

# IQ+ Pro EME Dual channel Receiver

Technological innovation against Faraday's rotation

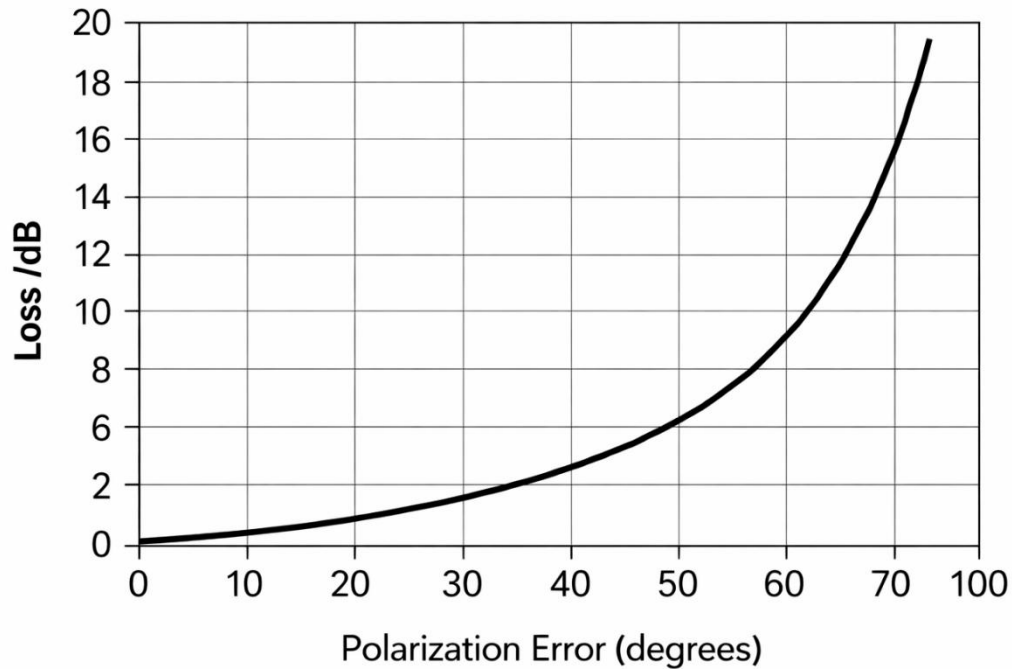
by Alex Artieda, HB9DRI

# Agenda

- Introduction
- Signal Polarization on the EME path
- The IQ+ EME Dual Channel Receiver
- The IQ+ PRO
- Practical Session: the IQ+ PRO SIM
- Future Plans
- Q & A

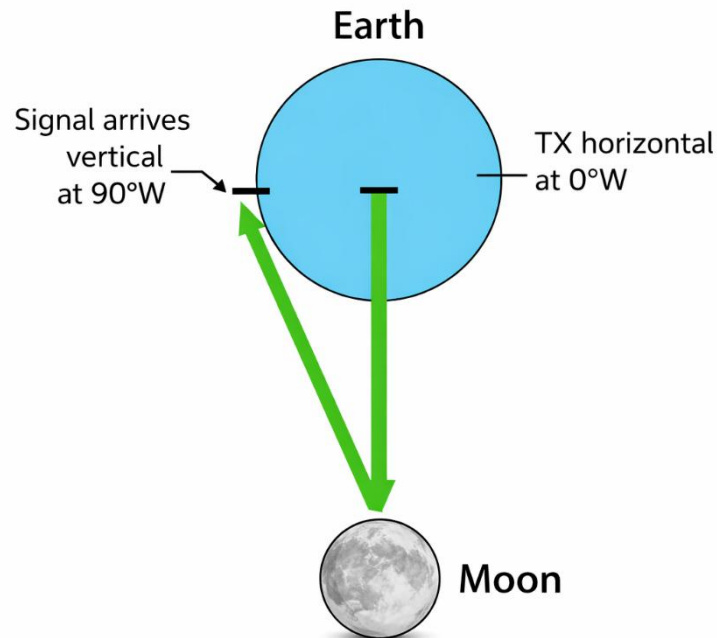
# Signal Polarization on the EME path

- In 50, 144 and 432 waves change polarization when propagate




# Signal Polarization on the EME path

- This change is the sum of 3 factors
  - Fixed component: Spatial rotation due the difference in longitude



# Signal Polarization on the EME path



- Geometric rotation or spatial polarization depends on moon position, means it varies during the moon pass making this fix element of the problem also variable but predictable.
- Some bands are more affected, lower the band faster the change. That create lock polarizations, for example in 432Mhz for several hours.

