X microwave

RF & Microwave System Design

Transforming the Industry with Modular Building Blocks

Erik Luther
Vice President
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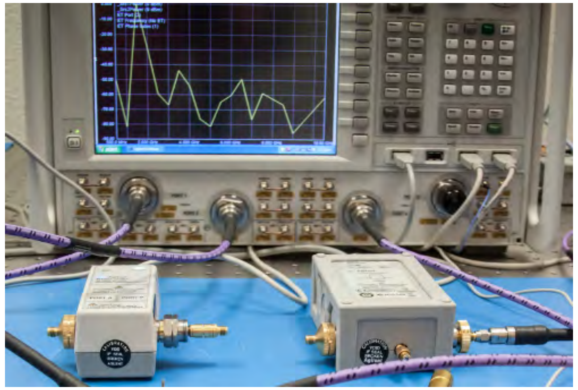
RF & Microwave Applications

Wireless Communications

Satellite Communications

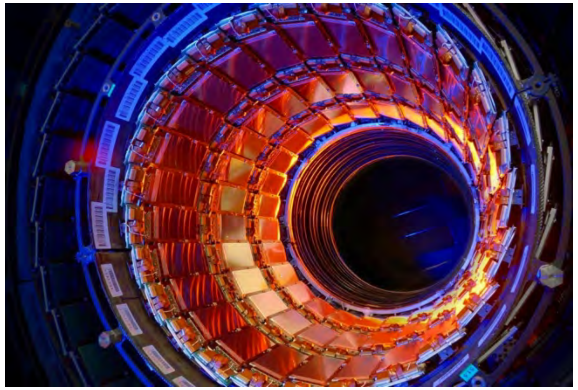
Radio Astronomy



Test & Measurement

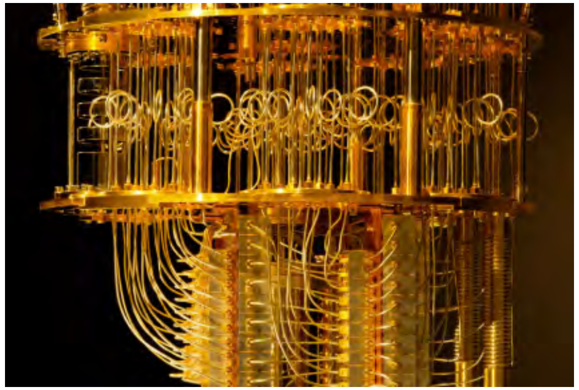
Radar & Sensing

Defense / Weather / Automotive



Big Physics

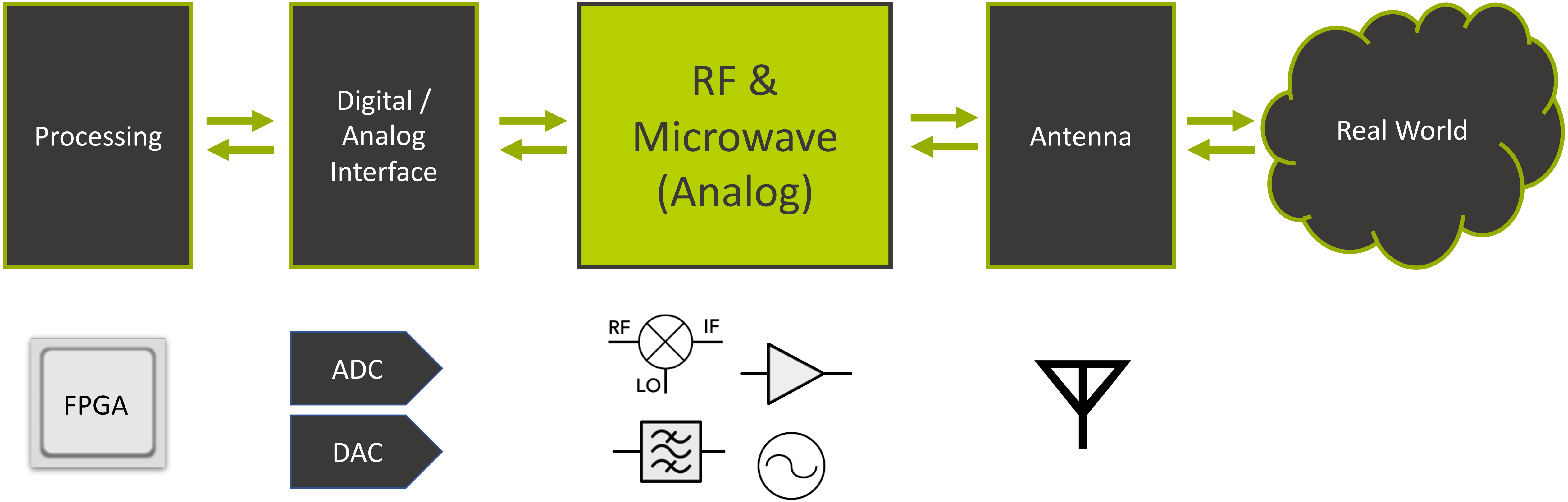
Particle Accelerator



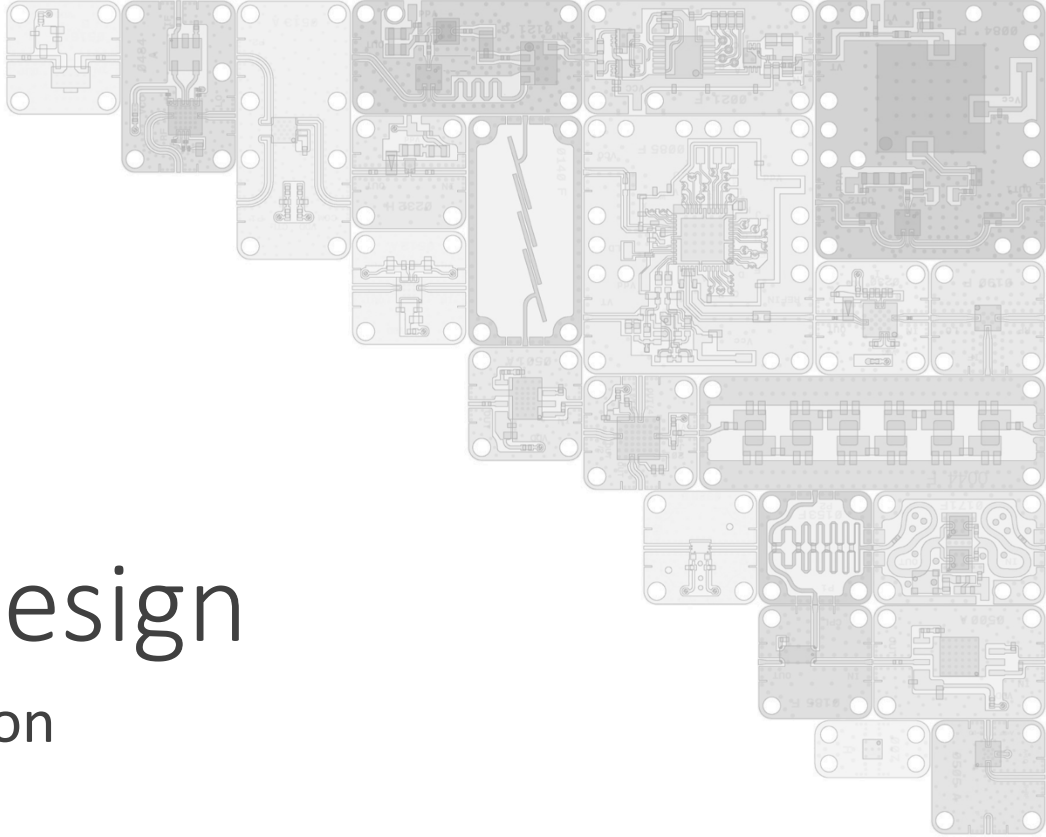
Quantum Computing

Medical Devices

RF and Microwave System

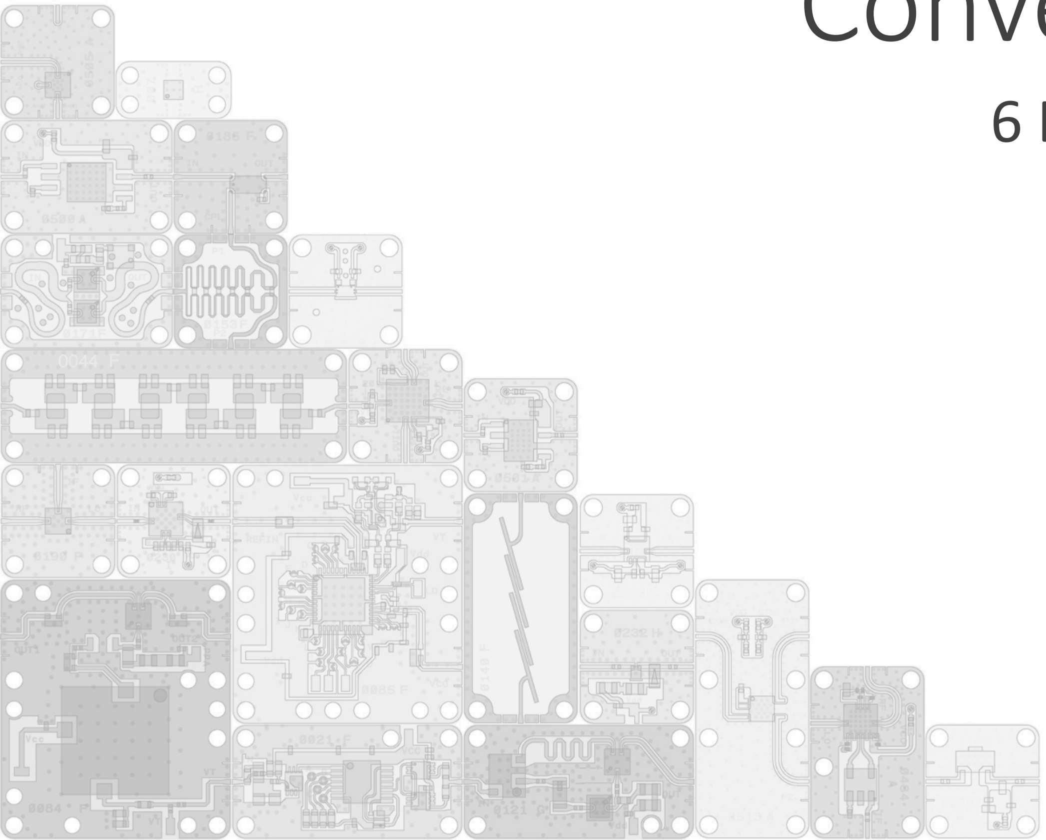


microwave

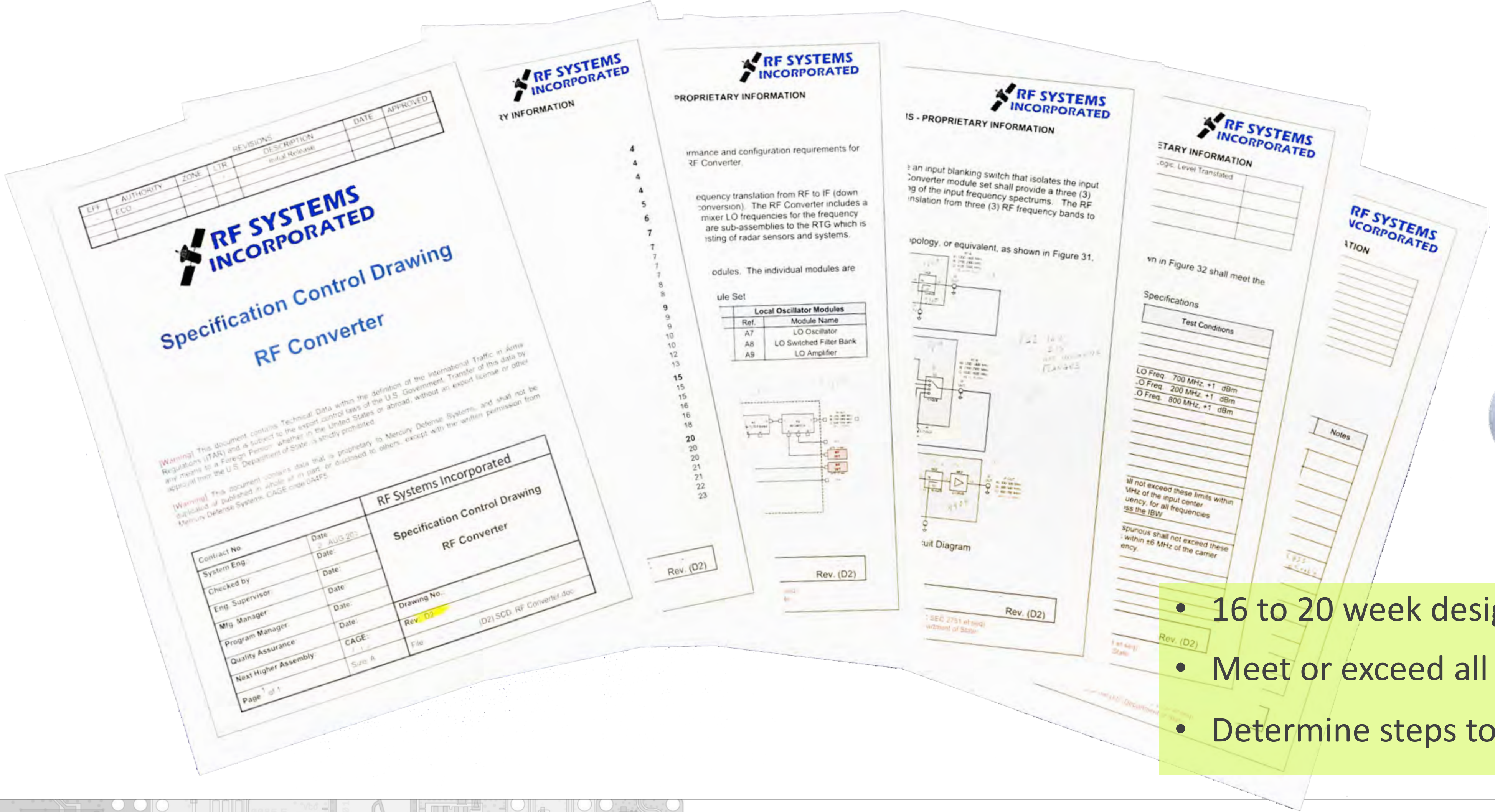


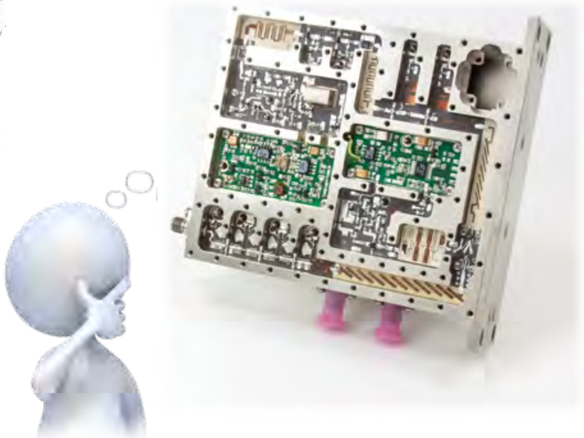
Conventional Design

6 Decades of Tradition



Specification Control Drawing

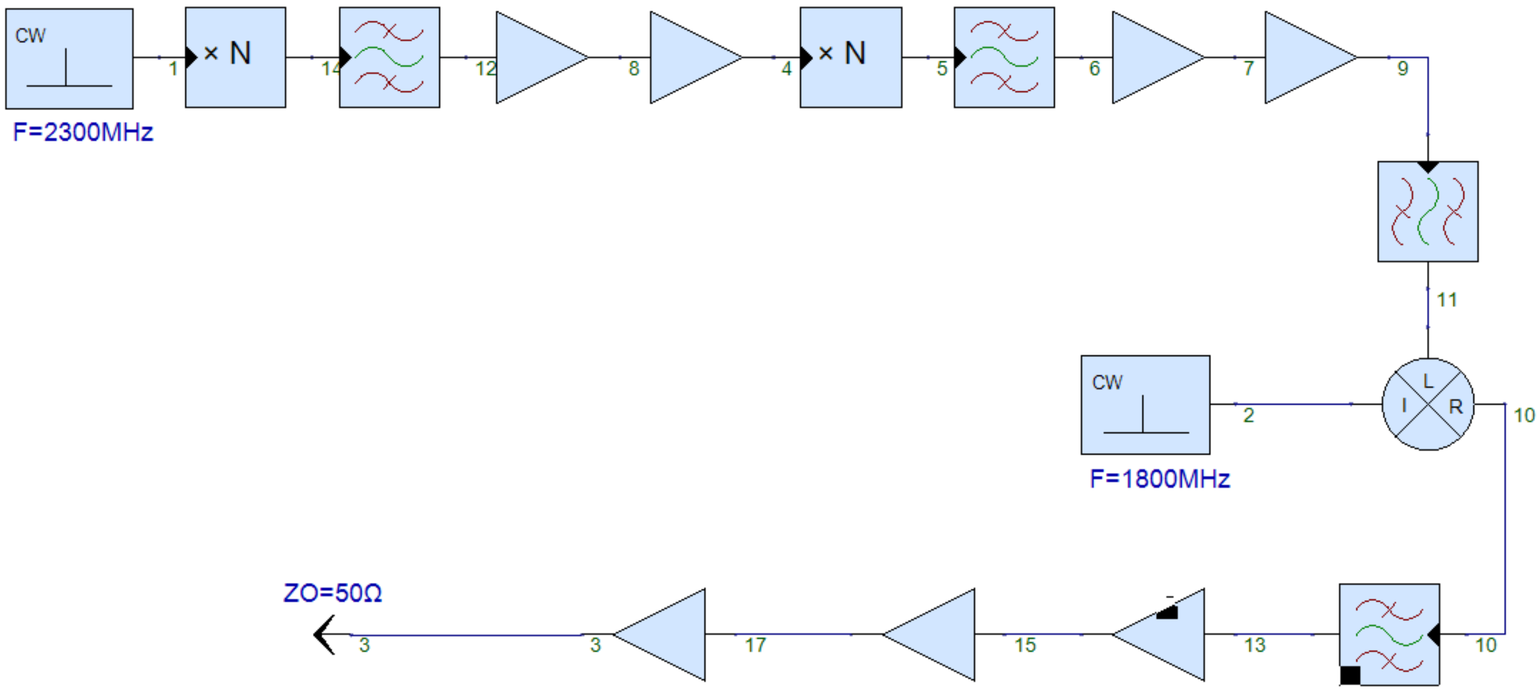




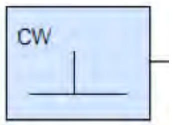
- 16 to 20 week design cycle
- Meet or exceed all design goals
- Determine steps to achieve first pass success

microwave

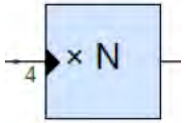
1. Design the System Diagram



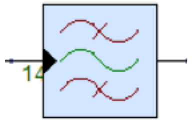
2. Component Selection



PLL + VCO

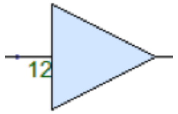


Multiplier



Band Pass Filter

Design vs Buy



Surface Mount

Monolithic Amplifier DC-4 GHz

Features
- InGaP HBT microwave amplifier
- Miniature SOT-89 package
- Internally Matched to 50 Ohms
- Frequency range, DC to 4 GHz
- Output power, 18.0 dBm typ.,
- Excellent package for heat dissipation, exposed metal bottom
- Low thermal resistance for high reliability
- Aqueous washable
- Protected by US Patent 6,943,629

