distribution:**

Protec GmbH • Europe:

 $\rightarrow$  Data compression (CCSDS)

Worldwide: TBD



# Status

- TRL4 currently
- TRL5/6 in 2022
- → Microsemi SAMV71RT (Cortex-M7)
- $\rightarrow$  Xilinx Zyng Ultrascale+ (Cortex-A53)

# **Competitive advantages**

- · Easily Configurable, with multicore uP
- Disruptive IP
- Fully European

- Ultra-low latency error
- Reduced footprint
- User-configurable
- Multicore support

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# **Microelectronic – 2.5Gbps SERDES IC**

## Vision/Goal

- Need of very High-speed Interfaces (increasing amount of dada handling)
- Replacement of Texas Instrument TLK2711 (due to obsolescence)
- Better SpaceWire compatibility than TLK2711
- Development in the frame of European Commission Eurostar program
- European alternative for SERDES transceivers ITAR/EAR free

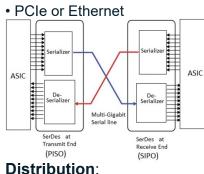
# Target

#### Any spacecraft Equipment that Requires:

- Noise tolerant data transmit along twisted pair cables at very high data-rates
- · Low EMI and low power
- Rad-Hardened devices

#### Typical applications:

SpaceFibre network



IMEC DARE65 Library

PROTEC

#### Digital TXD(15:0) SERializer Conditionning BIAS <u>Tx</u> Clk BIST PRBS/BERT EO Digital DESerializer RXD(15:0) Conditionning CDR Rx Clk SPI, Tx\_Clk Configuration. PLL Registers Digital CLK REF Rx Clk Ctrl I/F Signal

## Status

- Silicon ready (Rx not compliant)
- On-hold (Pending Rx fix cause identified)

## **Product Name & description**

**Competitive Advantage** 

• Unique alternative to TLK2711 as Integrated

- SECHIS AQSRD01 RadHard 1.6-2.5 Gbps SERDES transceiver device with embedded 8b/10b encoding
- · Interfaces to backplane, copper cables or optical converters



# SERDES IP PMA PMD PCS SUBLAYER Тх Rx LOS 🗲 Loss of

Circuit

# **Product Features**

- 130nm BiCMOS process
- 1.6 to 2.5 Gbps Tx/Rx
- 8-Bit/10-Bit Encode/Decode & Comma Detect
- Low Power < 500mW
- Tristate Power < 5mW</li>

#### • [-55°C to +125°C)]

- TID > 100 kRad
- LET(SEU)> 30MeV/mg/cm<sup>2</sup>
- BER<1E-12err/bit-day (GEO)
- SEL immune

#### Available options

- CQFP-68 package
- Soft IP

#### **Related documentation:**



SECHIS Datasheet



# **Microelectronic – 10/100M Ethernet PHY**

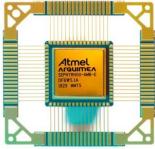
## Vision/Goal

- Ethernet standard is being widely implemented in space
- No RadHard Ethernet Phy alternative for space
- Development in the frame of H2020 program
- ITAR/EAR free



# **Product Name & description**

- SEPHY RadHard Ethernet 10BASE-T/100BASE-TX
- Full duplex mode
- Space-validated Time-Triggered Ethernet for deterministic real-time communication



# **Product Features**

- 150nm SOI process (ATMEL)
- IEEE 802.3
- Full Duplex
- 10 and 100 Mb/s
- Programmable loopback
- [-55°C to +125°C]
- Cold spare functionality
- MI & MII/RMII MAC I/F
- TID > 100 kRad
- LET(SEU)>30MeV/mg/cm<sup>2</sup>
- BER < 10-12 errors/bit-day (GEO orbit)
- SEL immune

#### Available options

- Soft/Hard IP
- Space-grade ceramic QFP64
- Hi-Rel Plastic

#### **Related documentation:**

http://www.sephy.eu/



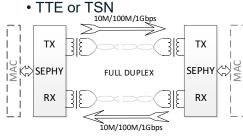
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#### Target Any spacecraft Equipment, specially for:

- Launchers
- Constellations
- Planetary mission
- Manned missions
- Harsh environment Installation (CERN)

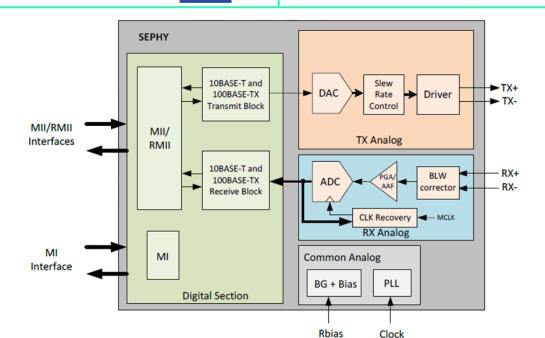
#### **Typical applications:**

Deterministic ethernet



#### Distribution:

- Europe: PROTEC
- Worldwide: TBD



Status

• TRL5, Pending Qualification

# **Competitive Advantage**

• Unique Rad-Hard Ethernet PHY IC in the market

# Microelectronic – Design & Test Services

## ASIC and IP Design for space applications

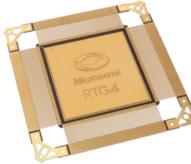
- Trade-off analysis for suitable technology selection and procurement flow
- Turnkey solutions from specification to space qualification
- Rad-Hardening of digital cells and analog IPs of the technology
- Test Vehicles and internal block design & characterization (Electrical & Radiation)
- Technology access and manufacturing
- Final design evaluation & qualification Test campaigns management
- **Product Assurance** based on ESCC/MIL standards



- Trade-off analysis for suitable FPGA selection
- Rad-Hardening by design based on customer specification
- Verification of SEU/SET mitigation technique's proper implementation applied at RTL or netlist level

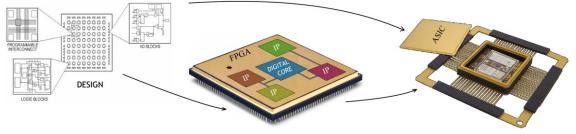
#### Heritage:

- Implementation and verification of space FPGAs (RTXA2000S & RTAX250) for Airbus DS based on ECSS-Q-60B – TRL9 achieved
- Implementation of standard and Rad-Hardened Test Vehicles for the SEE radiation characterization of RTG4 FPGA from Microchip under ESA project



## **FPGA to ASIC conversion**

- **Trade-off analysis** to assess on suitability for FPGA to ASIC conversion based on BOM costs, performances, integration and/or Power consumption requirements.
- Custom procurement flow and Long-term supply commitment
- **Design support** for RTL and netlist adaptation as well as SET/SEU mitigation.
- Design verification and validation based on ESCC/MIL standards



## Services for technology evaluation and qualification

- Electrical & Radiation Characterization of EEE parts (COTS, ASICs, FPGAs etc...)
- SEE/TID Test campaigns under Heavy Ion and Proton, Gamma ray
- Design assessment & consulting services
- Product Assurance Support (ESCC/MIL)

#### <u>Heritage:</u>

- Test Vehicle implementation and SEE tests on own and external products
- Radiation testing on SG13S & SGB25RH technologies from IHP.
- Design evaluation, Electrical, ESD and radiation characterization of space SoCs



# **EARQUIMEA**

Passion For Technology

Ferran Tejada

**Business Development Director** 

ftejada@arquimea.com

+49 (0) 173 618 1828

arquimea.com

# **EARQUIMEA**

Passion For Technology

## **Adrien Frouin**

Business Development Manager Microelectronics & Electronics <u>afrouin@arquimea.com</u> +34 91 689 80 94

Ana Fernandez

Business Development Manager Mechanisms and MAIT <u>afernandez@arquimea.com</u> +34 91 689 80 94

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