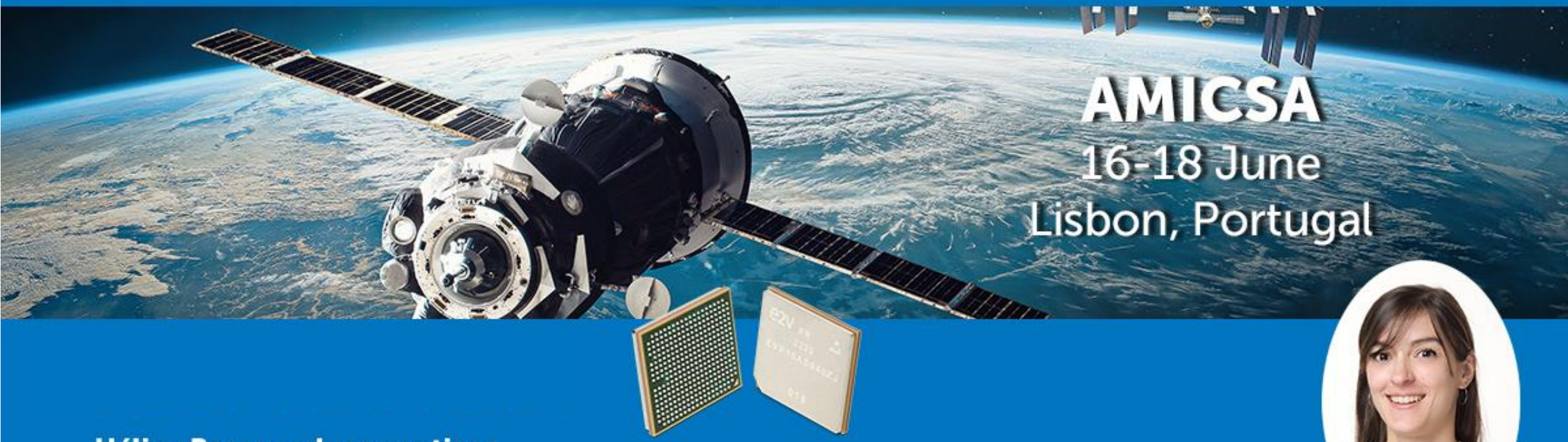
TELEDYNE | Teledyne e2v Semiconductors



# AMICSA
16-18 June
Lisbon, Portugal



**Héline Barneoud, presenting:**

"A 33 GHz Bandwidth 12.8 GSps 10-bit Analog-to-Digital Converter for Space and Ground Applications Enabling Direct Ka-band Conversion"

Tuesday, June 17th 2025

# Agenda



## Introduction

- Teledyne e2v Semiconductors

## Zoom on Teledyne Data converters for space application

- Key highlights and Target Applications
- Space Qualification Strategy
- Space Heritage

## Zoom on Teledyne EV12AS940 for space application

- EV10AS940 Features
- EV10AS940 performances
- EV10AS940 Timeline

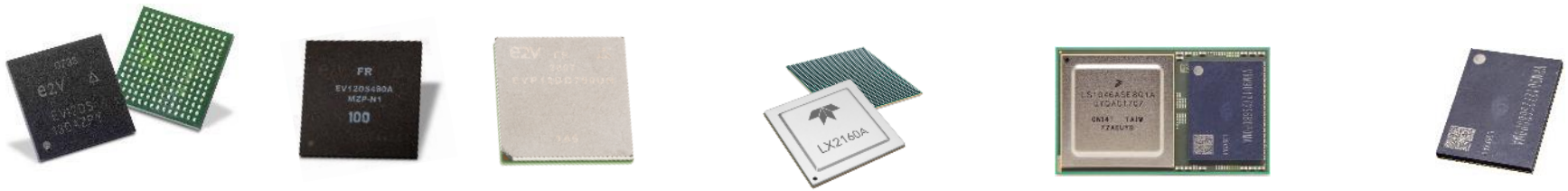
# Introduction

Teledyne e2v Semiconductors

# Teledyne e2v Semiconductors

**Teledyne e2v offers a large portfolio of high-reliability semiconductor solutions including high-speed data converters and advanced microprocessors. We also provide manufacturing and test services for high reliability markets.**

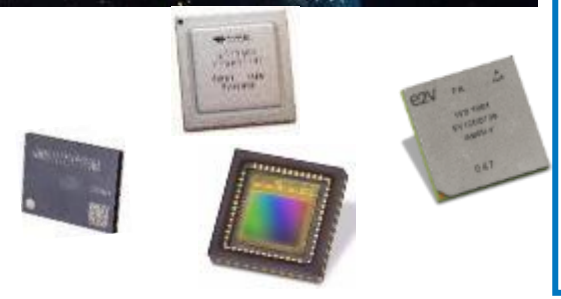
Teledyne e2v's unique approach involves listening to the market and application challenges of customers and collaborating with them to provide innovative standard, semi-custom or fully custom solutions, bringing increased value to their systems.






TELEDYNE e2v Semiconductors

# Teledyne e2v Semiconductors



High performance Semiconductors

System in Package & Firmware

Operation & Manufacturing Services

*Founded in 1955 in Grenoble*

*A 100% Teledyne subsidiary since 2017*

*400 employees*

*200 engineers*

## Qualification for Space

- Teledyne e2v's space qualification experience for ceramic, plastic packages and modules
- Flexibility in qualification flow and reliability level versus cost

QML Class-V

QML Class-Y

QML Class-Q

NASA Level 1/2/3

X1 New Space



TELEDYNE e2v Semiconductors

# Zoom on
# Teledyne e2v – Data Converters

Teledyne e2v – Signal Processing Solutions

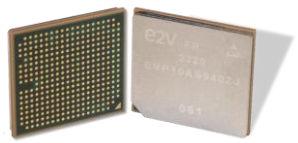
June 2025

# Teledyne e2v Data Converter Solutions



## Proven, cutting-edge Analog-to-Digital and Digital-to-Analog Converter designed for space

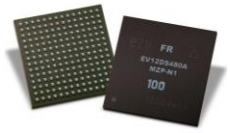
- **High-Speed/High-Bandwidth Data Converters**
  - Extending capability for Software Defined Radio architectures up to Ka-band,
- **Designed and qualified for space**
  - Over 6,000 Flight Model delivered,
  - Best in class radiation performance,
  - Qualification flow versatility from Teledyne e2v X1 up to QML-V to support all type of mission with the same component,