Gali[illegible]51+

CASE STYLE: DF782

+RoHS Compliant

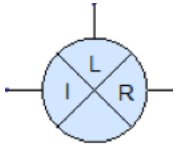
Applications
- Cellular
- PCS
- Communication receivers & transmitters

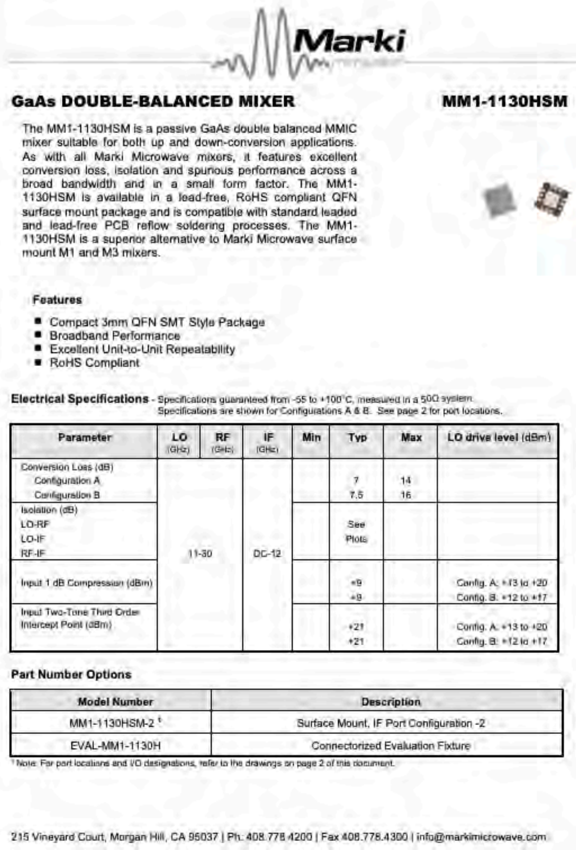
General Description

Gali[illegible]51+ (RoHS compliant) is a wideband amplifier offering high dynamic range. Lead finish is SnAgNi. It has repeatable performance from lot to lot, and is enclosed in a SOT-89 package. It uses patented Transient Protected Darlington configuration and is fabricated using InGaP HBT technology. Expected MTTF is 7,000 years at 85°C case temperature. Gali[illegible]51+ is designed to be rugged for ESD and supply switch-on transients.

simplified schematic and pin description

RF IN
RF-OUT and DC-IN
GROUND
3 RF-OUT & DC-IN
2 GROUND
1 RF-IN
4





Marki

GaAs DOUBLE-BALANCED MIXER **MM1-1130HSM**

The MM1-1130HSM is a passive GaAs double balanced MMIC mixer suitable for both up and down-conversion applications. As with all Marki Microwave mixers, it features excellent conversion loss, isolation and spurious performance across a broad bandwidth and in a small form factor. The MM1-1130HSM is available in a lead-free, RoHS compliant QFN surface mount package and is compatible with standard leaded and lead-free PCB reflow soldering processes. The MM1-1130HSM is a superior alternative to Marki Microwave surface mount M1 and M3 mixers.

Features
- Compact 3mm QFN SMT Style Package
- Broadband Performance
- Excellent Unit-to-Unit Repeatability
- RoHS Compliant

Electrical Specifications - Specifications guaranteed from -55 to +100°C, measured in a 50Ω system. Specifications are shown for Configurations A & B. See page 2 for port locations.

Parameter	LO (GHz)	RF (GHz)	IF (GHz)	Min	Typ	Max	LO drive level (dBm)
Conversion Loss (dB)							
Configuration A	11-30		DC-12		7	14	
Configuration B					7.5	16	
Isolation (dB) LO-RF LO-IF RF-IF					See Plots		
Input 1 dB Compression (dBm)					+9 +9		Config. A: +13 to +20 Config. B: +12 to +17
Input Two-Tone Third Order Intercept Point (dBm)					+21 +21		Config. A: +13 to +20 Config. B: +12 to +17

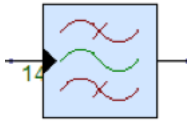
Part Number Options

Model Number	Description
MM1-1130HSM-2 [1]	Surface Mount, IF Port Configuration -2
EVAL-MM1-1130H	Connectorized Evaluation Fixture

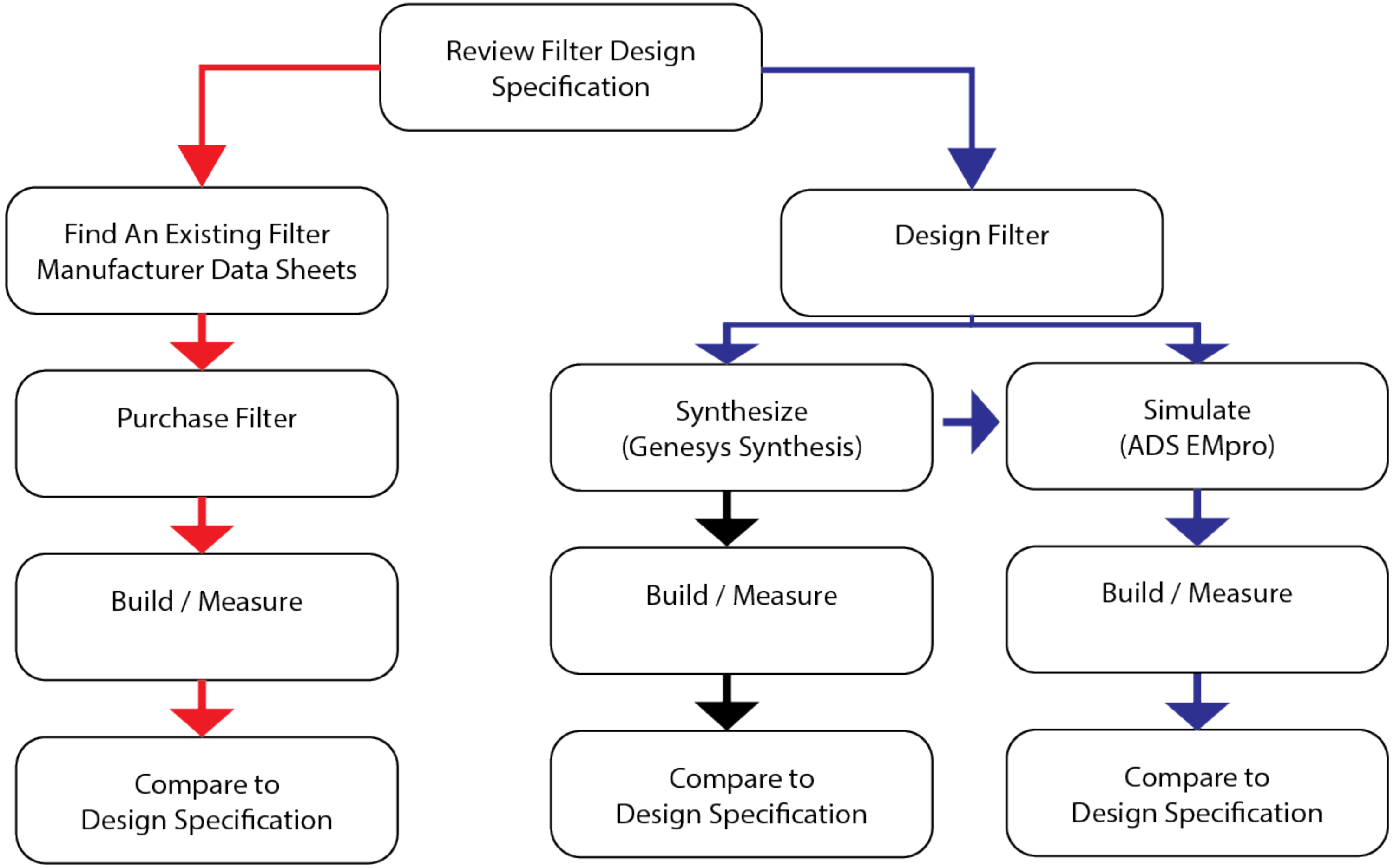
[1] Note: For port locations and I/O designations, refer to the drawings on page 2 of this document.

215 Vineyard Court, Morgan Hill, CA 95037 | Ph: 408.778.4200 | Fax 408.778.4300 | info@markimicrowave.com

2a. Component Selection Process

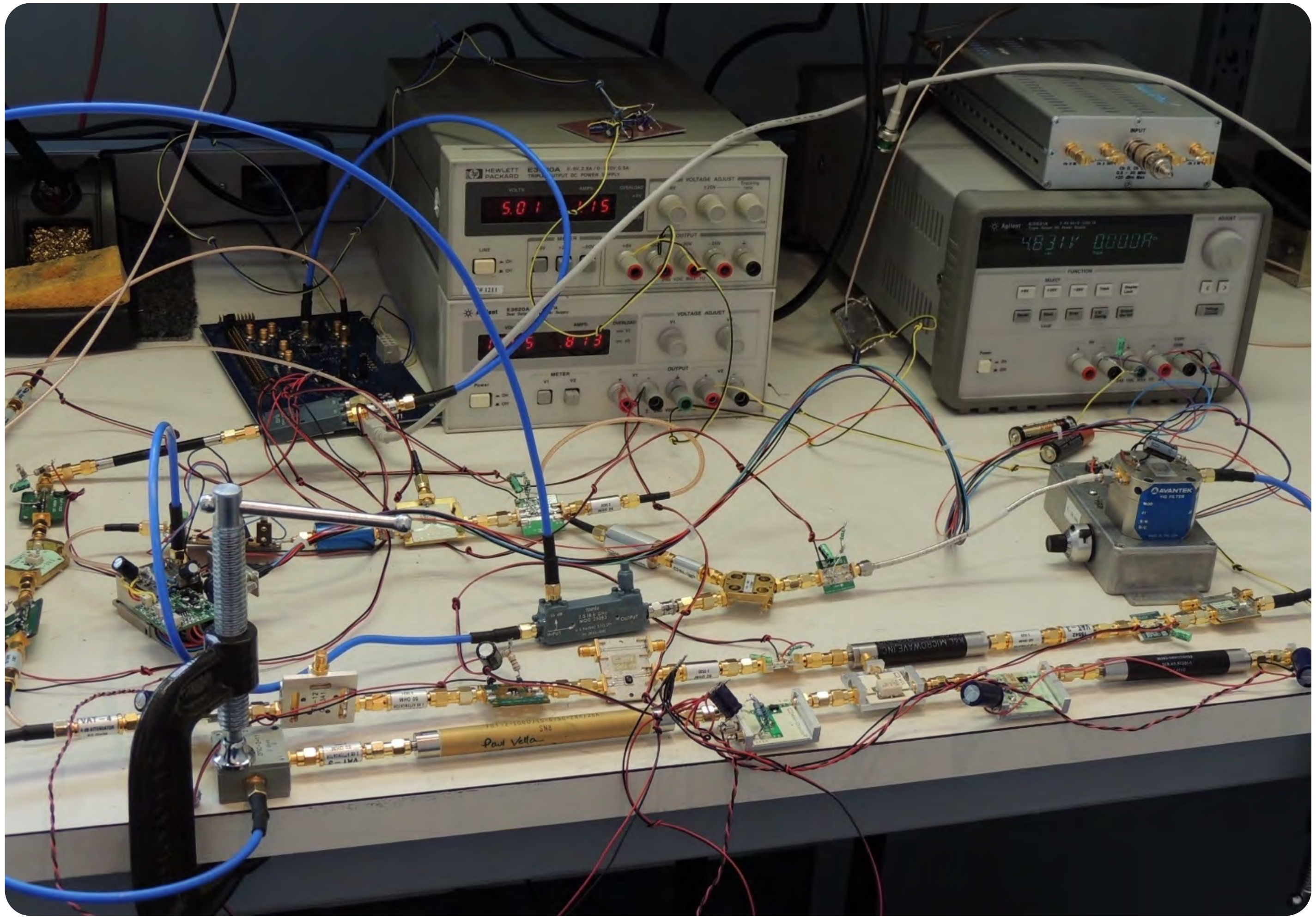


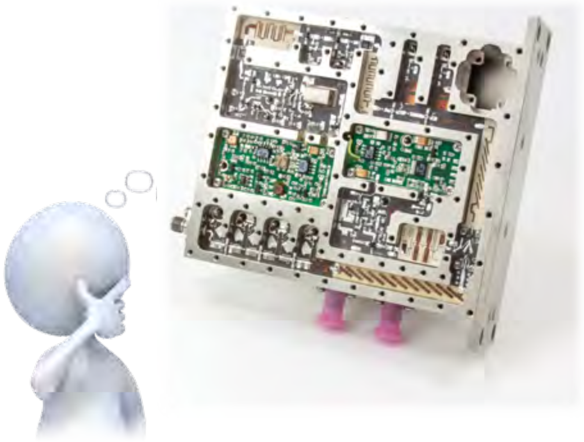
Band Pass Filter



3. Cascade Analysis and Simulation from Measured Data

4. Bench Prototype





X microwave

5. Prototype to Layout Process

ADF4159 PLL

ADF4159

PIN CONFIGURATION AND FUNCTION DESCRIPTIONS

NOTES
1. THE LFCSP HAS AN EXPOSED PAD THAT MUST BE CONNECTED TO AGND

Figure 5. Pin Configuration

Table 6. Pin Function Descriptions

Pin No.	Mnemonic	Description
1	CPGND	Charge Pump Ground. This pin is the ground return path for the charge pump.
2, 3	AGND	Analog Ground.
4	$RF_{IN}B$	Complementary input to the RF Prescaler. Decouple this pin to the ground plane with a small bypass capacitor, typically 100 pF.
5	$RF_{IN}A$	Input to the RF Prescaler. This small signal input is normally ac-coupled from the VCO.
6, 7, 8	AV_{DD}	Positive Power Supply for the RF Section. Place decoupling capacitors to the ground plane as close as possible to these pins.
9	REF_{IN}	Reference Input. This CMOS input has a nominal threshold of $DV_{DD}/2$ and an equivalent input resistance of 100 kΩ. It can be driven from a TTL or CMOS crystal oscillator, or it can be ac-coupled.
10	DGND	Digital Ground.
11	SDGND	Digital Σ-Δ Modulator Ground. This pin is the ground return path for the Σ-Δ modulator.
12	TX_{DATA}	Transmit Data Pin. This pin provides the data to be transmitted in FSK or PSK mode and also controls some ramping functionality.
13	CE	Chip Enable (1.8 V Logic). A logic low on this pin powers down the device and places the charge pump output into three-state mode.
14	CLK	Serial Clock Input. This input is used to clock in the serial data to the registers. The data is latched into the input shift register on the CLK rising edge. This input is a high impedance CMOS input.
15	DATA	Serial Data Input. The serial data is loaded MSB first; the three LSBs are the control bits. This input is a high impedance CMOS input.
16	LE	Load Enable Input. When LE is high, the data stored in the input shift register is loaded into one of the eight latches; the latch is selected using the control bits. This input is a high impedance CMOS input.
17	MUXOUT	Multiplexer Output. This pin allows various internal signals to be accessed externally.
18	SDV_{DD}	Power Supply for the Digital Σ-Δ Modulator. Place decoupling capacitors to the ground plane as close as possible to this pin.
19	DV_{DD}	Positive Power Supply for the Digital Section. Place decoupling capacitors to the digital ground plane as close as possible to this pin.
20, 21	SW1, SW2	Switches for Fast Lock.
22	V_P	Charge Pump Power Supply. The voltage on this pin must be greater than or equal to AV_{DD}.
23	R_{SET}	Connecting a resistor between this pin and ground sets the maximum charge pump output current. The relationship between I_{CP} and R_{SET} is as follows: $I_{CP\ MAX} = 24.48/R_{SET}$ where: $I_{CP\ MAX} = 4.8$ mA. $R_{SET} = 5.1$ kΩ.
24	CP	Charge Pump Output. When the charge pump is enabled, this output provides $\pm I_{CP}$ to the external loop filter, which, in turn, drives the external VCO.
25	EPAD	Exposed Pad. The LFCSP has an exposed pad that must be connected to AGND.