# Signal Polarization on the EME path

- The variable and unpredictable FARADAY ROTATION
  - It occurs when linear polarized signals pass through the ionosphere due to the interaction with charged particles and Earth's magnetic field.
  - The lower the frequency the faster the rotation and inverse
  - That makes the Faraday rotation in 144MHz 9 times faster than in 432MHz
  - In 50 MHz is 74 times faster compared with 432MHz

To fight FARADAY ROTATION the IQ+  
was created 15 years ago

# The IQ+ EME Dual Channel Receiver

- First functional prototype 2010
- Inspire in the WSE radios from Leif, SM5BSZ
- It was the 1st massive real option for MAP65 and JT65 boosting Joe Taylor K1JT code
- More then 400 units sold in different versions

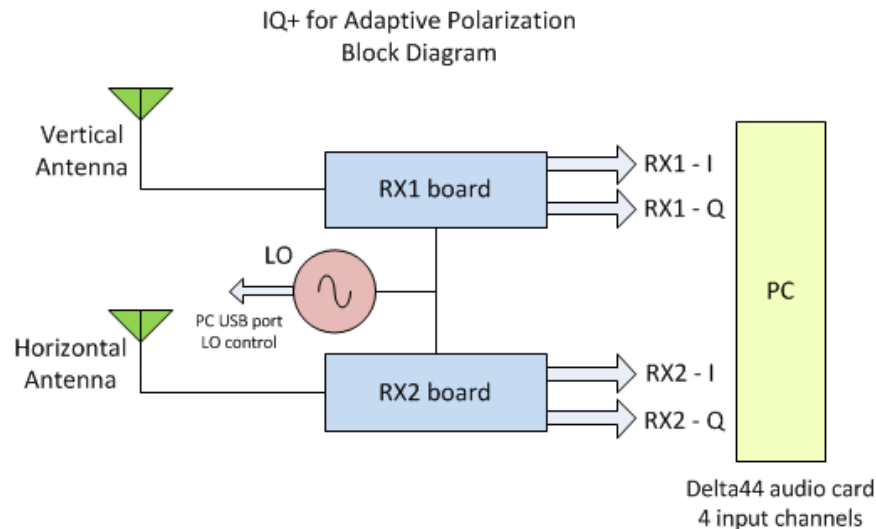
But what a dual channel receiver can do against Faraday rotation?

**A lot if not ALL!!**

# The IQ+ EME Dual Channel Receiver

- To fight Faraday rotation the IQ+ use two gemini RX channels lock with the same LO preserving amplitude and phase
- Each channel is attach to a multipol antenna, V and H.
- When the signals are digitized and pass to the PC, Linrad and/or MAP65 create a weighted sum of the ortogonal signals extracting the correct polarization with the best polarization angle.
- Litteraly you rotate the antenna «digitaly» insted of physicaly rotate the entired array, someting most of the time impossible.