**EV10AS940**
ADC, 12.8GSps, Ka-band

**EV12AQ600**
ADC, 6.4GSps, C-band

**EV12DD700**
DAC, 12GSps, K-band



**EV12DS480**
DAC, 8GSps, C-band

**EV12DS130**
DAC, 3GSps, C-band



TELEDYNE e2v Semiconductors

# Teledyne e2v Semiconductor Solutions

## Addressable Projects & Target Applications in Space

**Satellites**: Intelligence Gathering,
Earth Observation, Communication, …

Payload Sensing (Observation)

Payload Transponders (Telecom)

Payload GNSS (Location)

Data Link / TT&C (To ground & sat-to-sat)

Satellite Bus Routing of data

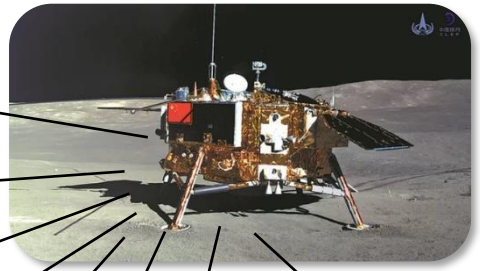
Power Management

Propulsion

Positioning

Sub-system Control / Monitoring / Watchdog

**Space Landers, Launch Vehicules**



Payload

Space Avionics

Robotics

Power Management

Bus Routing of data

Data Link / TT&C

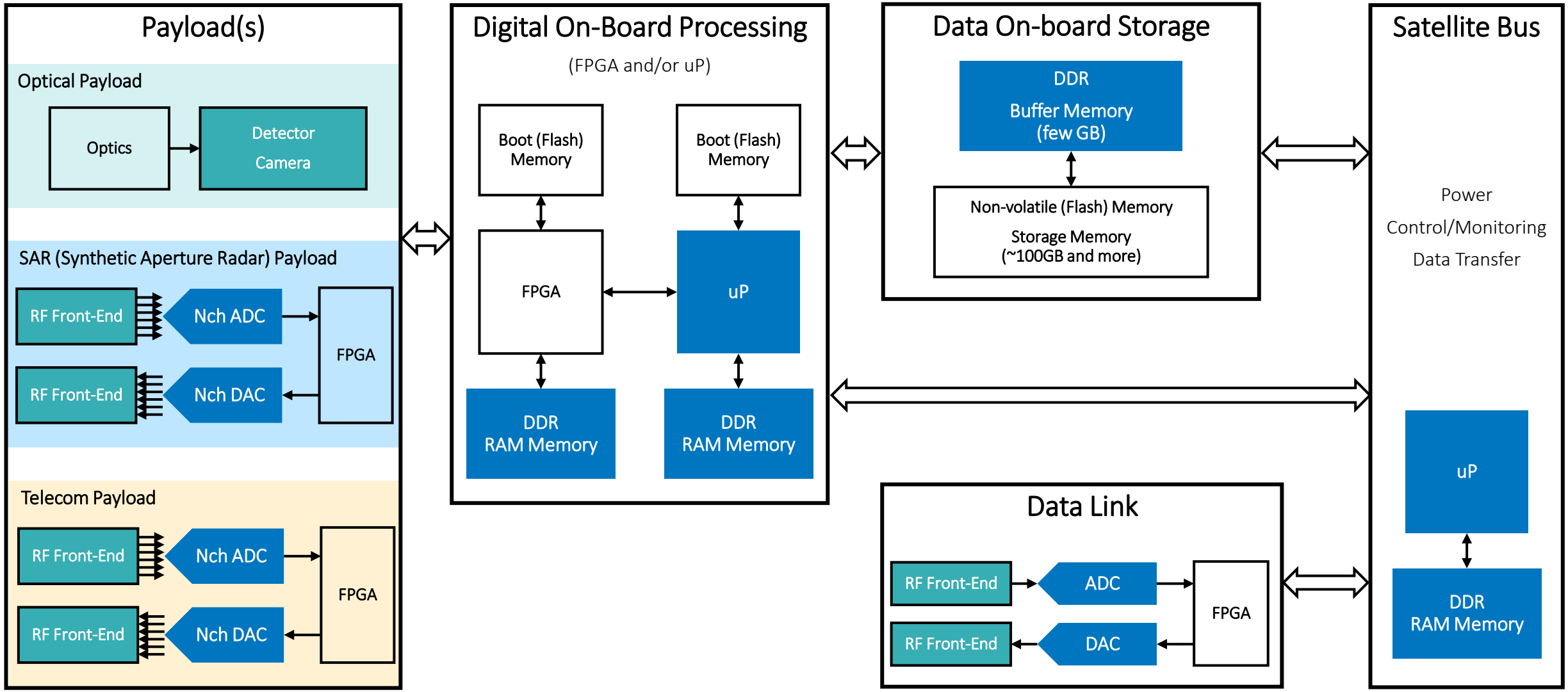
Positioning

Sub-system Control / Monitoring / Watchdog

*Addressable with Teledyne e2v Signal Processing Solutions*

# Satellite – High level Architecture





# Versatility of Space Quality Level

## Enabling optimized qualification level vs. cost for each mission with a single platform

## New Data Converters quality flow

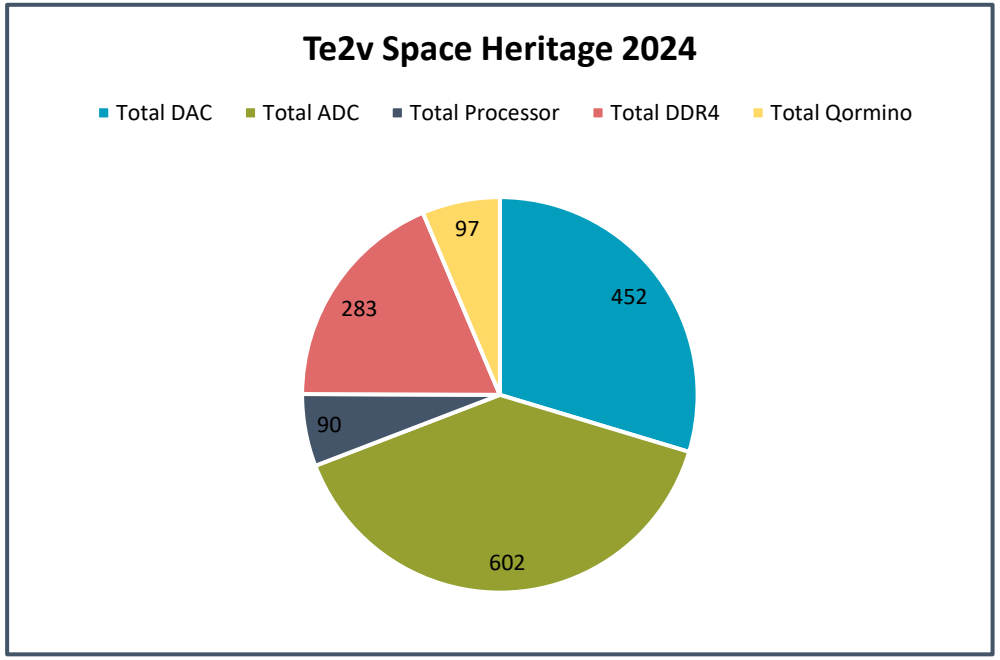
| | | QML-Y | Nasa 1 (N1) | ECSS 1 (E1) | ECSS 3 (E3) | New Space (X1) |
|---|---|---|---|---|---|---|
| Space Screening | Temperature cycling | Yes | Yes | Yes | No | Yes |
| | Burn-in | Yes | Yes | Yes | No | No |
| | CSAM or X-Ray (Non destructive analysis) | 100% | 100% | 100% | No | Sampling |
| | Serialization | Yes | Yes | Yes | No | No |
| Lot Qualification | Single Lot Date Code | Yes | Yes | Yes | Yes | Yes |