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ANALOG DEVICES

EV-ADF4159EB1Z/EV-ADF4159EB3Z User Guide
UG-383

One Technology Way • P.O. Box 9106 • Norwood, MA 02062-9106, U.S.A. • Tel: 781.329.4700 • Fax: 781.461.3113 • www.analog.com

Evaluating the ADF4159 Frequency Synthesizer for Phase-Locked Loops

FEATURES

- Self-contained board, including synthesizer, 100 MHz reference, USB interface, and voltage regulators
- Accompanying software allows control of synthesizer functions from a PC (via USB interface)
- Externally powered by 5.5 V and 15 V supplies
- Evaluates the ADF4169

EVALUATION KIT CONTENTS

- EV-ADF4159EB1Z or EV-ADF4159EB3Z evaluation board
- CD with evaluation software
- USB cable

REQUIRED ADDITIONAL EQUIPMENT

- VCO (for EV-ADF4159EB3Z)
- Loop filter components (for EV-ADF4159EB3Z)
- Soldering equipment
- Spectrum analyzer
- Power supplies (5.5 V and 15 V)
- Windows®-based PC with USB port for evaluation software

REQUIRED DOCUMENTS

- ADF4159 data sheet
- ADF4169 data sheet
- UG-383 user guide

REQUIRED SOFTWARE

Analog Devices, Inc., ADF4158/9/69 PLL evaluation software, Version 4.x or higher (included on the CD in the evaluation board kit or available for download at www.analog.com)

GENERAL DESCRIPTION

The EV-ADF4159EB1Z/EV-ADF4159EB3Z evaluates the performance of the ADF4159 frequency synthesizer for phase locked loops (PLL) and the ADF4169 frequency synthesizer. A photograph of the evaluation board is shown in Figure 1. The evaluation board involves the ADF4159 synthesizer, a USB connector, SMA connectors, a reference oscillator, and power supply connectors. There are also footprints for active filter components and a voltage controlled oscillator (VCO); if used, these components must be soldered to the board to complete the loop. An on-board temperature compensated crystal oscillator (TCXO) provides the 100 MHz reference frequency. A USB cable is included to connect the board to a PC USB port.

In addition, the evaluation kit contains Windows®-based software to allow easy programming of the synthesizer.

EVALUATION BOARD PHOTOGRAPH

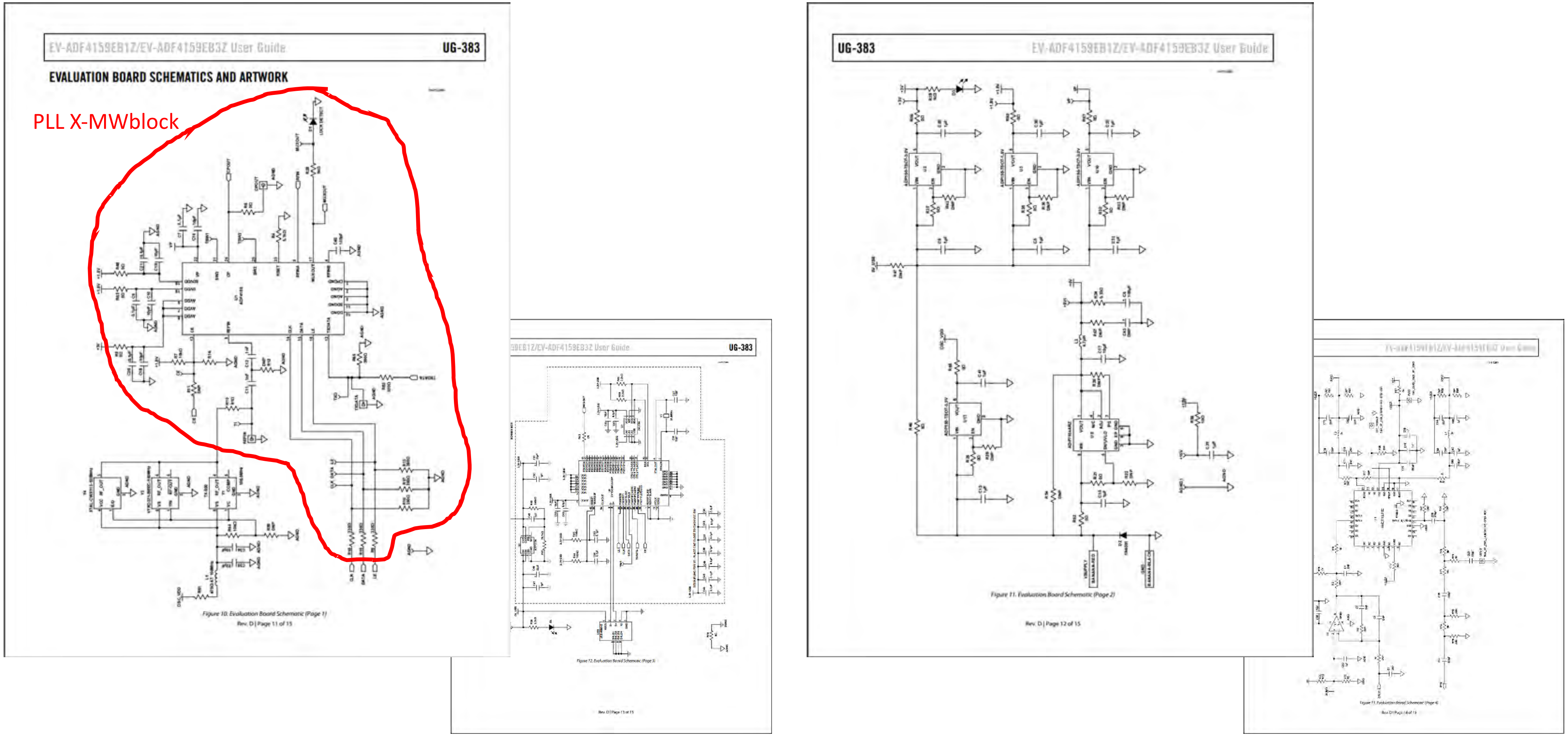
Figure 1.

PLEASE SEE THE LAST PAGE FOR AN IMPORTANT WARNING AND LEGAL TERMS AND CONDITIONS.

Rev. D | Page 1 of 15

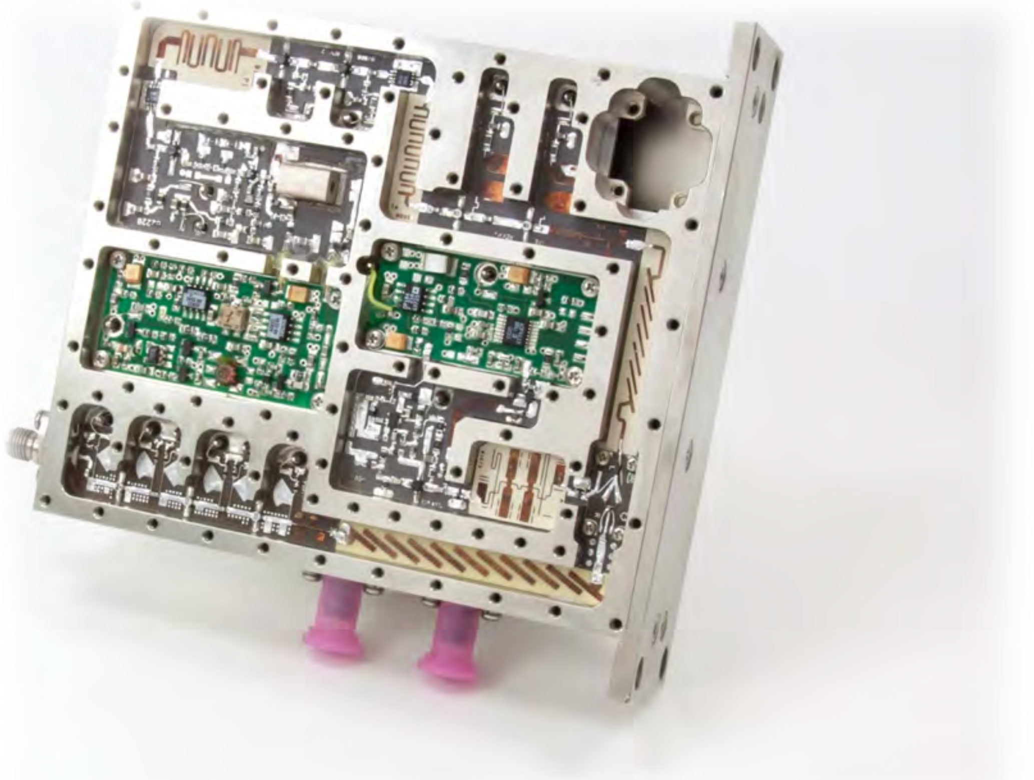
X microwave

5. Prototype to Layout Process



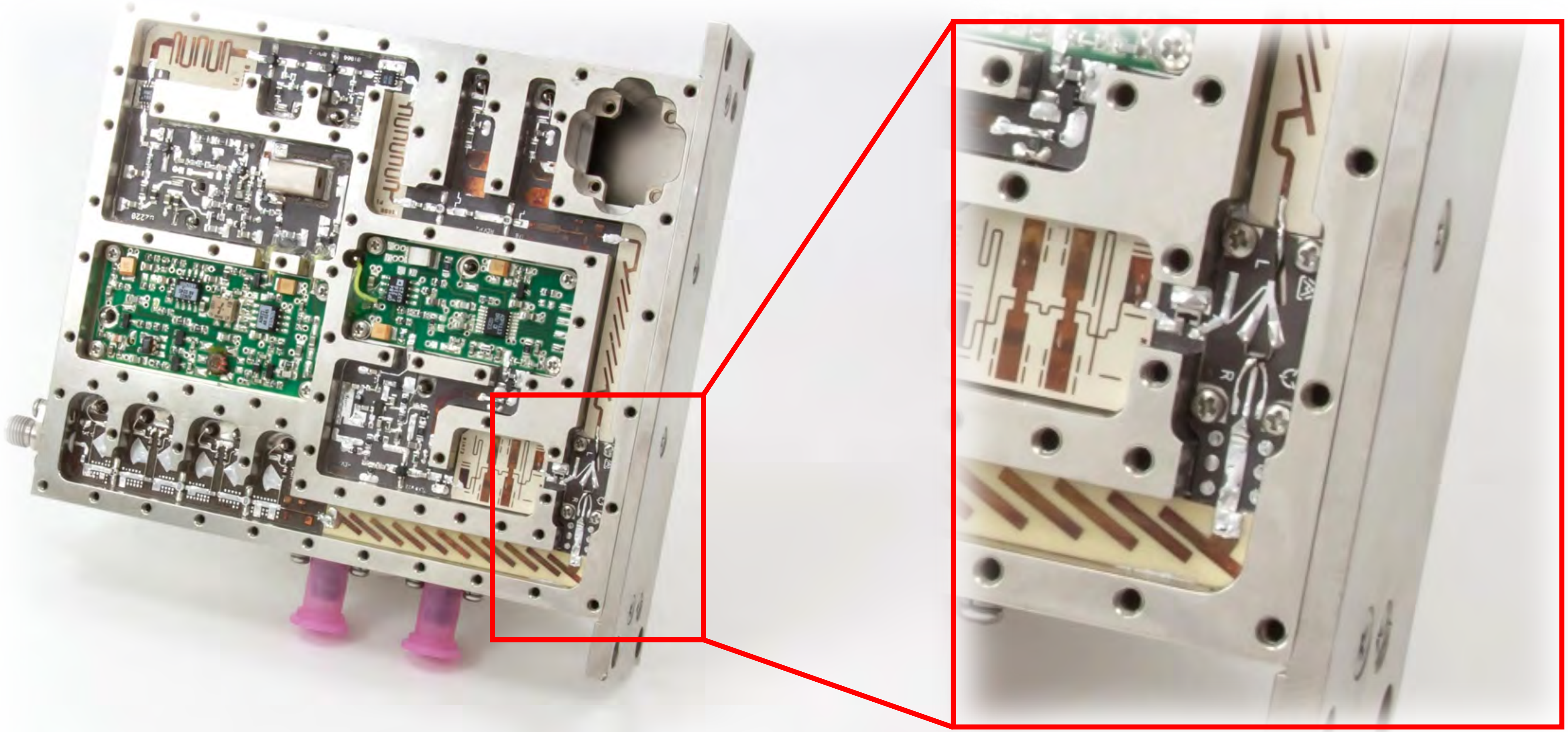
Many Decisions, So Little Time

- PCB
  - Material (FR4, Rogergers,…)
  - PCB plating (Solder, wire bond, …)
  - Layers (2, 4, …)
- RF Trace specification
  - Type (Microstrip, coplanar, ...)
  - Dimensions (dK, pad size,…)
  - Launch / Transition (connector, board-to-board…)
- Available components
  - Off the shelf options (ADI, MiniCircuits, …)
  - Reference circuits (Datasheet, past designs, …)
  - Bias, control requirements (regulation, active bias…)
- Design and Layout
  - System diagram
  - Analysis (simulation, cascade,…)
  - Prototyping
- Housing
  - SWAP (size, weight, power/thermal, …)
  - Materials (aluminum, brass, …)
  - Cavity effects (resonance, shielding, …)



X microwave

Drop-in Component



X microwave

Drop-in Component

Advantages

- Exists with known lead time
- Characterized launch-to-launch
- Defined form factor
- Known manufacturability / repeat ability
- Ready to integrate
- Reasonably priced

“Why not drop-in everything?”

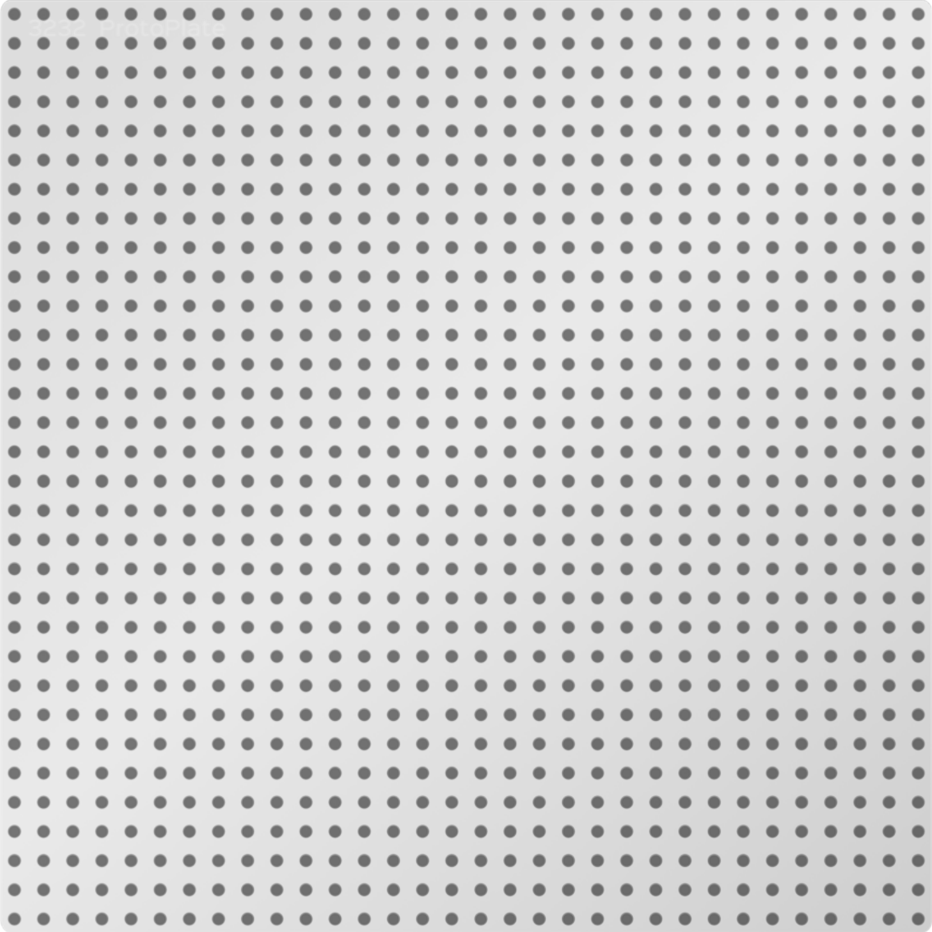
"If you want to *teach* people a *new way* of thinking, don't bother trying to *teach* them. Instead, give them a tool, the use of which will lead to *new ways* of thinking."