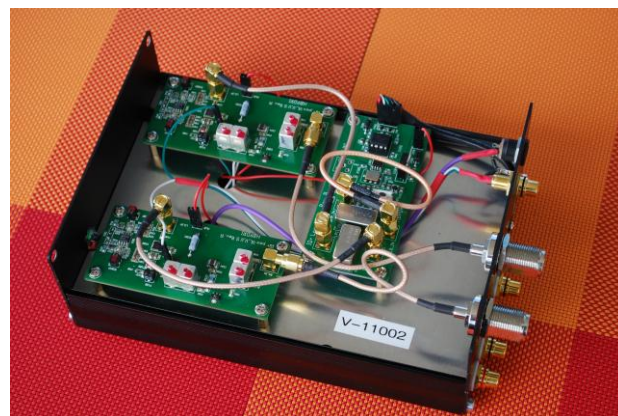
# The IQ+ EME Dual Channel Receiver



The IQ+ use the PC audio card to do the ADC conversion

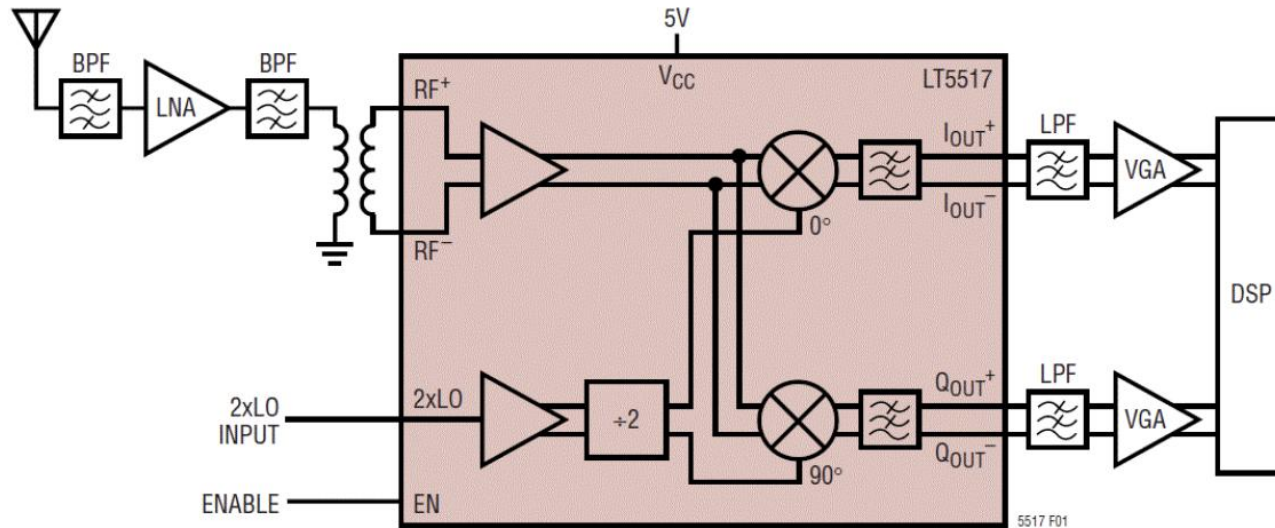
- Clever but not efficient way, audio cards are for audio not for SDR
- Later the UADC4 converter was the 1st dedicate ADC for ZERO IF receiver like the IQ+ to replace audio cards.

# The IQ+ EME Dual Channel Receiver



# The IQ+ EME Dual Channel Receiver

## IQ Mixer LT5517



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# The IQ+ EME Dual Channel Receiver

- Within the last 5 years many SDR radios capable to do diversity or Adaptive polarization appears.

They have fancy software interface, «a nice to have»

They promise «sampling on the antenna» cool!!

They auto denominate them selft as a pure SDR radios, not really

**BUT!!!!**

- They have just 12 to 16bit ADC's, limiting the dinamic range
- And most of them needs «mixer transverters» to cover 144 and 432 Mhz

# The IQ+ EME Dual Channel Receiver

- The IQ+ / UADC4 is native 24bit solution
- SFDR is in the range of 95dB
- Lower bit depth reach only:

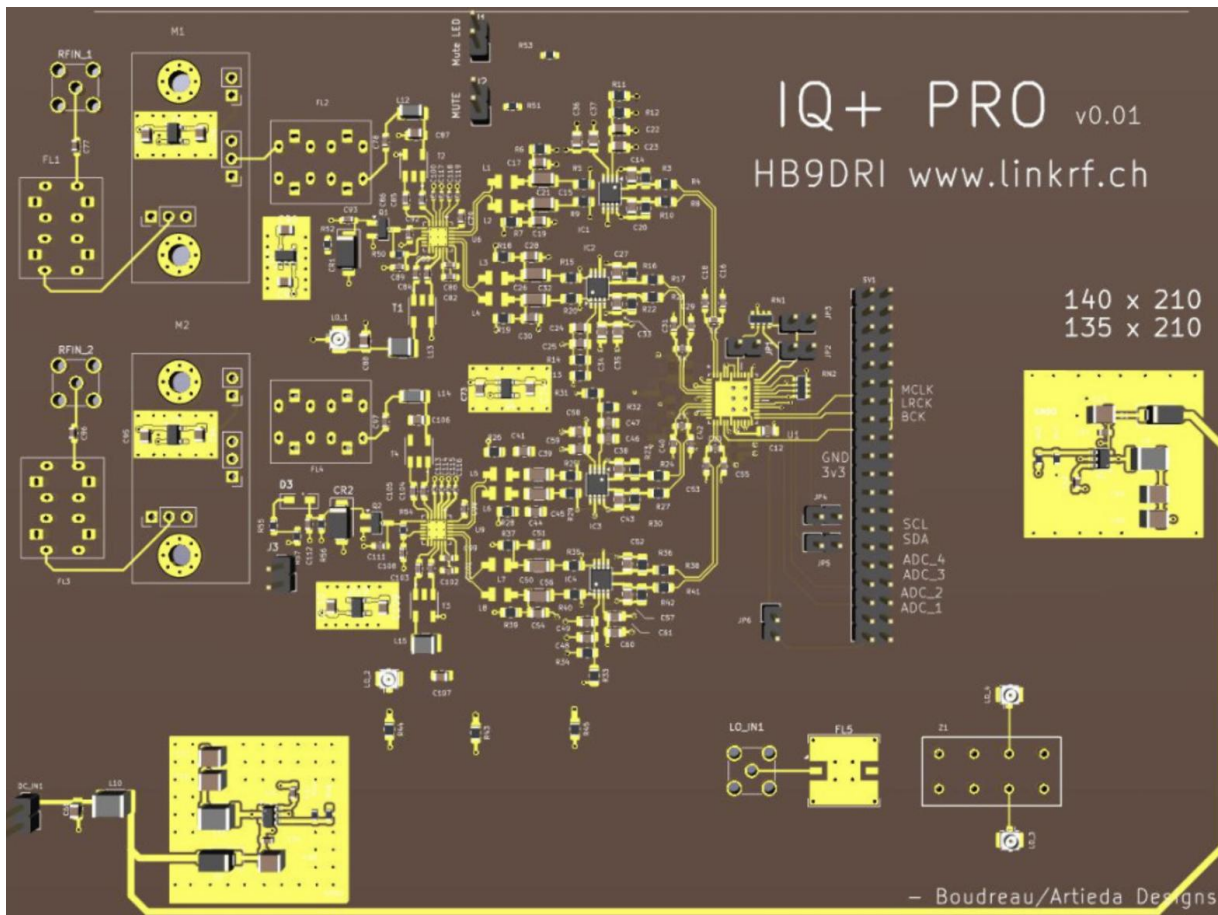
Resolution (bits)	Dynamic Range (dB)
12-bit	≈ 74 dB
14-bit	≈ 86 dB
16-bit	≈ 98 dB
18-bit	≈ 110 dB
24-bit	≈ 146 dB

# The IQ+ PRO

- Is a full integrated solution
- Preamplifier --- IQ mixer --- post conv.amp --- ADC --- USB to pc
- All elements in a single box with LO included
- Improvement performance:

Parameter	IQ+	IQ+ PRO	Improvement
<b>Input saturation point</b>	-26 dBm	0 dBm	+26 dB headroom
<b>Noise floor</b>	-122 dBm (-152 dBm/Hz @1kHz)	-131 dBm (-161 dBm/Hz @1kHz)	9 dB lower noise
<b>SFDR</b>	85 dB	100 dB	+15 dB spurious-free dynamic range