| | Quality Conformance Inspection or Lot Acceptance (Life & Stress Tests) | Yes On Date Code | Yes On Trace Code | Yes On Trace Code | Yes On Trace Code | No |
| | DPA (Destructive Physical Analysis) | On request | Yes | Yes | Yes | No |
| Radiation Performance | Designed for Space | | | | | |
| | TID | 100K rad (SI) | 100K rad (SI) | 100K rad (SI) | 100K rad (SI) | 100K rad (SI) |
| | SEE (Data available up to) | > 60MeV.cm2/mg | > 60MeV.cm2/mg | > 60MeV.cm2/mg | > 60MeV.cm2/mg | > 43MeV.cm2/mg |
| | Temperature range | -55 to +125°C | -55 to +125°C | -55 to +125°C | -55 to +125°C | -55to +125°C |

# Teledyne e2v Semiconductors – Space Heritage

## 2024 Overview

**Highlights 2024:**

- ~1,400 flight models delivered in 2024,
- Continued, strong heritage of our space DAC portfolio (DS130/DS480),
- Milestone of 4,000 DS130 FM shipped passed in 2024,
- Milestone of 500 AQ600 FM shipped passed in 2024 (qualified in 2022),
- Milestone of 500 DDR4 FM shipped passed in 2024 (qualified in 2022),
- More and more project implementing our DDR4 4GB and 8GB. Some already launched and more getting closer to flight,

# Zoom on
# Teledyne e2v – EV10AS940

Teledyne e2v – Signal Processing Solutions

June 2025

# Direct conversion up to Ka Band

## Space and Defence Applications

**Jamming**
Prevent comms or detection

**Radar**
Detect objects

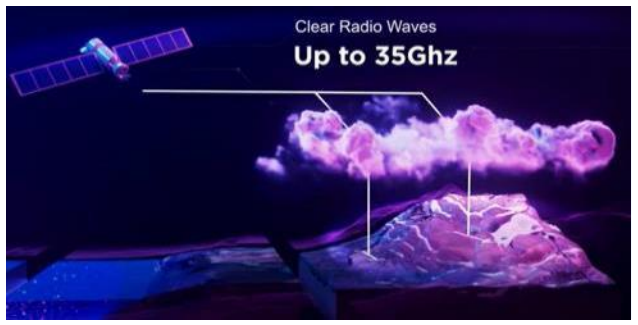
**Governmental Space**
Secured Communication

**Spectrum Surveillance**
Detect threats

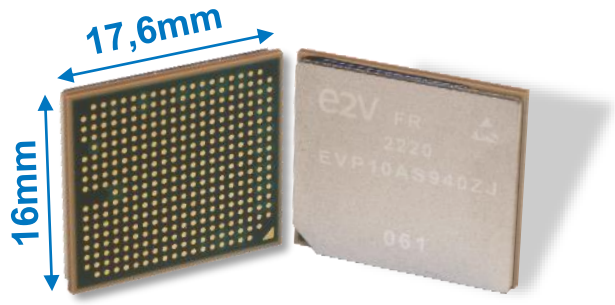
# Teledyne e2v EV10AS940:

## Military and Space grade, low power, Ka-Band capable ADC

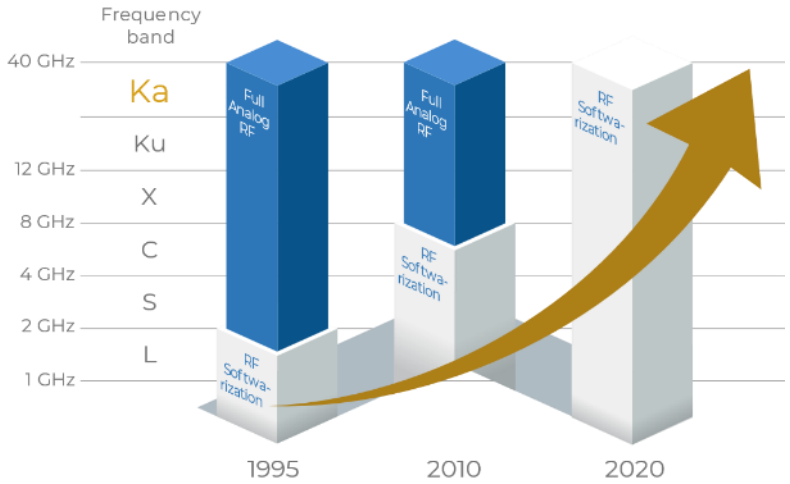
Radiation hardened by design.




Direct conversion up to 35GHz with very clean signals.