— Robert Buckminster Fuller

Drop-in Design Process

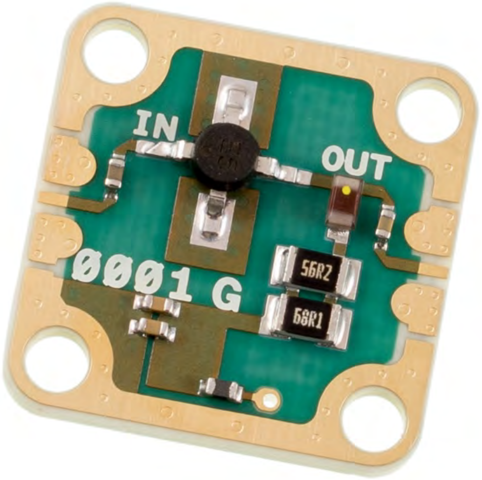
Modular Platform 101

RF & Microwave Breadboard



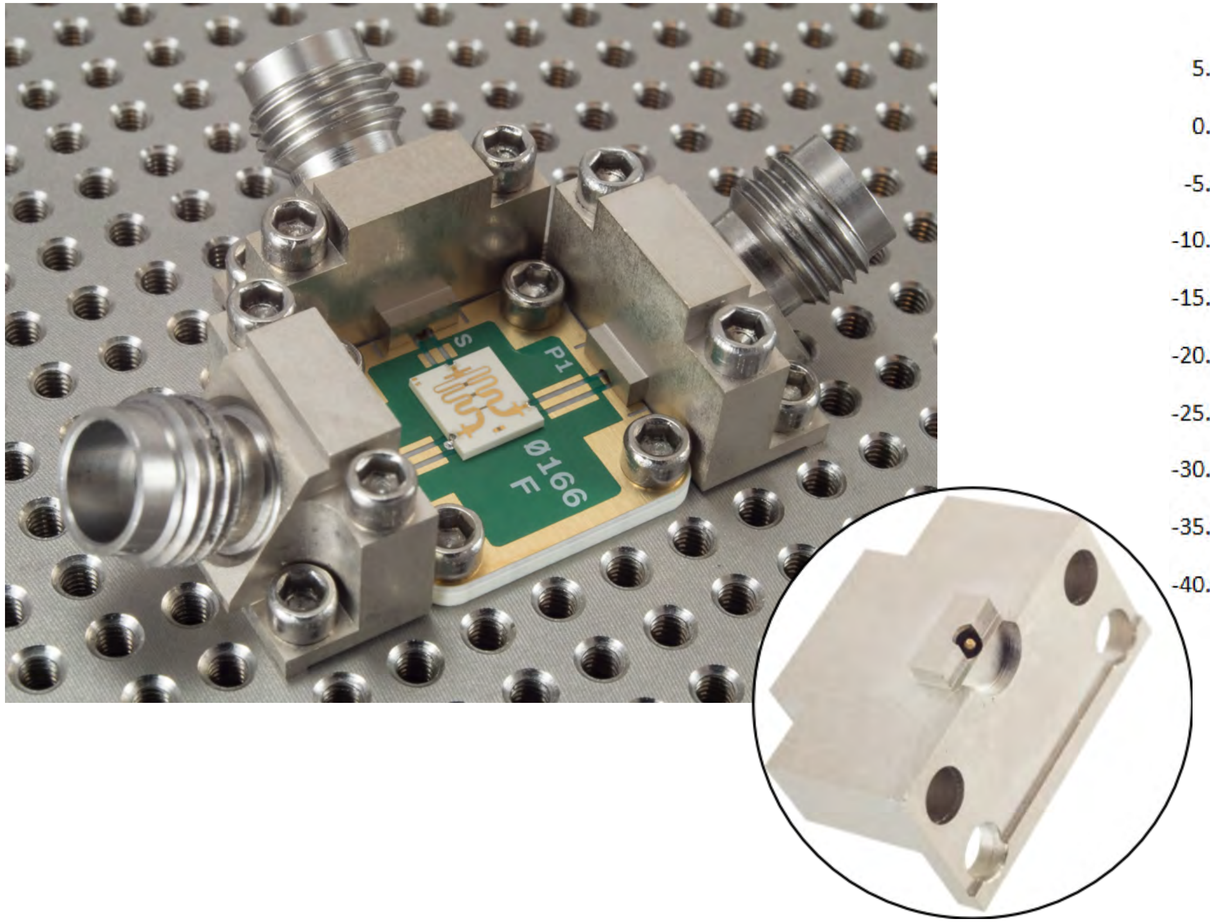
32 x 32 units
(1 unit = 0.135 Inches)

Standardized Drop-in

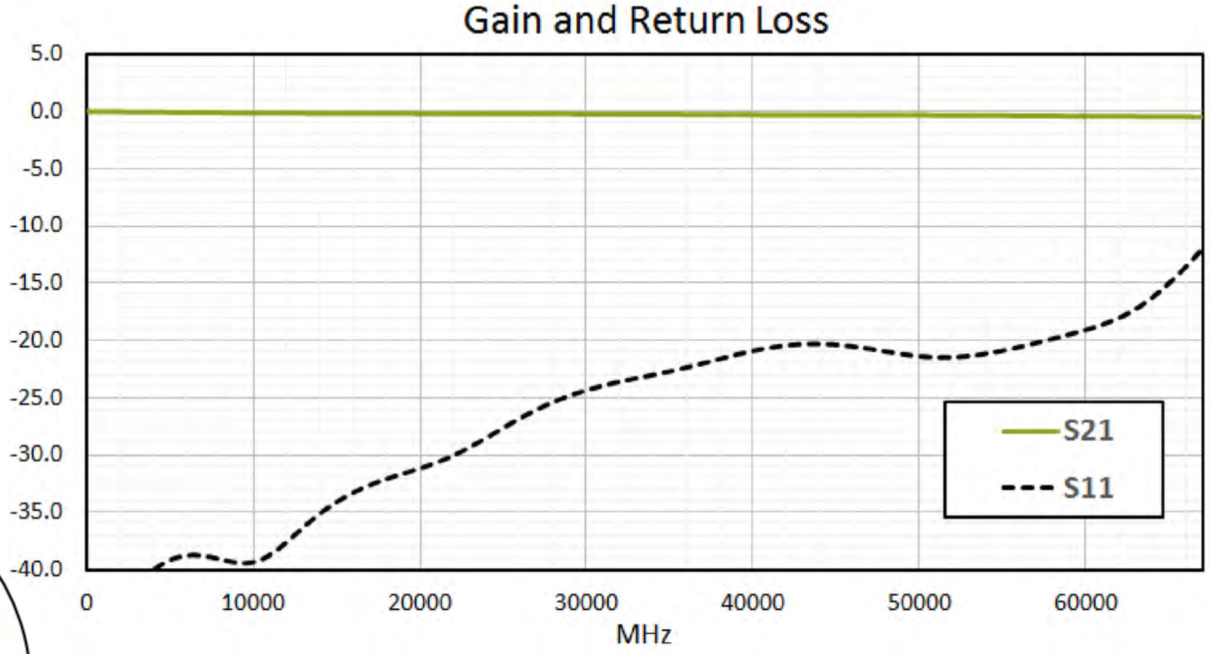


- Coplanar launch
- 0.54” x 0.54”
- Holes at corners
- 8 mil RO4003

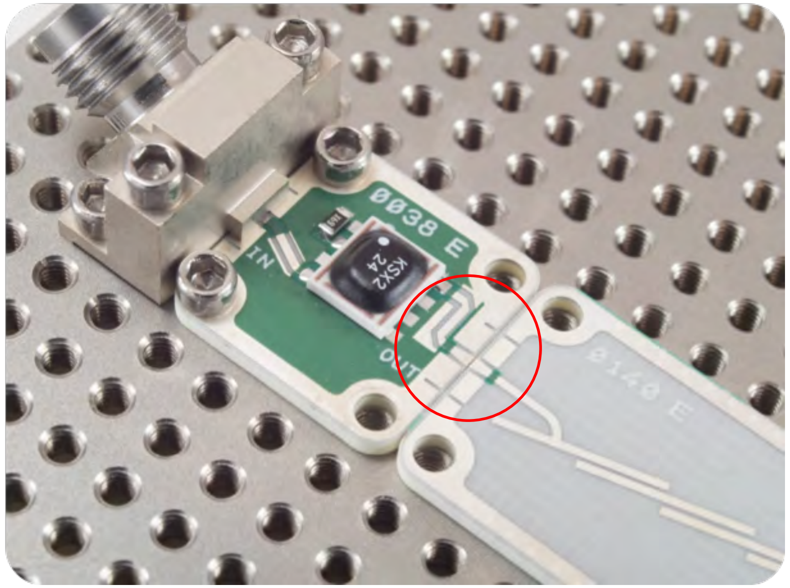
X-MW Probe (DC to 67 GHz)



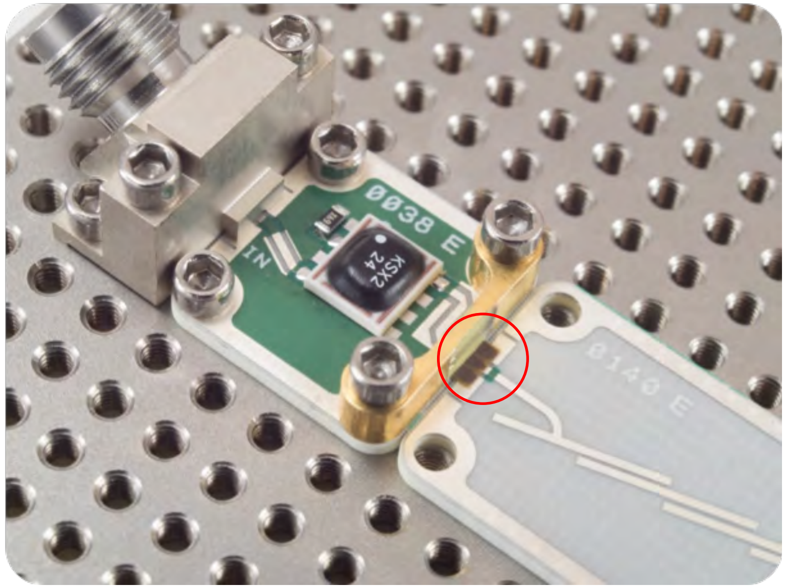
bottom view



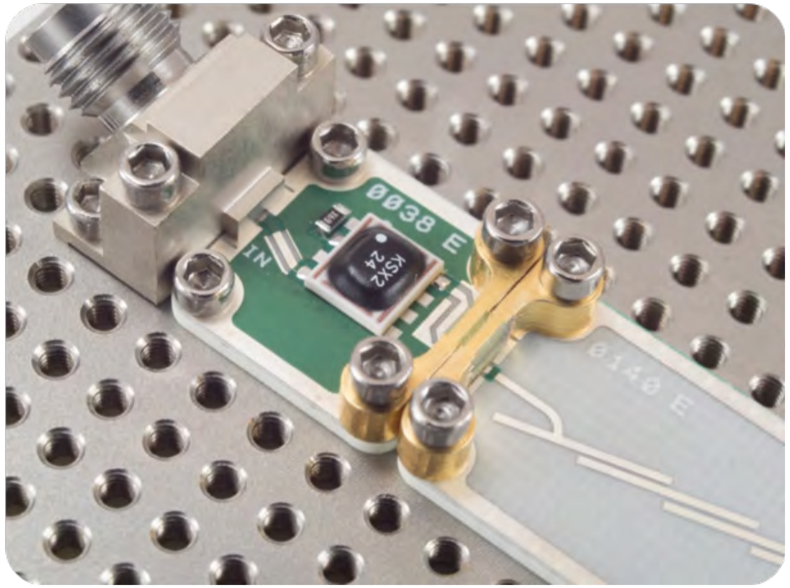
Launch-to-Launch Solderless Interconnect



1. Line up the Launch

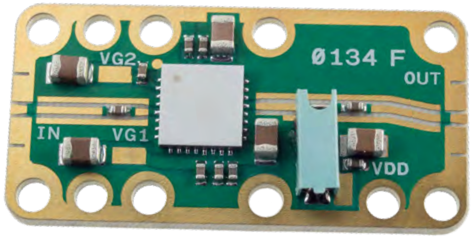


2. Place the G-S-G Jumper



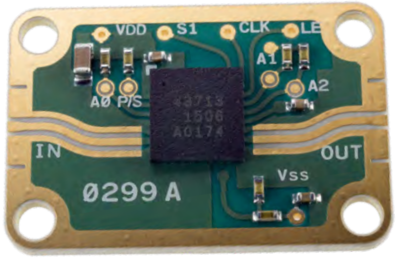
3. Attach the Anchors

1000's of Drop-Ins

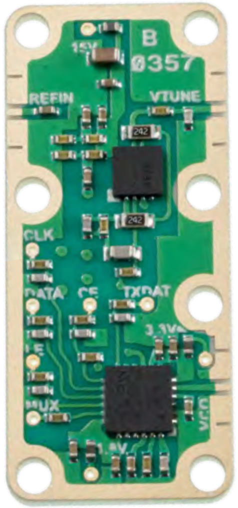


Custom MMIC – CMD192C5
Distributed Amplifier

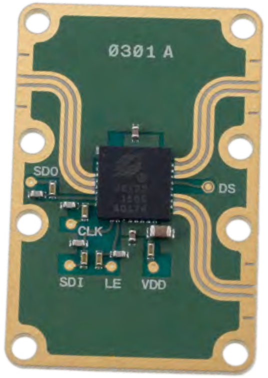
X-Microwave
Cavity Filter



Peregrine – PE43704
Digital Step Attenuator



Analog Devices - ADF4159
Phase Lock Loop



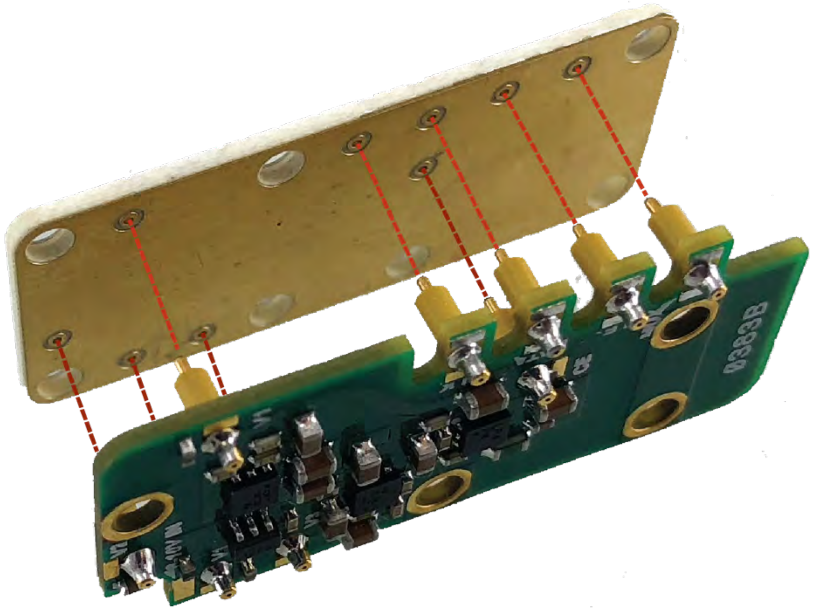
Peregrine – PE46120
Phase and Amplitude Controller