# The IQ+ PRO



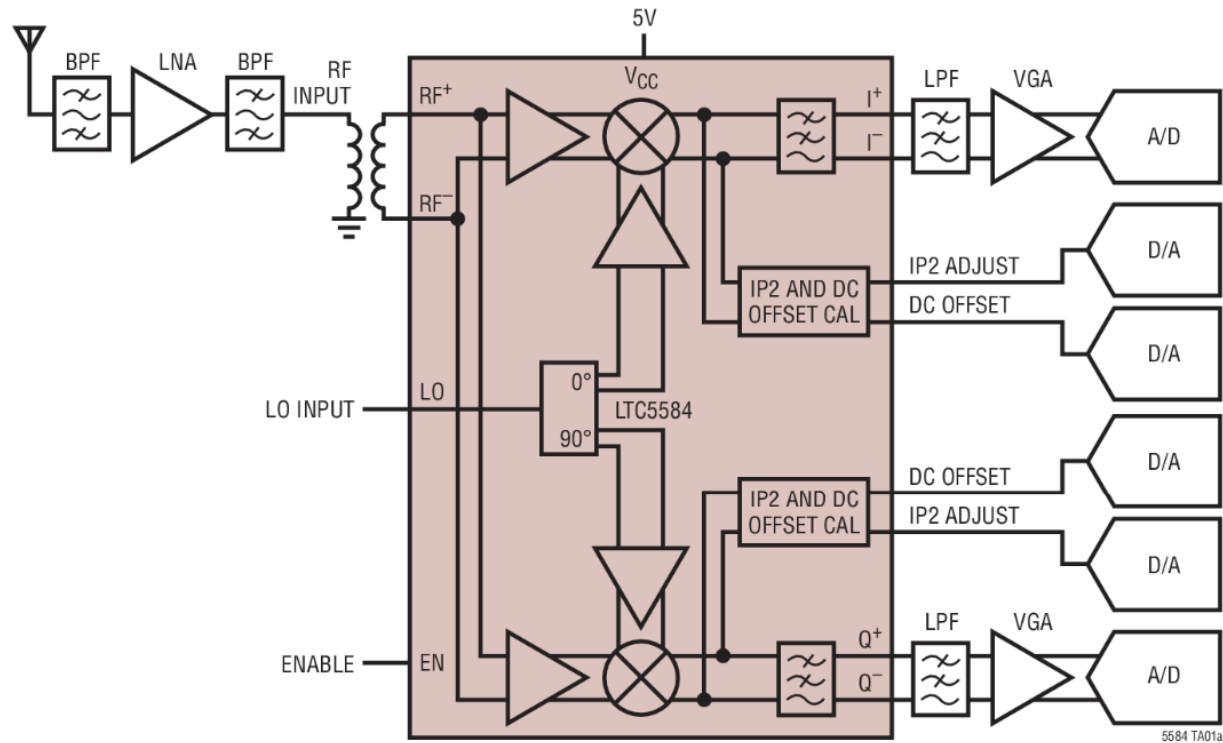
# The IQ+ PRO

Performance explanation:

- **Headroom:** Raising the saturation point from  $-26$  dBm to  $0$  dBm means the IQ+ PRO can handle **26 dB stronger signals** before compression.
- **Noise floor:** A  $9$  dB lower noise floor translates to **almost 8× better sensitivity** in power terms, allowing detection of weaker signals without degradation.
- **SFDR:** The  $15$  dB SFDR improvement means **spurious components are 30× lower**, giving cleaner spectra and more accurate demodulation in crowded bands.
- It use as preamplifier the LTC6431-15 with  $47$ dBm OIP3, deployed in a separate “easy fit” module to speed and simply reparations if needed.

# The IQ+ PRO

## IQ Mixer LTC5584



# The IQ+ PRO

Benefits in practice:

- **Higher dynamic range:** Enables simultaneous reception of weak lunar echoes and strong terrestrial signals without intermodulation.
- **Improved linearity:** Reduces distortion in complex modulation schemes (e.g., Q65, JT65).
- **Cleaner spectral purity:** Essential for precision frequency and phase measurements in GNSSDO or Rubidium-disciplined systems.
- **Better SNR margin:** The lower noise floor enhances weak-signal decoding reliability, especially under Faraday rotation or fading.

In short, the **IQ+ PRO** moves from a sensitive lab-grade receiver to a **precision-instrument-class front end**, capable of handling both ultra-weak and high-power signals with exceptional clarity.

# The IQ+ PRO simulator

The top of the slide features a dark, space-themed background. On the left, a large, dark, curved shape represents the horizon of a planet. On the right, a smaller, dark, spherical object represents the moon, set against a backdrop of a reddish-brown nebula and a starry field.

## Practical demonstration

# The IQ+ PRO

## Future plans:

- Actually we have 31 pre-orders
- The last prototype confirm repetability and performance
- It will be just ONE & UNIQUE batch of 40 units.
- What means ONE & UNIQUE?
  - Single batch, it will not be a regular production, after the 40 units are sold will not enter in production again, if you desire s unit them place your pre-order ASAP.

A dark space background featuring a large, dark planet on the left side and a smaller, dark planet in the upper right corner. The background is filled with numerous small, white stars.

# Questions?