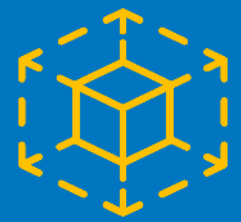

**Multiple frequency bands, from L-Band to Ka-Band.**




RF Softwarization


Gain reconfigurability

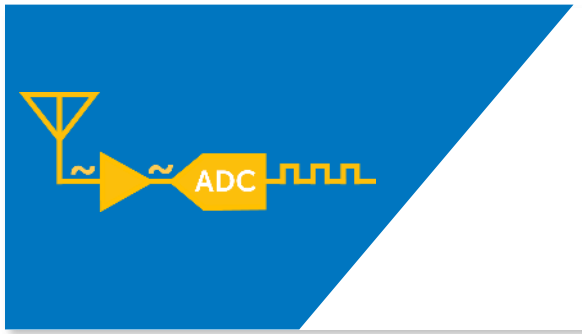
Single ended analog input



Gain Space & Cost

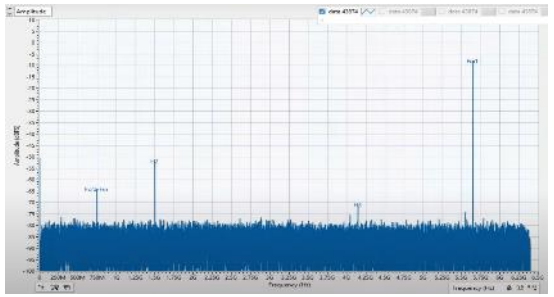
# EV10AS940: Military & Space, low power, Ka-Band ADC

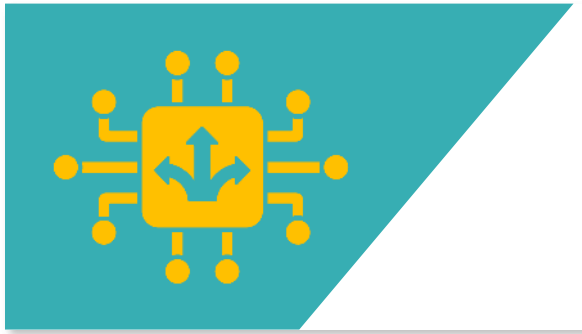





## Single ended Direct conversion up to 35GHz

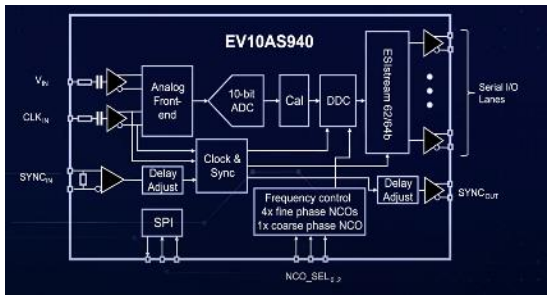
- 6GHz Instantaneous Bandwidth with 12.8GSPS.
- 44dBc SFDR at 28GHz at –6dBFS; 38dBc SFDR at 35GHz at -6dBFS.
- 31dB NPR between 25.6GHz to 32GHz.
- No need for baluns, removal of balun distortion effects and board space.





## Digital features

- Fast frequency hopping (30ns).
- Deterministic latency high speed serial interface (ESIstream)
- 4x Digital Down Conversion Channels.
- Scalable Chained SYNC.




## Radiation hardened by design and space qualified

- The only Space qualified Ka-band ADC.
- QML-Y Qualified.
- TID 100krad, Latchup free, 64mEV SEL, 100Krad ELDRS-Free