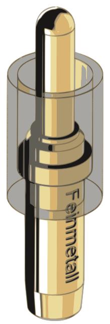
DLI - PDW05758
Splitter

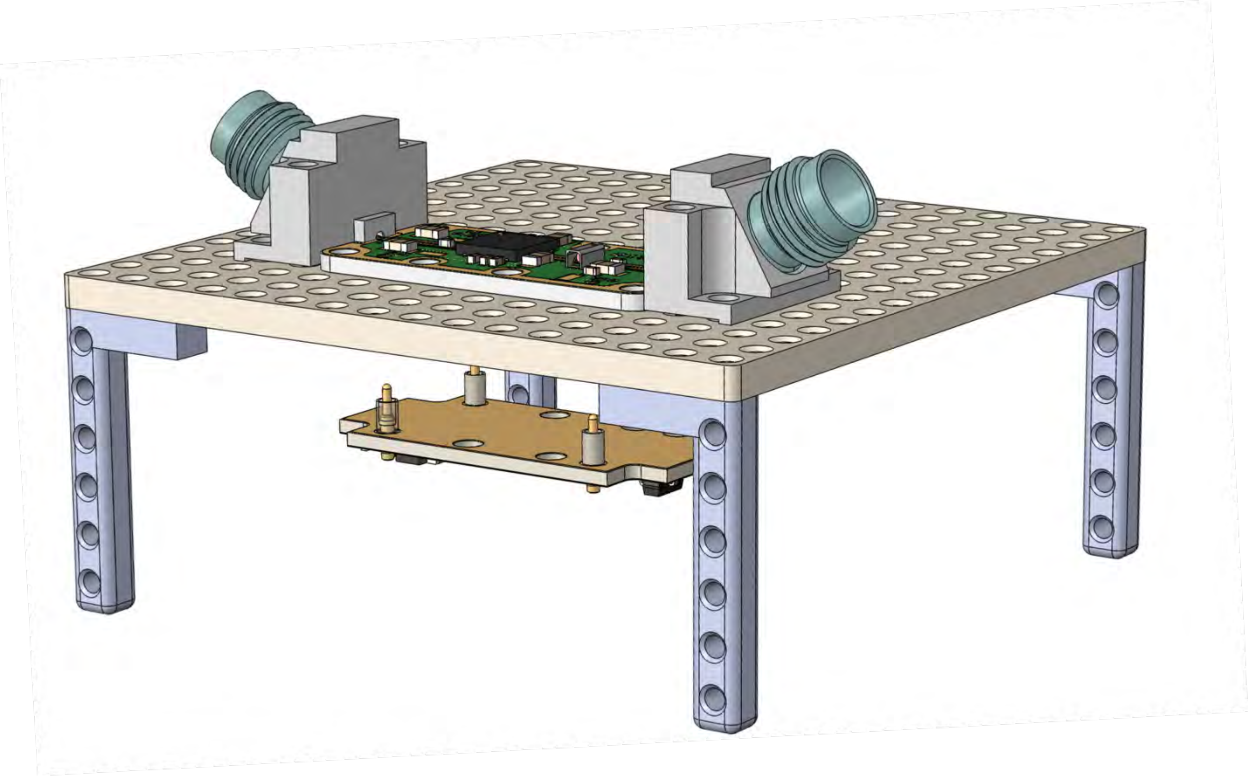
NEL – O-CS8
Low Phase Noise Osc

VCO

Bias and Control from the Bottom via Spring Pins

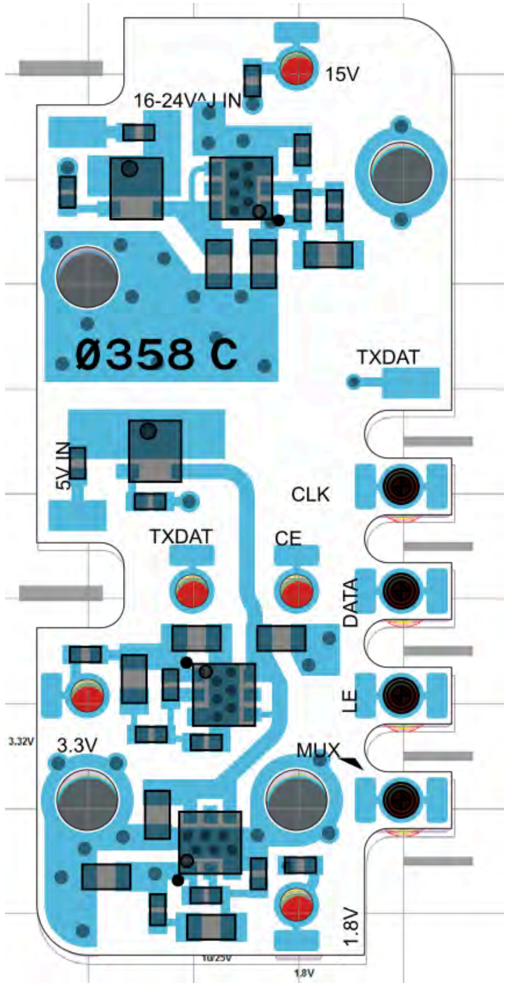




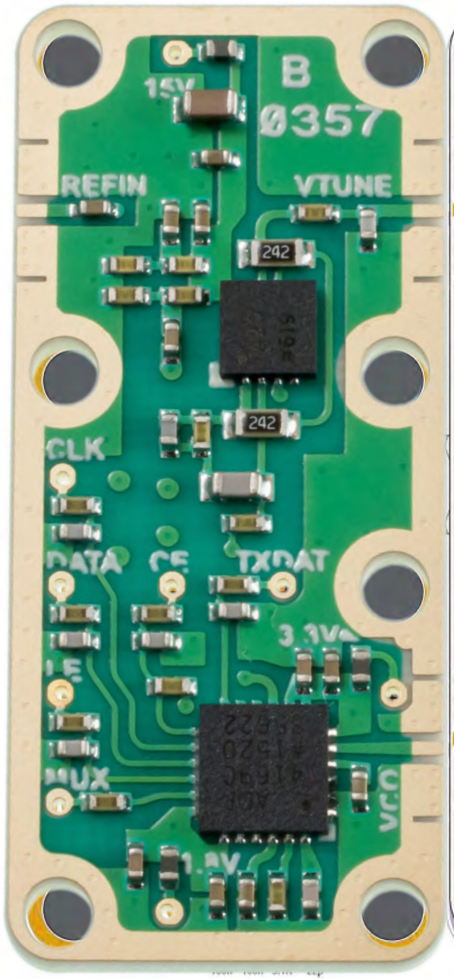


X-Microwave PLL Evaluation Solution

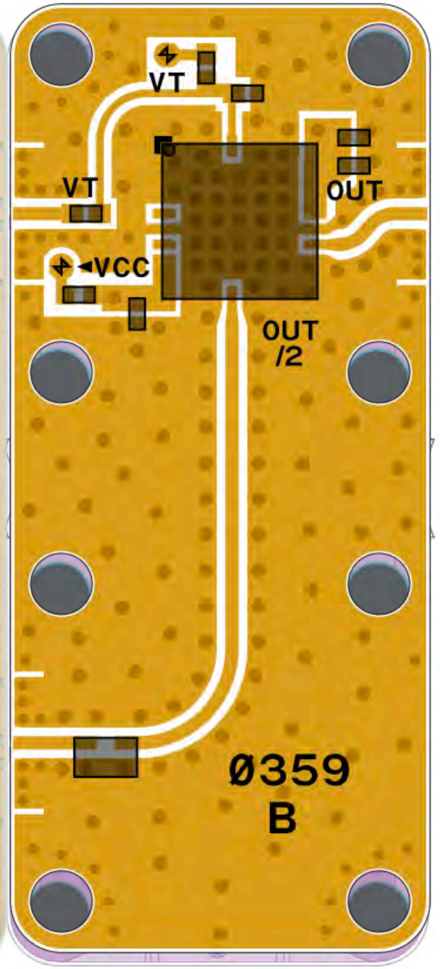
PLL CNTL

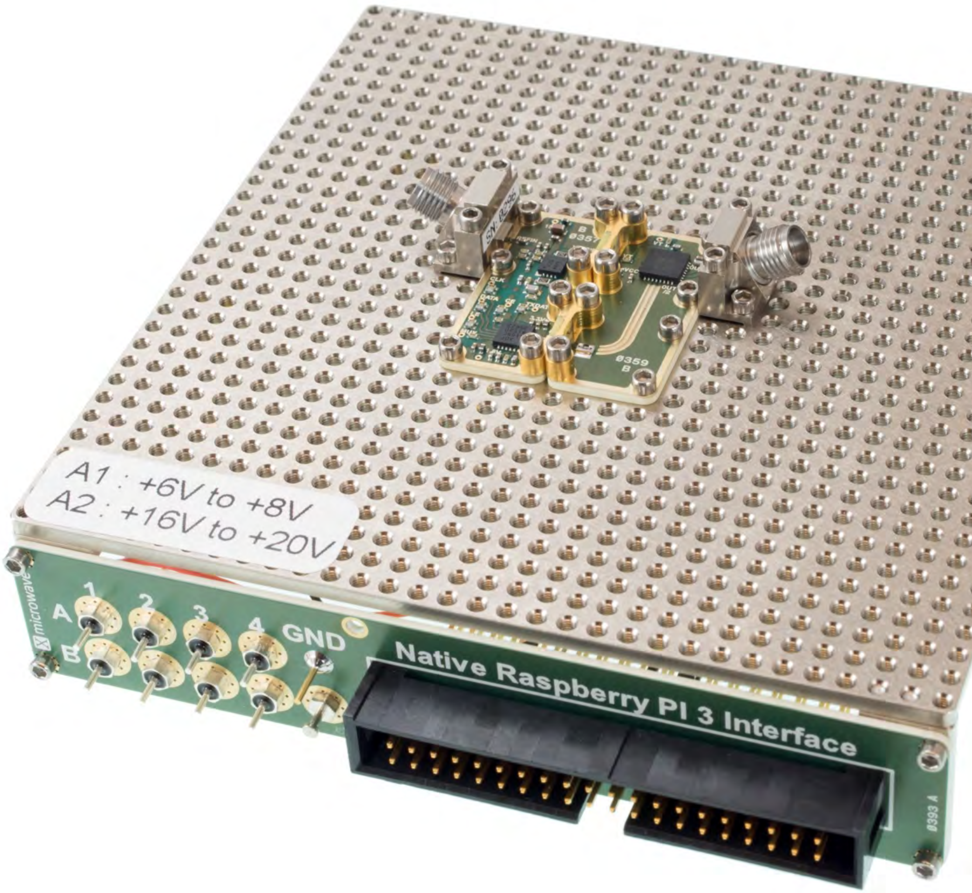


PLL block



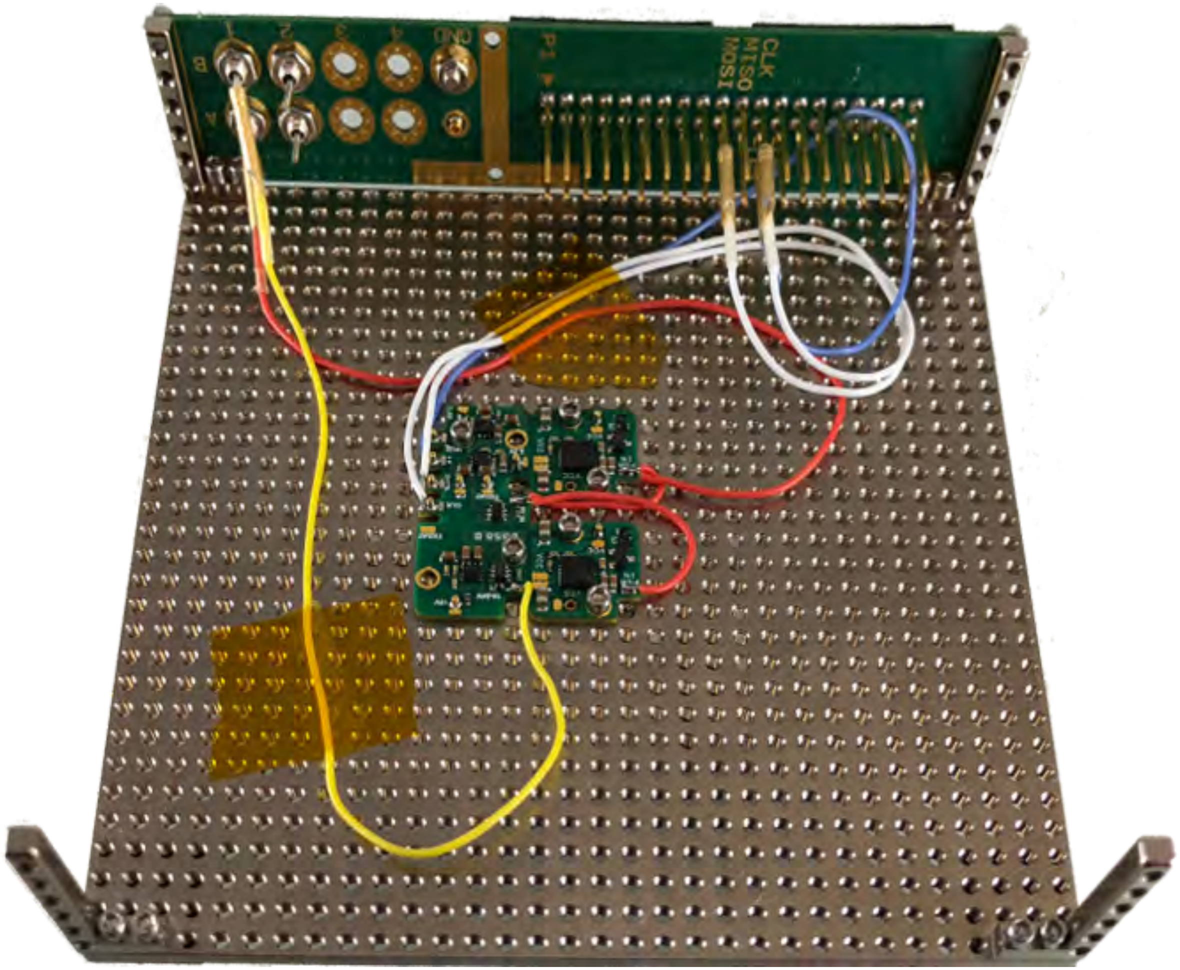
VCO block

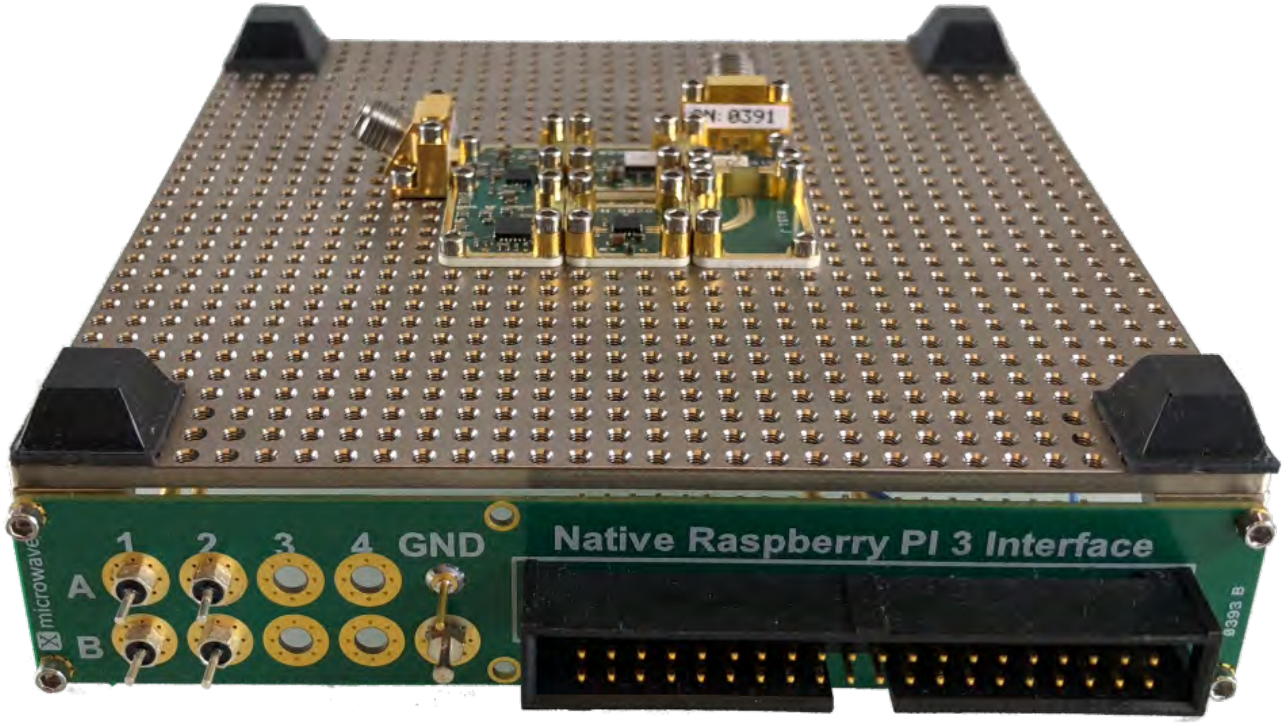




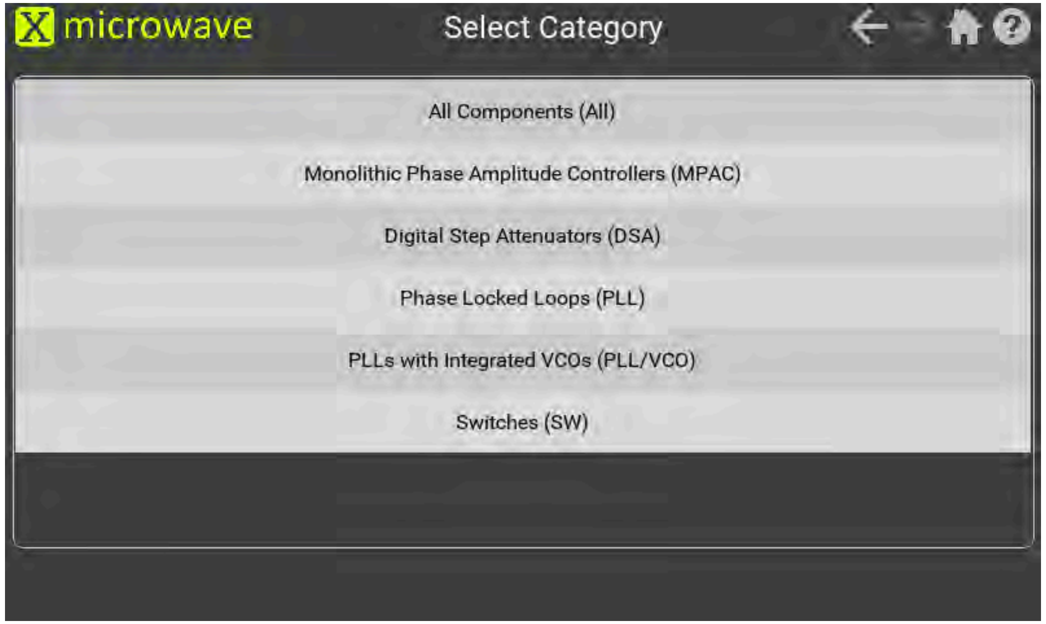
microwave

Completed Prototype of a PLL / VCO Circuit