TELEDYNE e2v Semiconductors

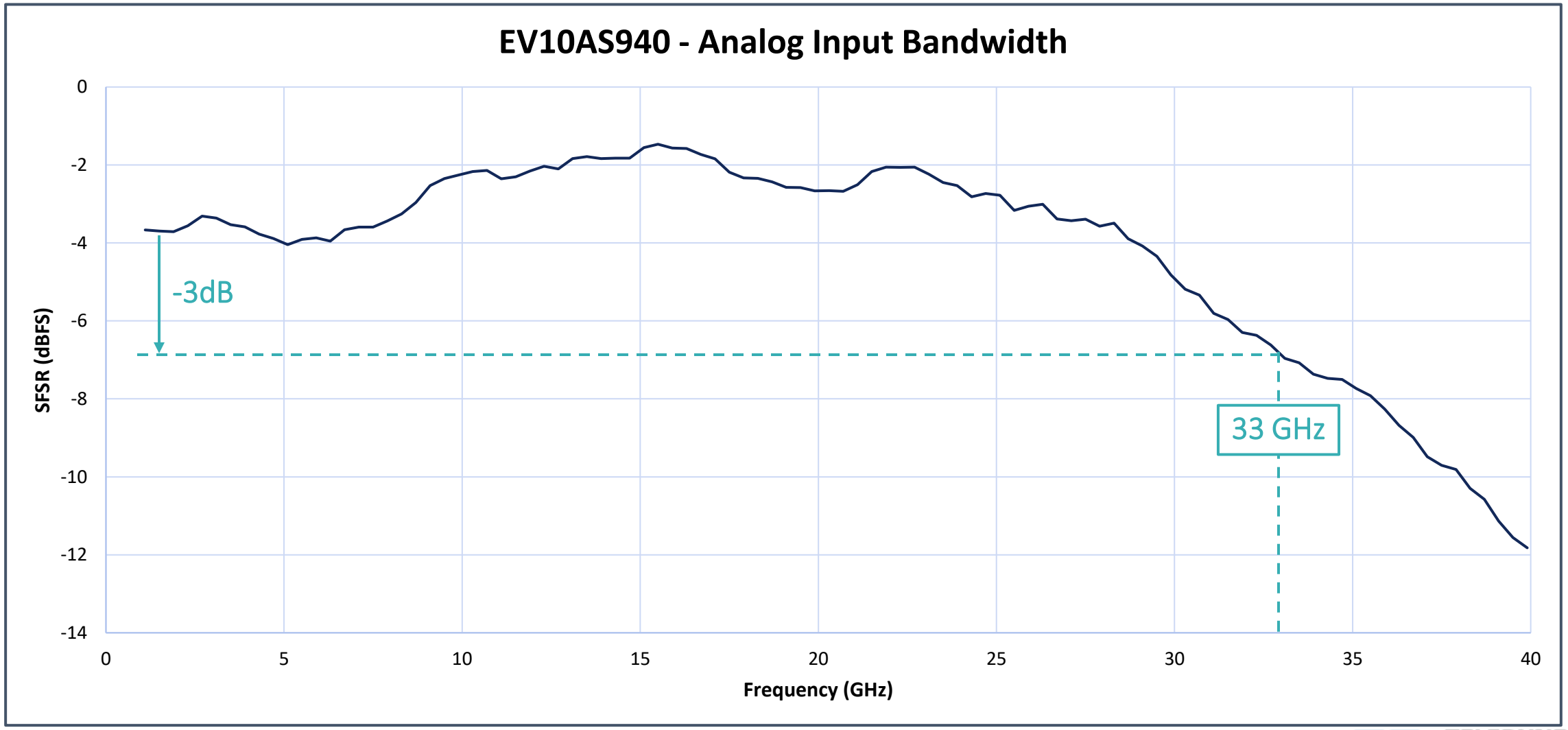
# EV10AS940 Performances

| Performances | AS940 measurement |
|---|---|
| Noise Power Ratio (NPR) with 50MHz notch and 80% Nyquist occupation | 28.2dB |
| Power consumption (without DDC) | 2.5W |
| Power consumption (with 4x FINE DDC) | 3.1W |
| -3dB analog bandwidth | 33GHz |
| ENOB (Fin= 34 GHz) | 5.1bits |

| SFDR | |
|---|---|
| L Band (@ 1GHz / -6dBFs) | 51.7 dBc |
| C Band (@ 6.8GHz / -6dBFs) | 41.8 dBc |
| Ku Band (@ 15GHz / -6dBFs) | 42.0 dBc |
| Ka Band (@ 28GHz / -6dBFs) | 43.4 dBc |
| Ka Band (@ 34GHz / -6dBFs) | 39.8 dBc |
| Ka Band (@ 40GHz / -6dBFs) | 34.6 dBc |

# EV10AS940 – Analog Input Bandwidth

## 33 GHz (-3dB) Analog Input Bandwidth

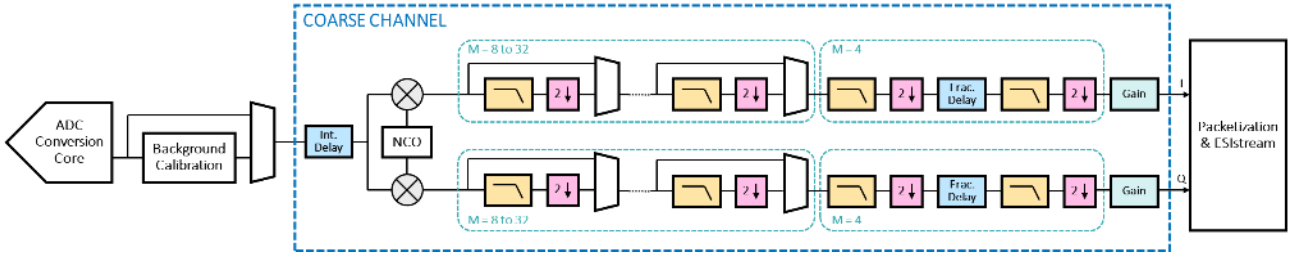


# EV10AS940 – Digital Down Conversion

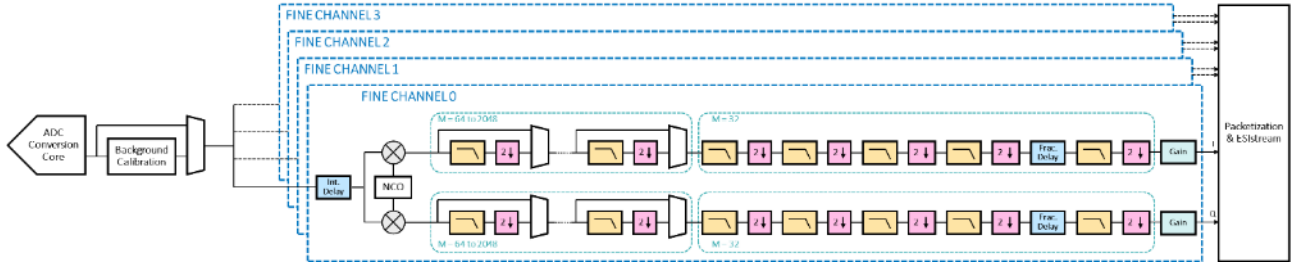
## Overview

- DDC disabled, the ADC operates in real mode,
  - Address the full Nyquist Zone up to 6.4GHz
  - 11 HSSL
- DDC enabled with one (COARSE) channel supporting complex decimation ratio from 4 to 32,
  - Address complex frequency band from 320MHz to 2.56GHz at 12.8GSps
  - 1-8 HSSL depending on decimation ratio
- DDC enabled with up to four (FINE) channels supporting complex decimation ratio of 32 to 2048.
  - Address complex frequency band from 5MHz to 320MHz at 12.8GSps
  - 1-4 HSSL depending on decimation ratio and number of FINE channels

COARSE Channel




FINE Channel(s)