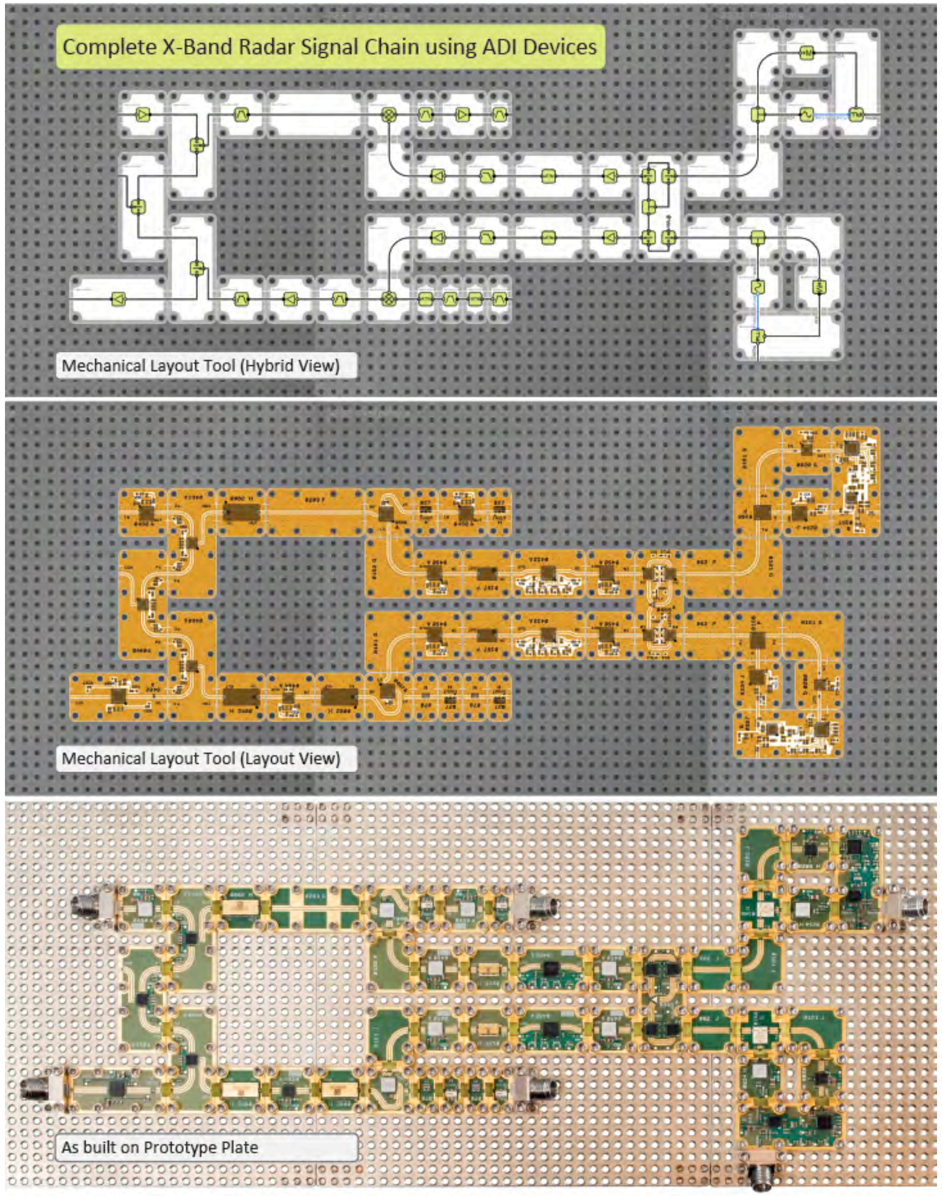


One-Touch Component Configuration



- One-touch config for all manufacturers' parts
- Plug and play operation
- Supports for Serial (SPI) and parallel control
- Over 200 controllable parts

Online Design Tools



Mechanical Layout / BOM Creation / Cascade Analysis

cascade.xmicrowave.com

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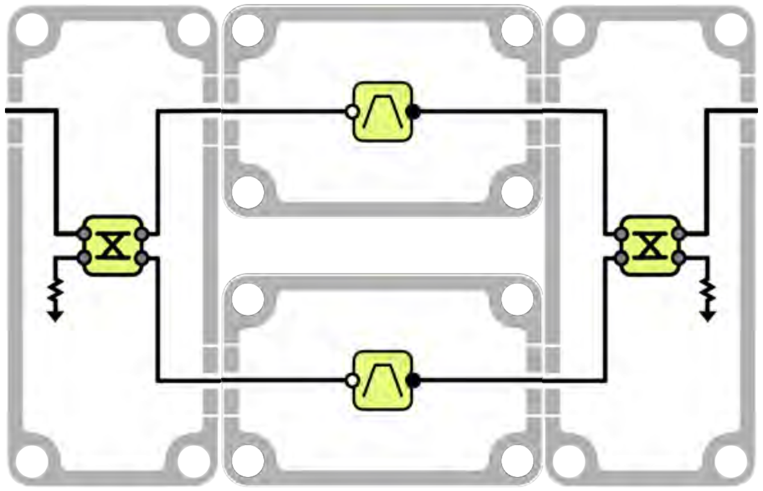
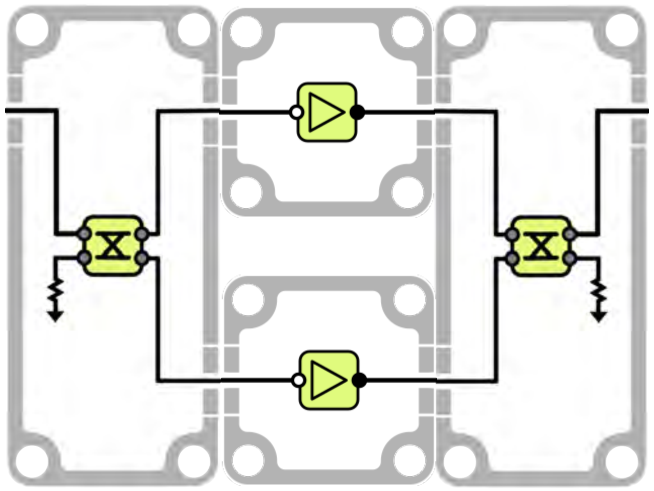
Common Subsystems



Reflectionless Filter



Balanced Amplifier

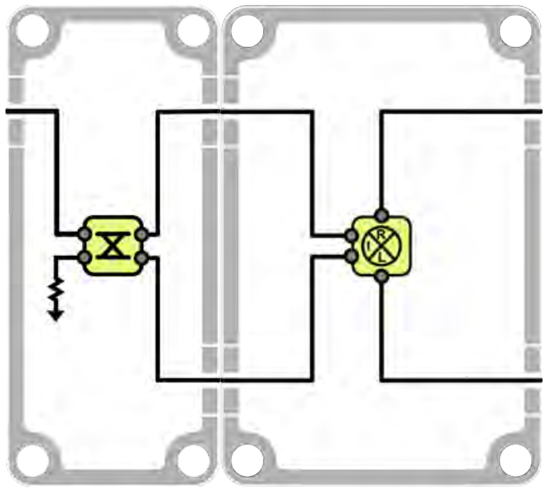
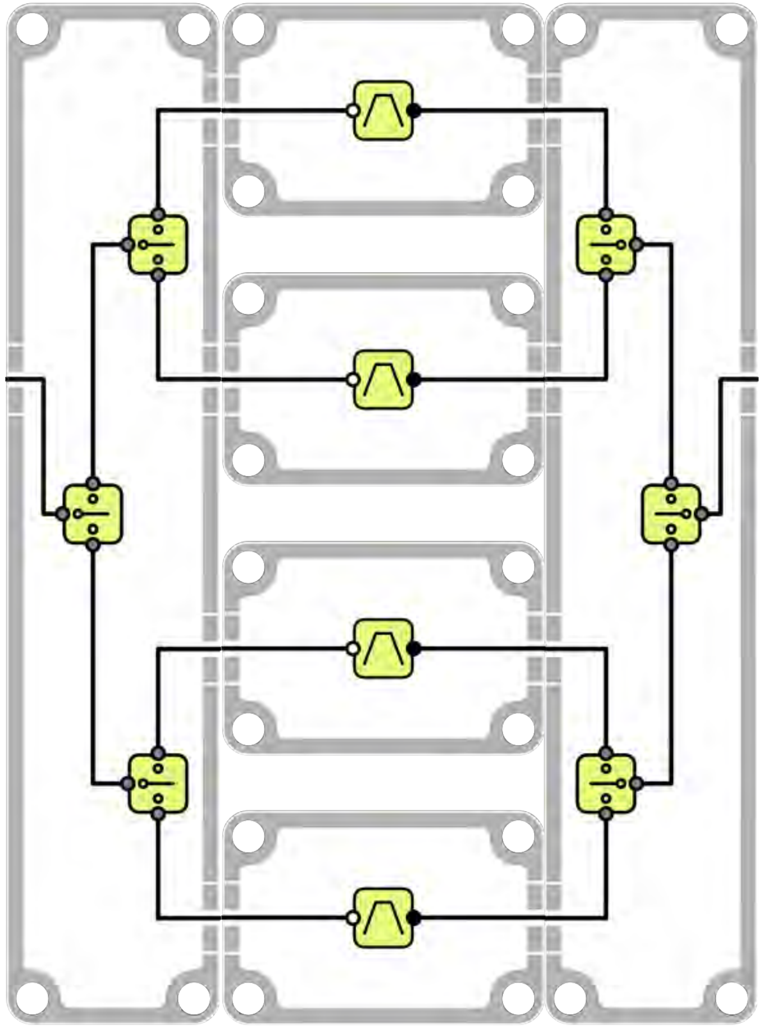
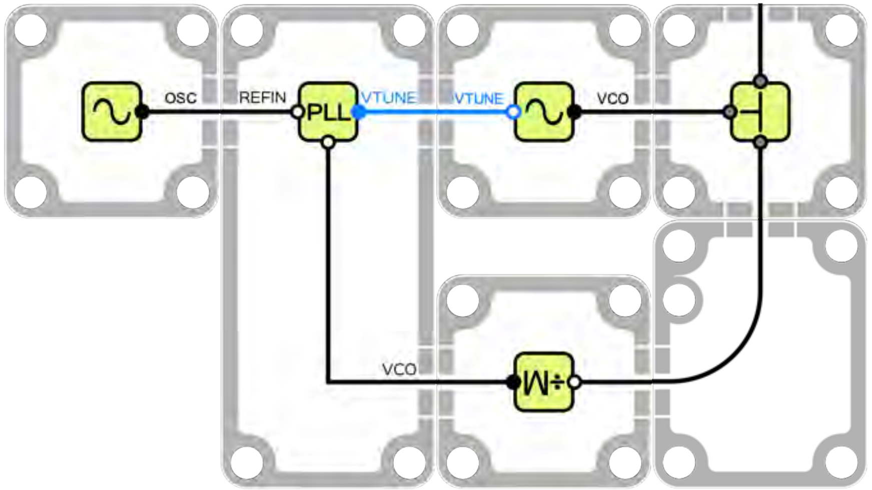