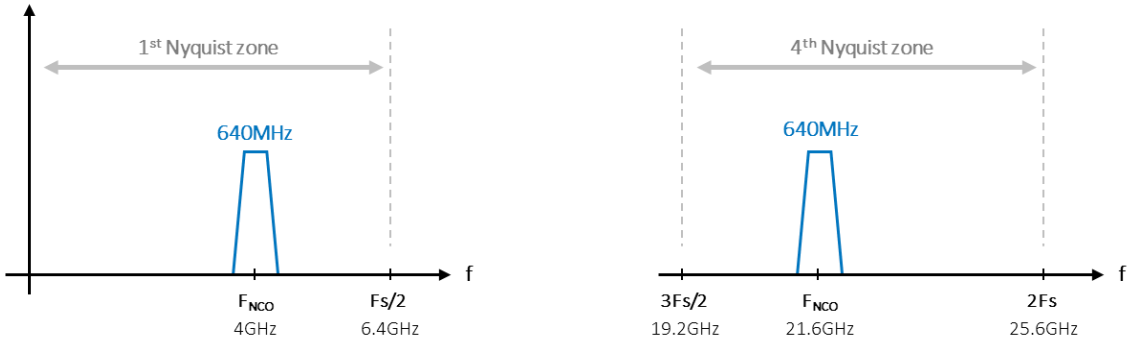


# EV10AS940 – Digital Down Conversion

## Example Configurations

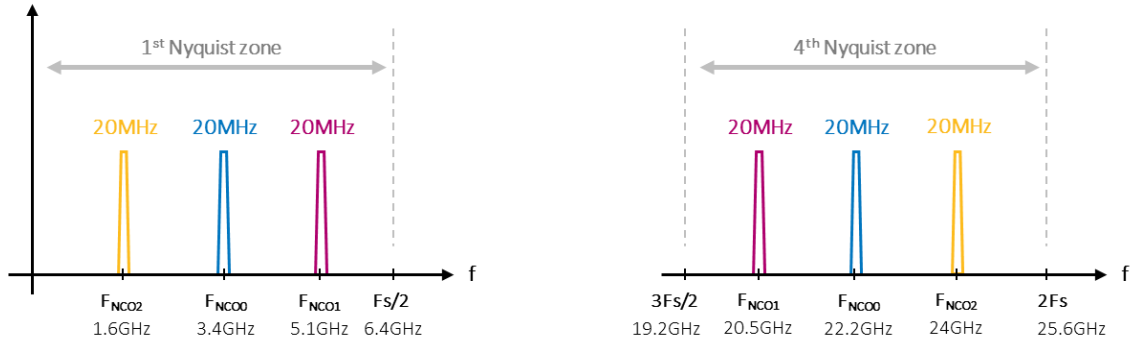
### 1x COARSE Digital Channel

| Sampling Speed | DDC Configuration | Decimation Ratio | NCO Frequency |
|---|---|---|---|
| 12.8Gsps | 1x COARSE ch | 16 | 4GHz |




### 3x FINE Digital Channels

| Sampling Speed | DDC Configuration | Decimation Ratio | NCO Frequency |
|---|---|---|---|
| 12.8Gsps | FINE channel 0 | 512 | 3.4GHz |
| | FINE channel 1 | | 5.1GHz |
| | FINE channel 2 | | 1.6GHz |



# EV10AS940 – Digital Down Conversion

## Gain Setting, Integer and Fractional Delay

### Gain Setting

- Independently set for each DDC channel(s)
- Range from 0 to 1.65
- Steps of 2.10-4
- Default value compensates the decimation filters loss and set an overall gain of 1

### Integer Delay

- Independently set for each DDC channel(s)
- Up to 15 $T_{CLK}$ integer delay
- Steps of 1x $T_{CLK}$

### Fractional Delay

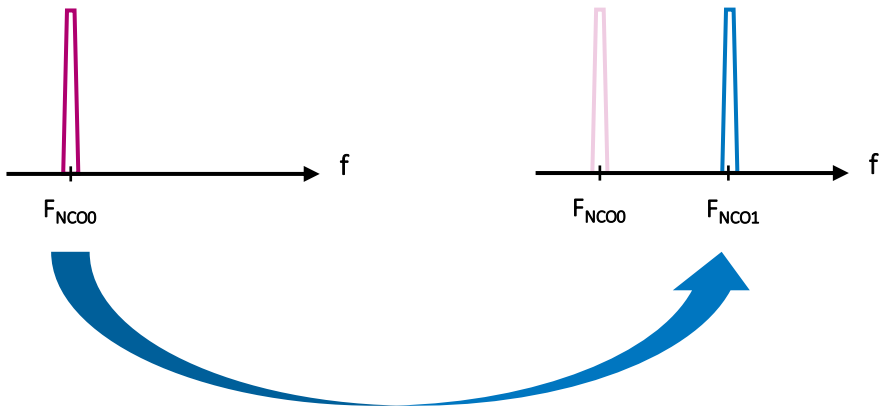
- Independently set for each DDC channel(s)
- Delays of -0.5 to +0.5 $T_{CLK}$
- Steps of $7.8.10^{-3}$ $T_{CLK}$

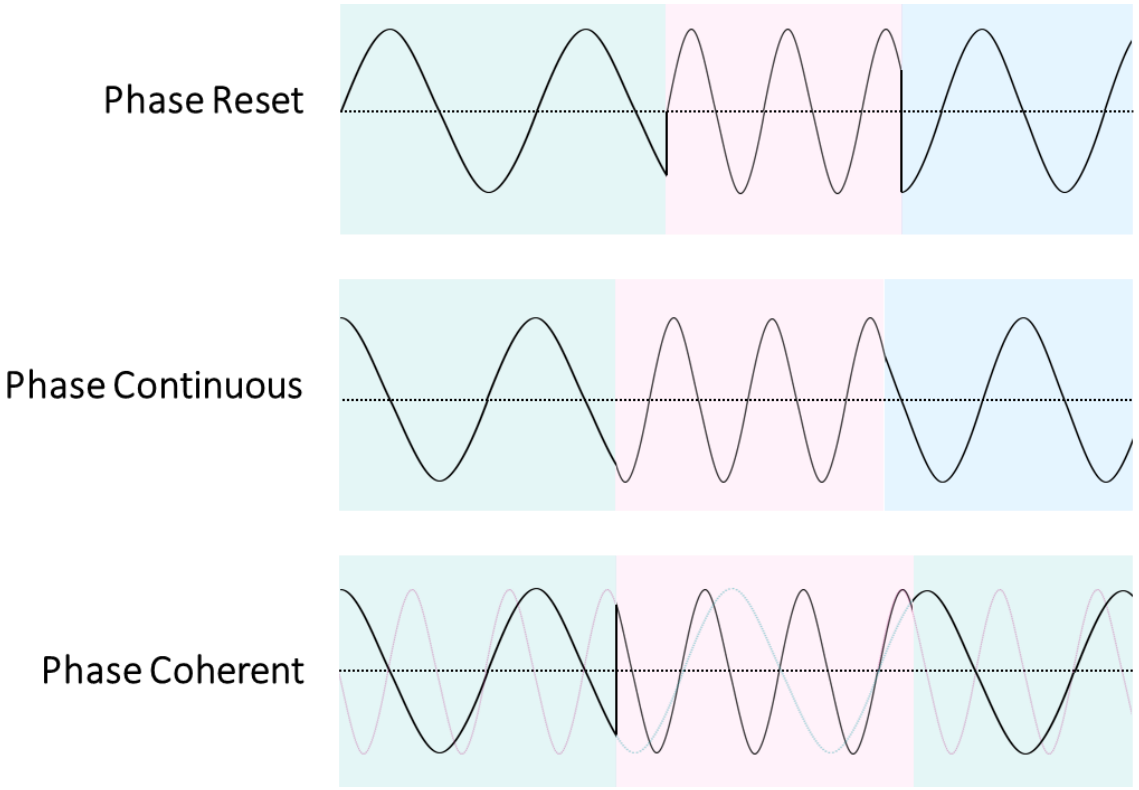
# EV10AS940 – Frequency Hopping

The NCO frequency and phase of the DDC can be quickly switched to enable fast frequency hopping.