Image Rejection Mixer

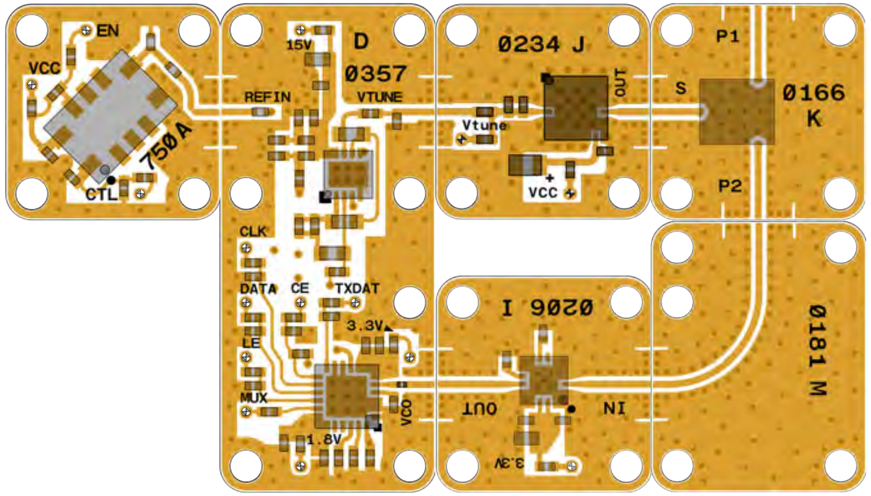
Common Subsystems



Switch Filter Bank

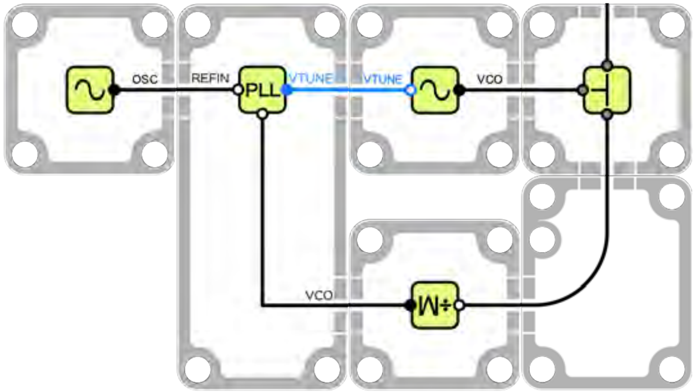


Synthesizer

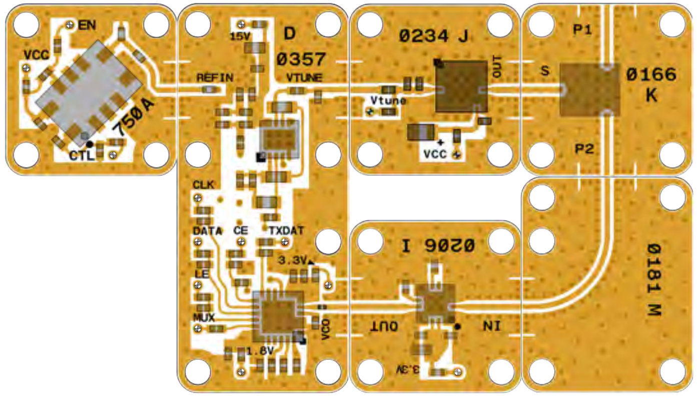


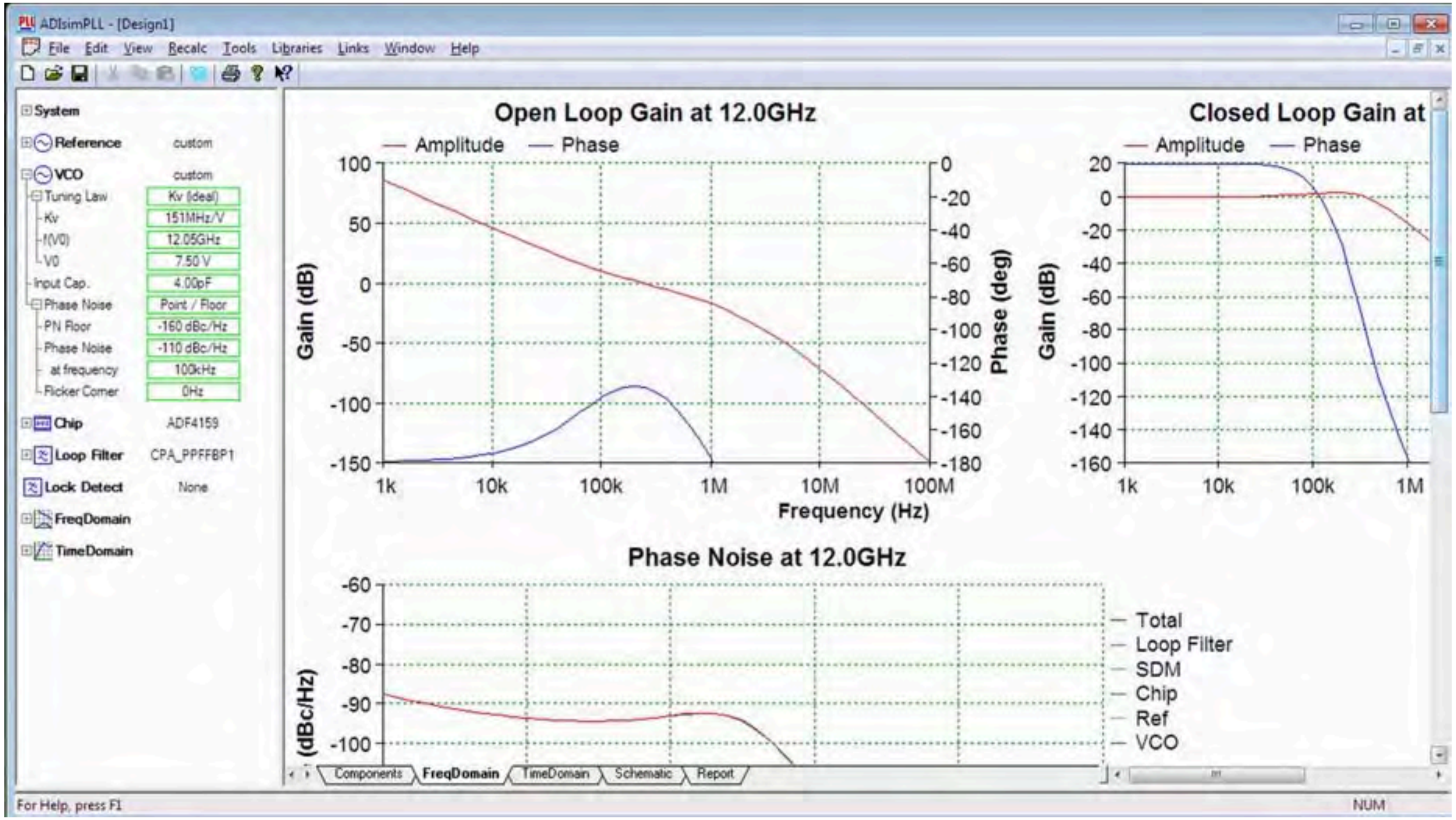
X microwave

ADIsimPLL

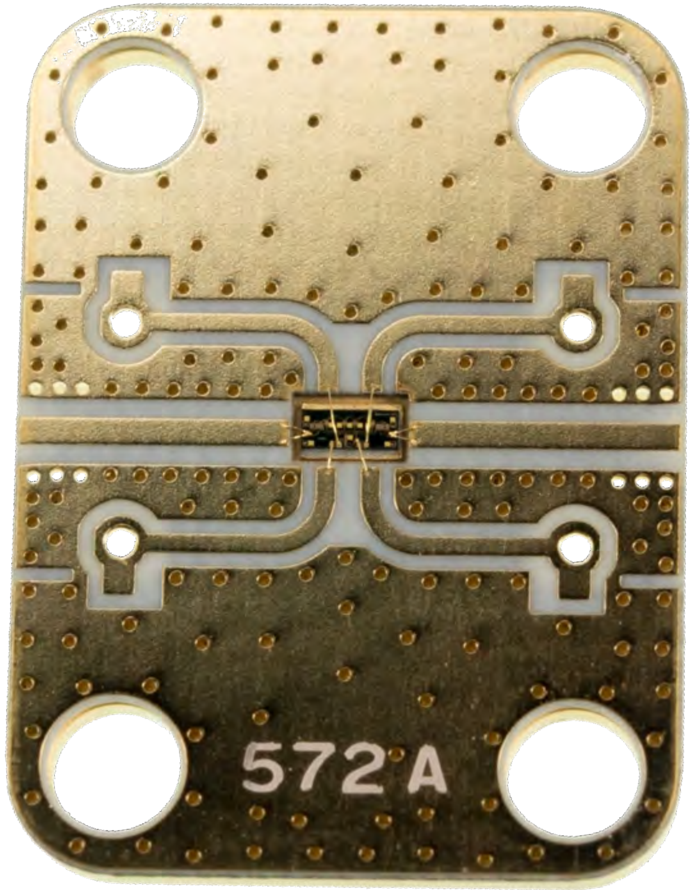


Synthesizer

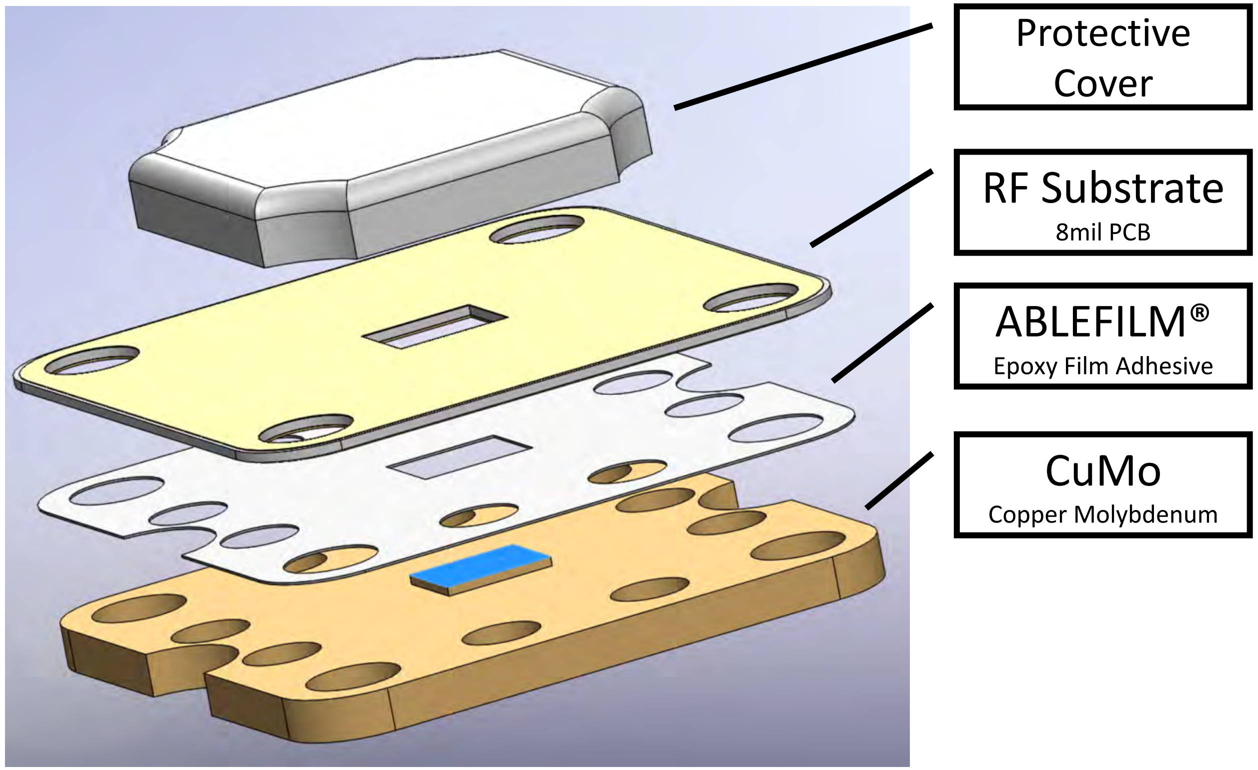




DIE Drop-In Blocks

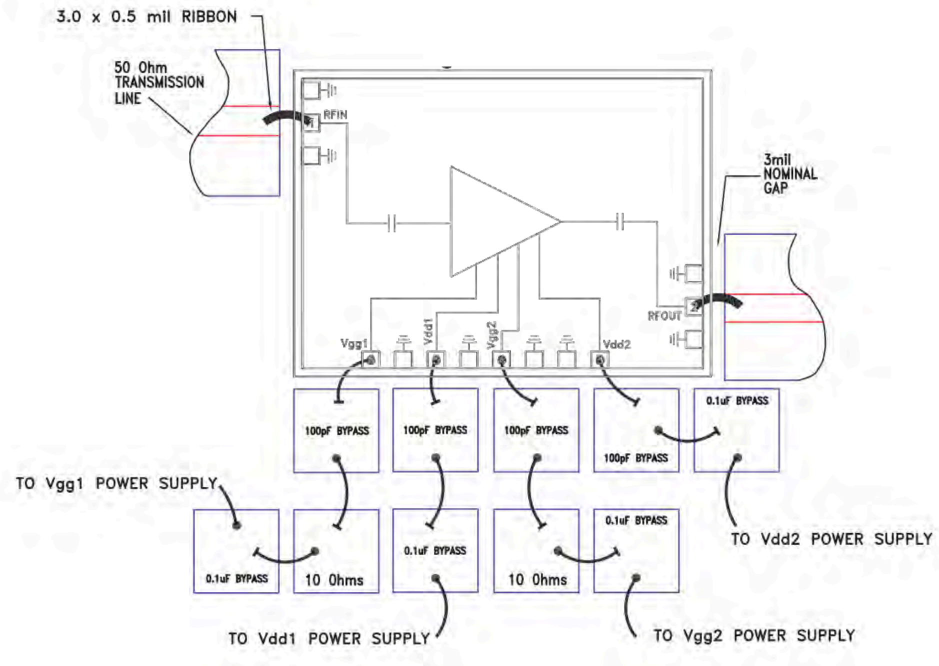


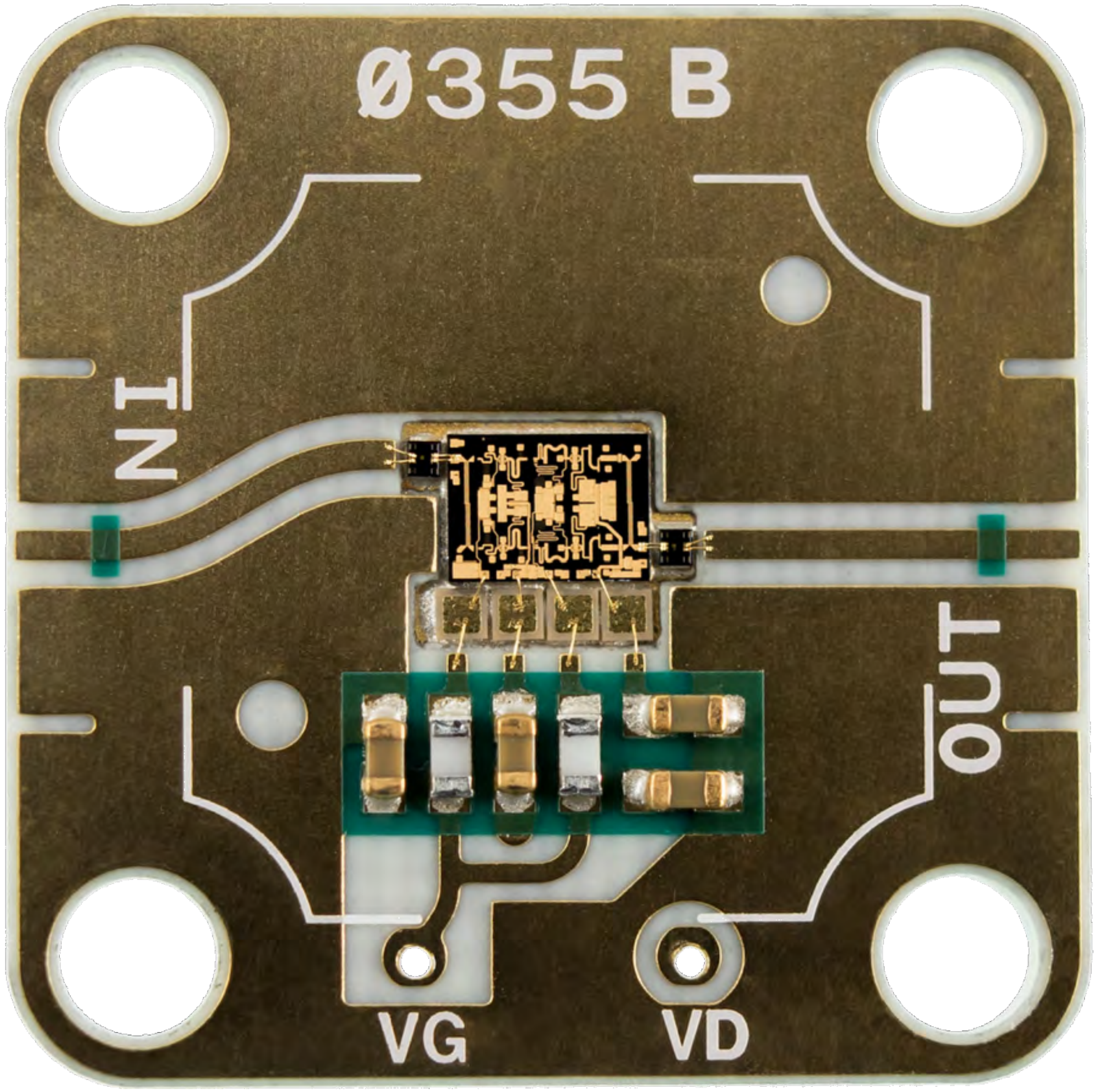
Keysight HMMC-1002



HMC-APH596

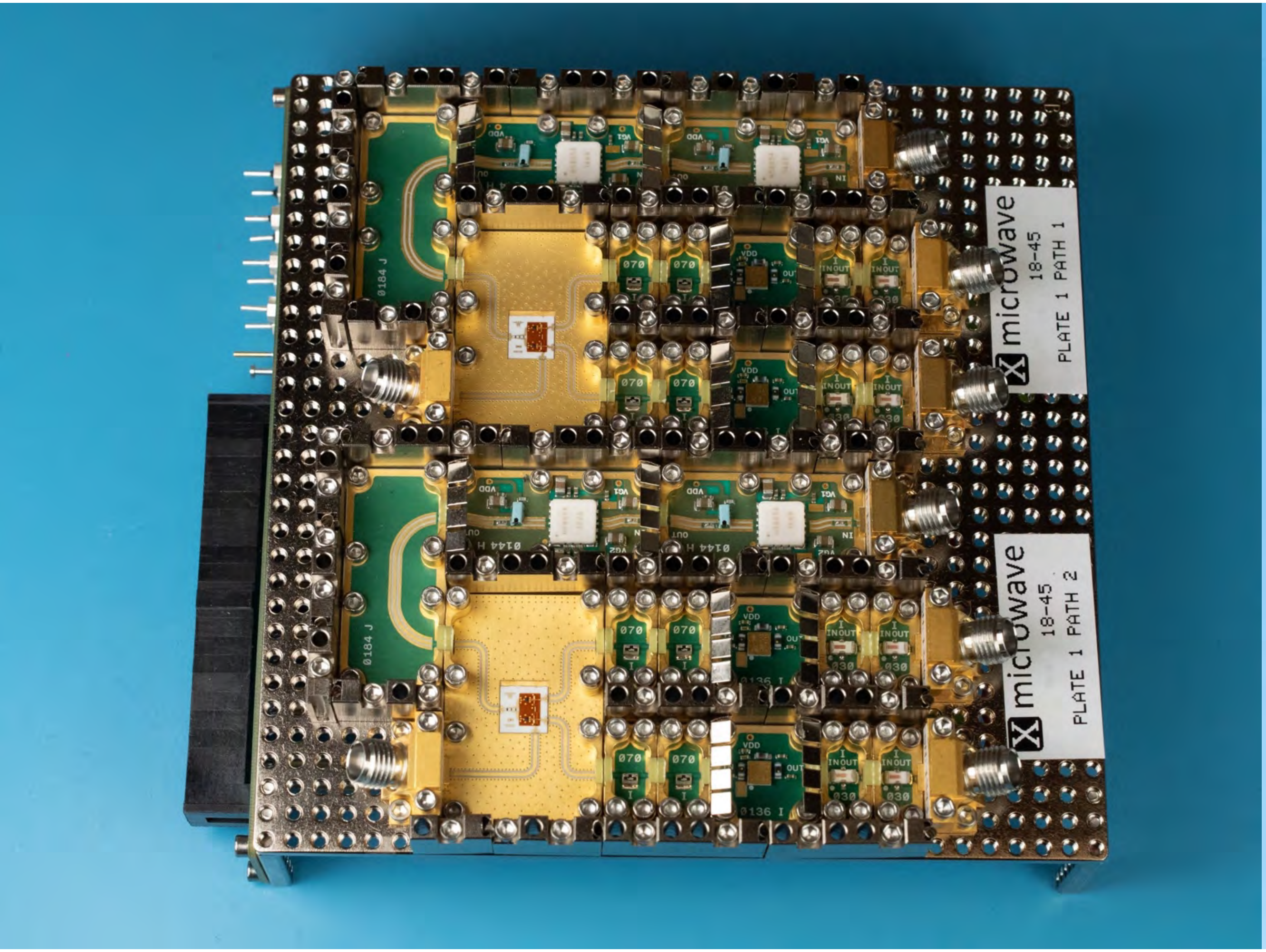