Three Hopping Modes:

- Phase Reset Mode: the phase is reset to the initially configured phases every time a hop occurs,
- Phase Continuous Mode: the phase stays continuous from frequency hop to frequency hop,
- Phase Coherent Mode: the phase stays coherent from hop to hop.



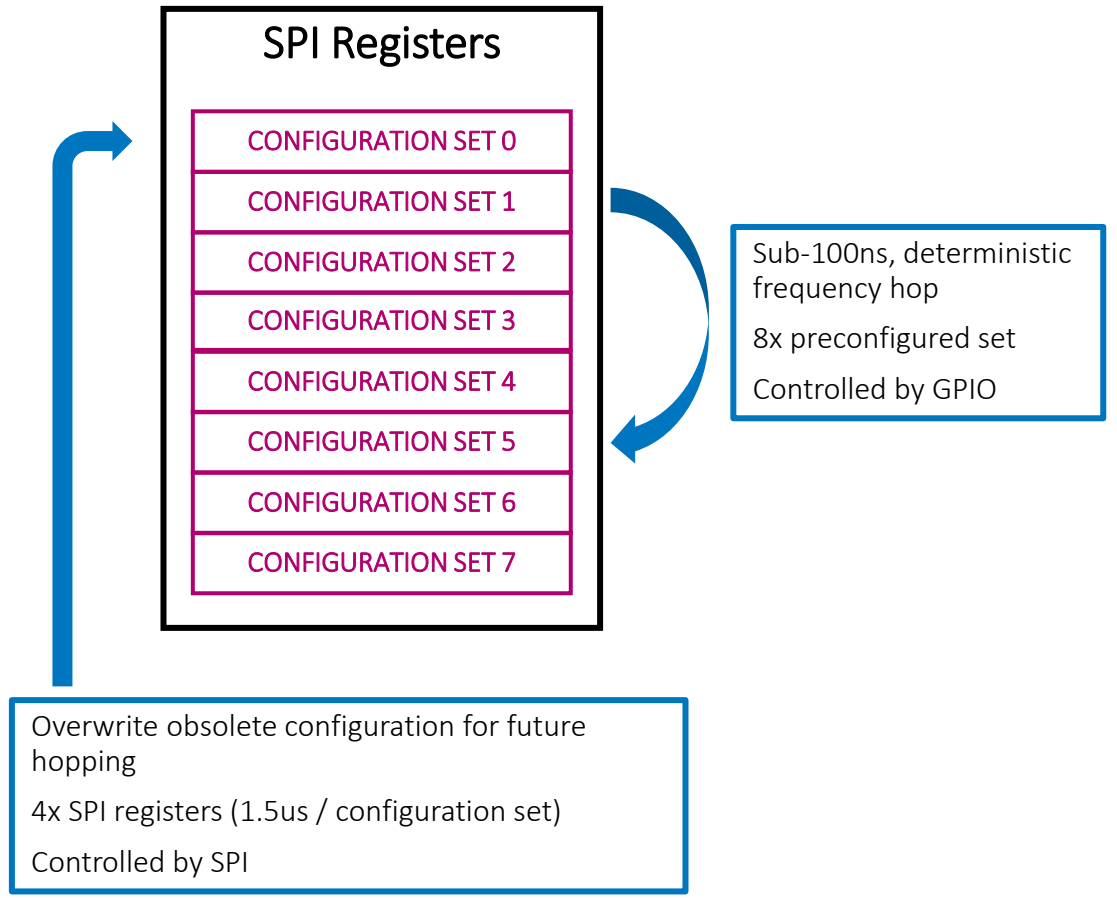

 

# EV10AS940 – Frequency Hopping

The NCO frequency and phase of the DDC can be quickly switched to enable fast frequency hopping.

Sub-100ns frequency hop

- Hop trigger sequence controlled through 2/3 GPIO,
- Hop between 8 configuration pre-set through SPI register for Phase Reset and Phase Continuous Mode. Possibility to rewrite a profile during operation via SPI if more than 8 profiles are needed (~1.5us to rewrite a digital channel frequency/phase profile),
- Hop between 4 configuration pre-set through SPI register for Phase Coherent Mode. Possibility to rewrite a profile during operation via SPI if more than 4 profiles are needed (~1.5us to rewrite a digital channel frequency/phase profile). When rewriting a profile, coherency of that profile is lost unless specific application-level handling is done,



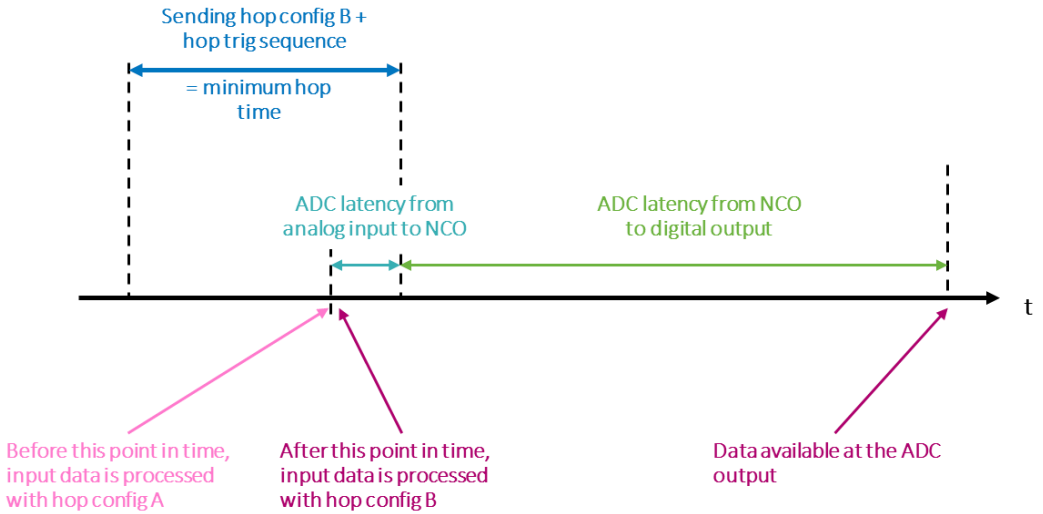

 

# EV10AS940 - Hop & Settling times

## Example Configurations

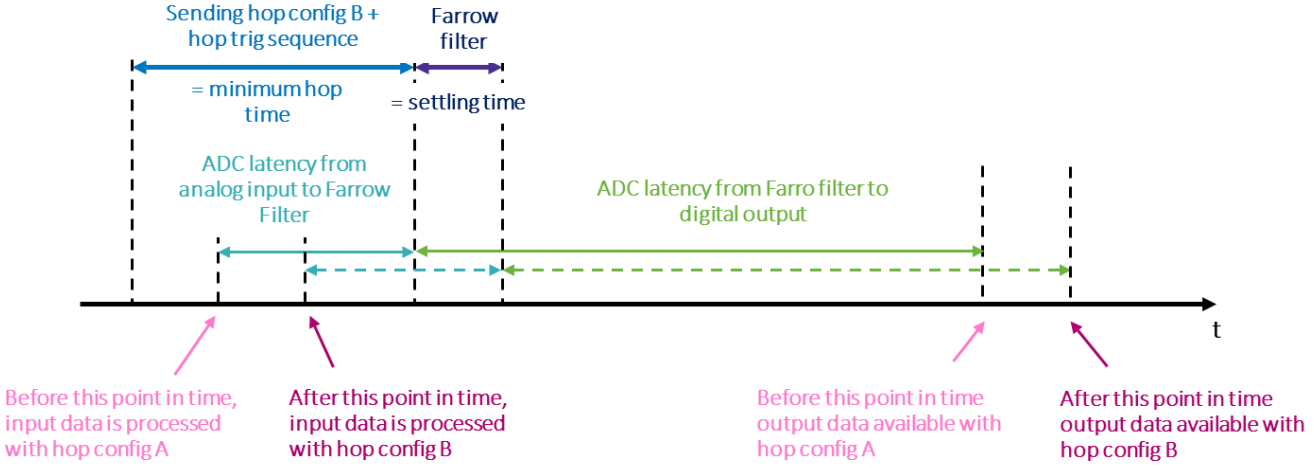
**For Frequency Hopping:**

- Hop time < 100ns (GPIO sequence)
- Settling time – expected instantaneous TBC
- Fixed latency through decimation & farrow filter for a given decimation ratio
- Deterministic hops




**For Beam Hopping:**

- Hop time = 8ch x 3 SPI reg x 16b x 50MHz + SYNC < 10us
- Settling time = latency through farrow filter < 200ns (66cc at 400MHz)
- Non-deterministic hops (through SPI register)



# EV10AS940 Development tools



## Demo Kit

Getting Started Quickly

**P/N : EV10AS940X-FMC-EVM**


Can be used for:

- Quick start
- Initial Evaluation of RF performance
- Multi-ADC Synchro

In the Kit:

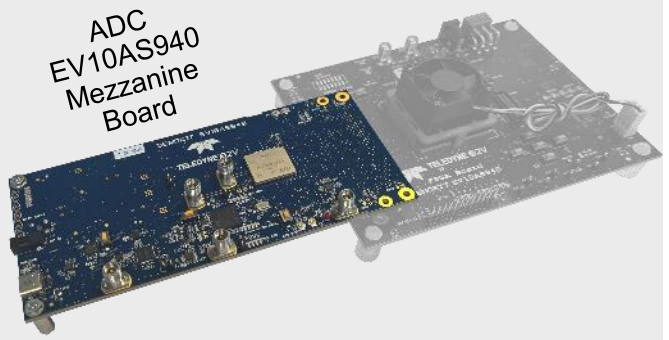
- ADC Mezzanine Board
- XKU035 FPGA Carrier Board
- Power Supply
- GUI

**Available**

## Development Kit

Breadboarding

**P/N : EV10AS940X-FPG-EVM**




Can be used for:

- Breadboarding
- Proof of Concept
- Multi-ADC Synchro

In the Kit:

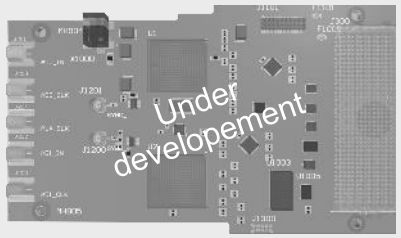
- ADC Mezzanine Board
- Power Supply

**Available**

## Synchronization Kit

Evaluate Synchronization Capability

**P/N : EV10AS940X-2ADC-EVM**




Can be used for:

- Breadboarding
- Proof of Concept
- Ready multi-ADC Synchro

In the Kit:

- ADC Mezzanine Board
- Power Supply

**TBC**

# EV10AS940 – Timeline and Documentation

Click on links to download documents

## EV10AS940 Timeline

- Beta Samples → November 2024
- Regular Samples → Q2 2025
- C,V,M → February 2026
- EQM → February 2026
- FM → Q2 2026

## Implementing the product

- Product Page (which contains the following)
  - EV10AS940 Preliminary Datasheet
  - EV10AS940-FMC-EVM GUI User Manual
  - EV10AS940-FMC-EVM User Guide
  - EV10AS940 Product Brief V1.1

## Application level consideration

### Videos

- ADC Performance in multiple frequency bands up to Ka with only 195mW/GSPS and single ended inputs.
- State of the art microwave capable ADC: a demonstration of EV10AS940 FMC Board
- Use our Ka-band capable ADC EV10AS940 with the latest ESIstream 62B64B high-speed serial interface
- Discover the most advanced microwave capable ADC: EV10AS940

### White Papers

- Direct microwave conversion capabilities now made possible deep into the Ka-band
- Satellite telemetry boosted by new chips to enhance & secure the radio link (TT&C)

# Thank you


- New generation ADC/DAC supporting Software Defined Radio architecture up to K-band
- Number of integrated digital function to optimize data converter to FPGA interface and add new capabilities

Contact information

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Signal Processing Solutions

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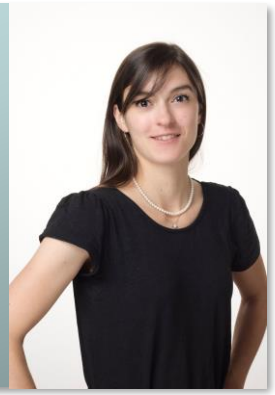
Grenoble - France





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