AMPLIFIER, 16 - 33 GHz

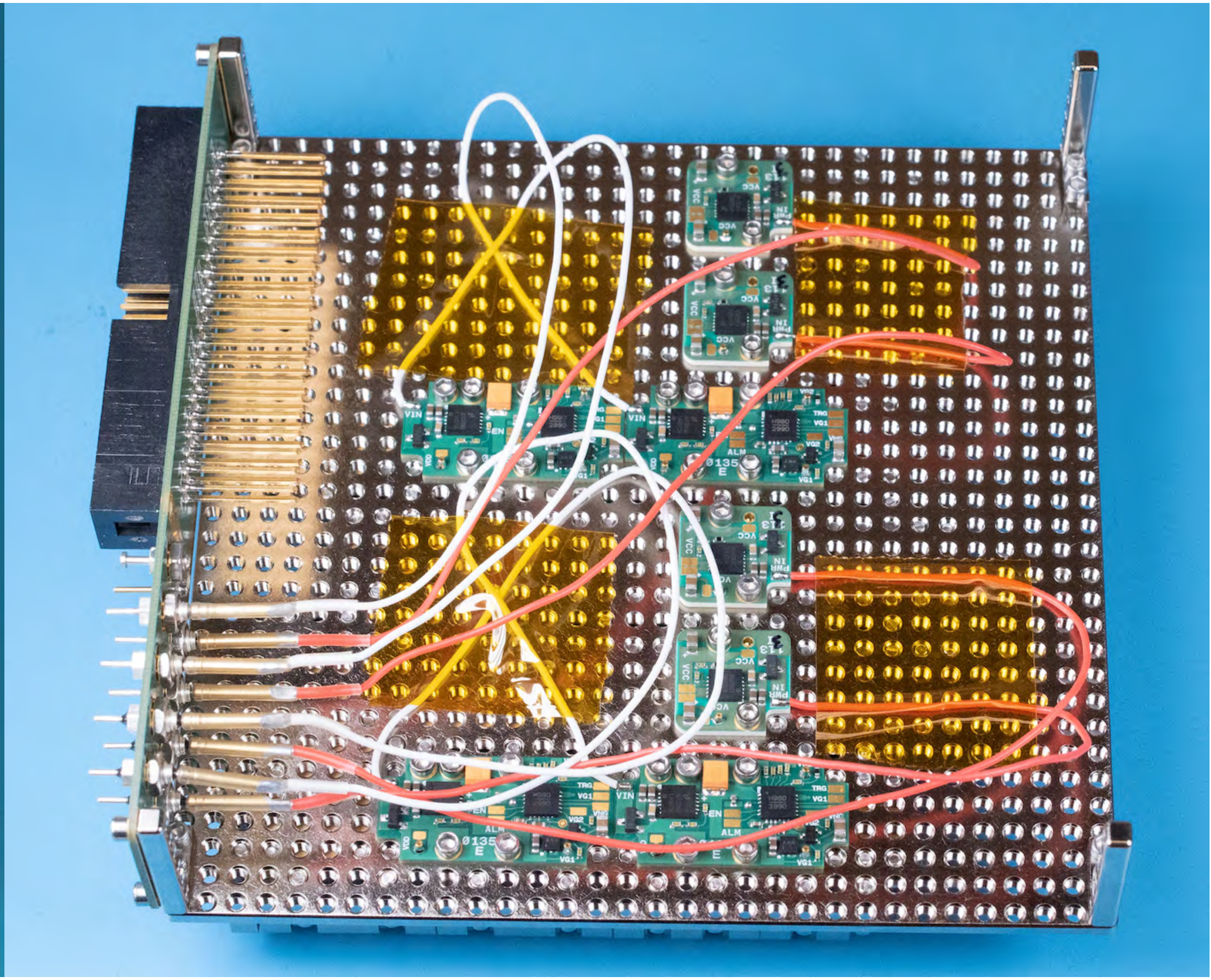




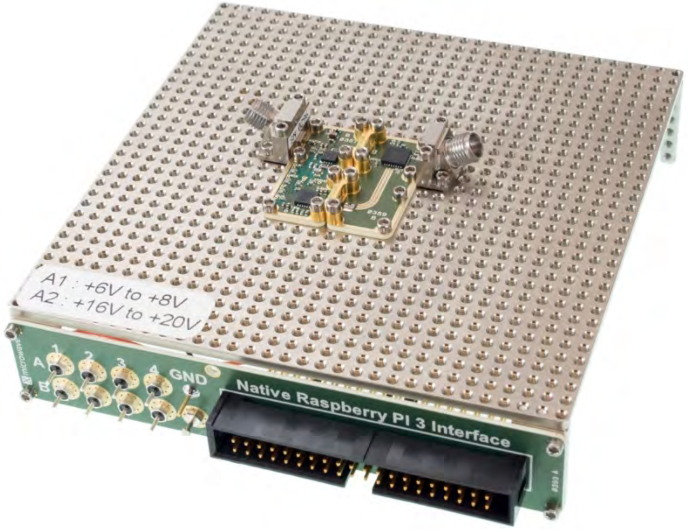
X microwave

Two Channel IQ Receiver (18-40 GHz)

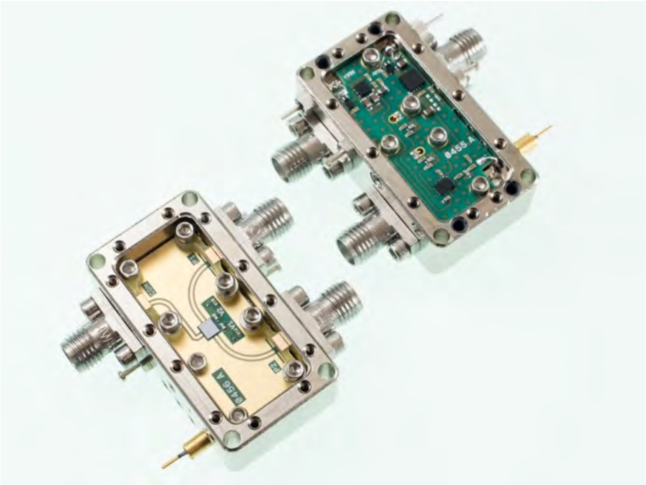




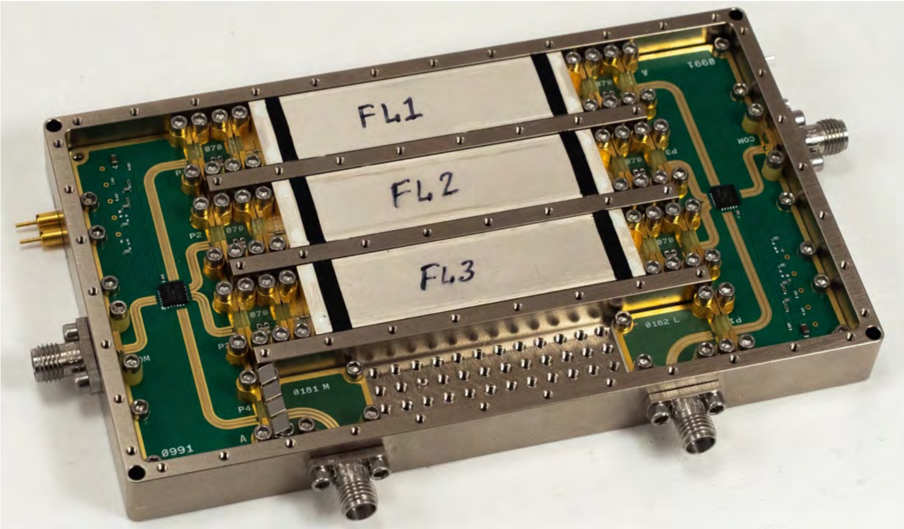
Utility of Modular Drop-ins



Prototyping

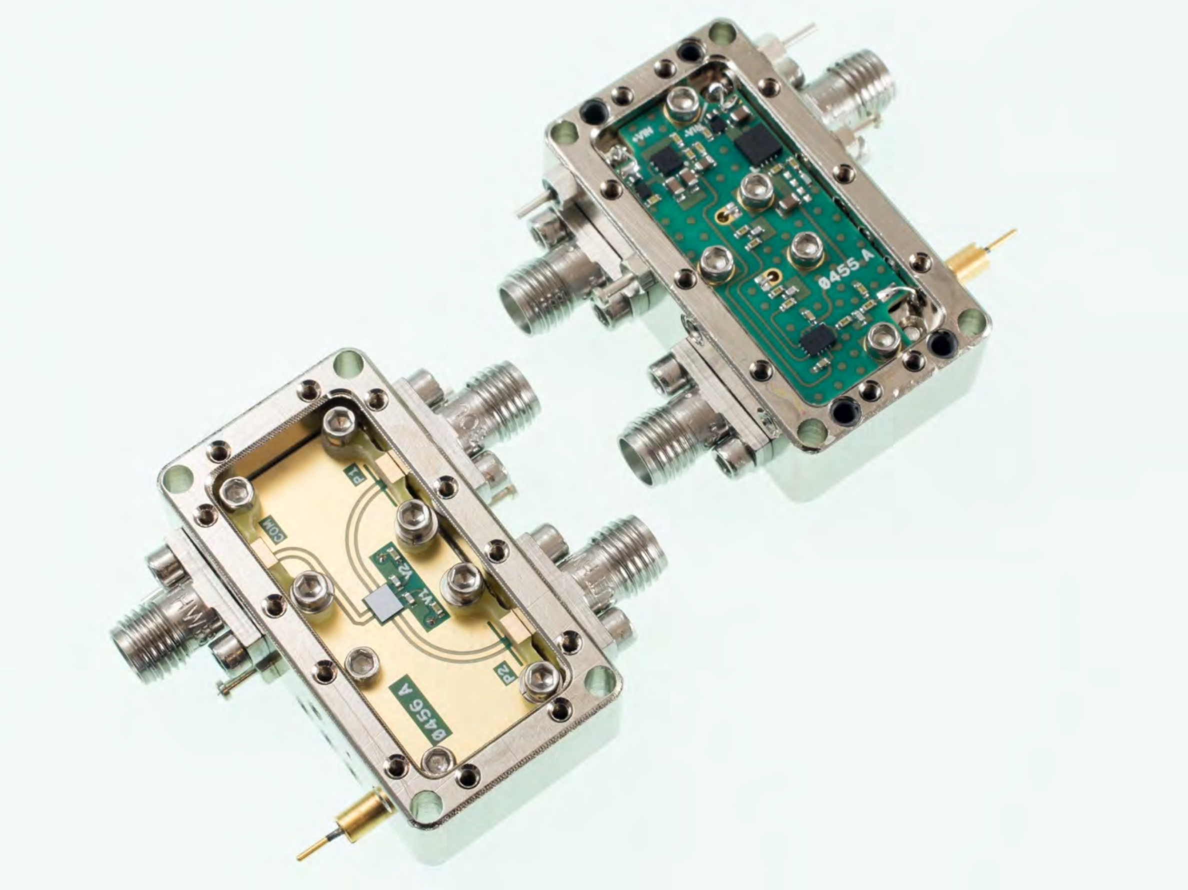


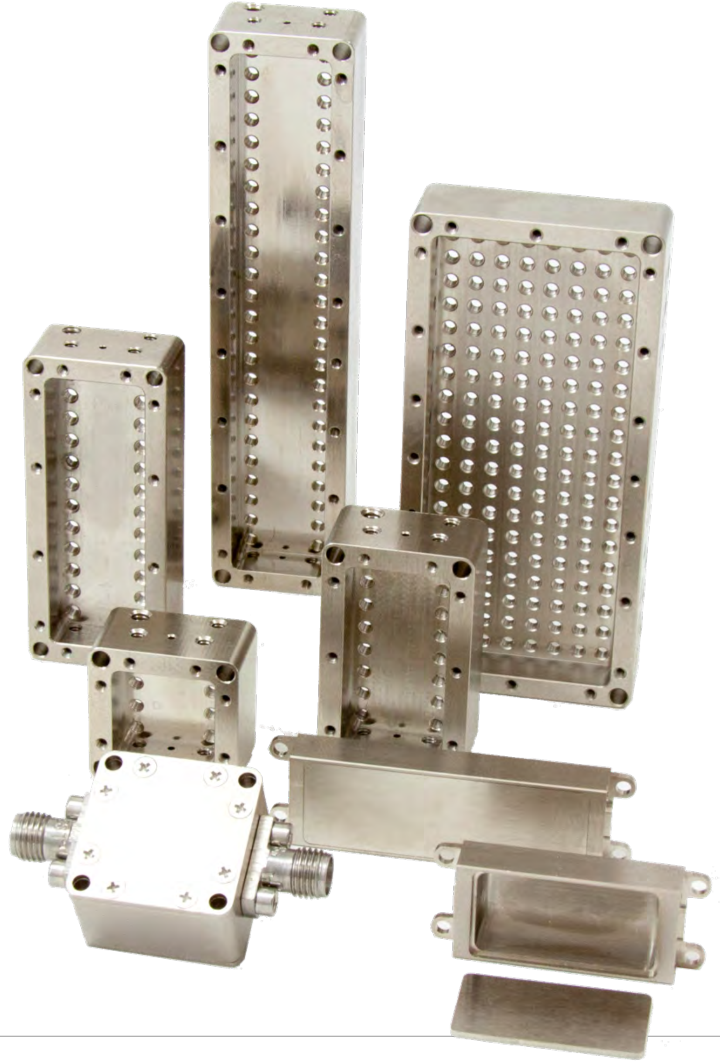
Connectorized Modules



Integrated Microwave Assembly

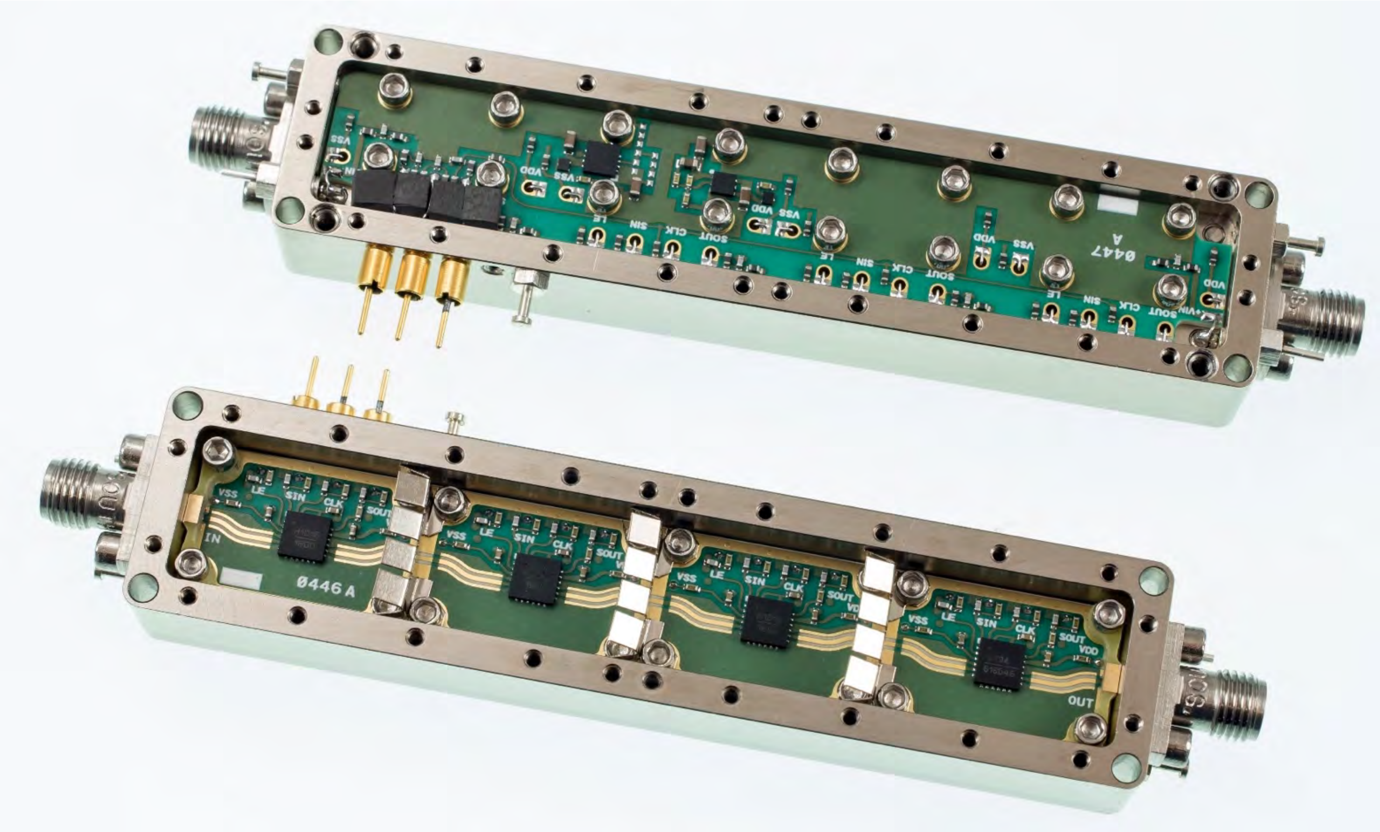
Core Products: X-MWblock Connectorized Modules

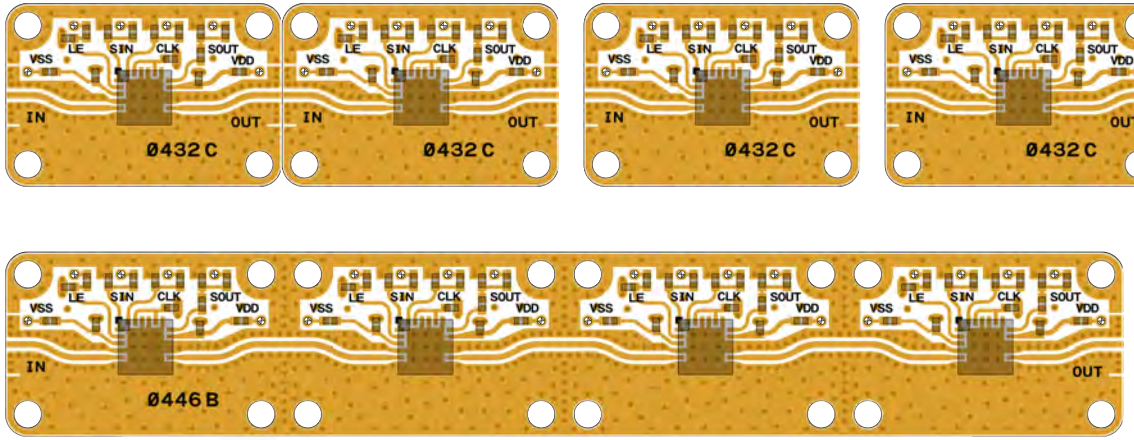


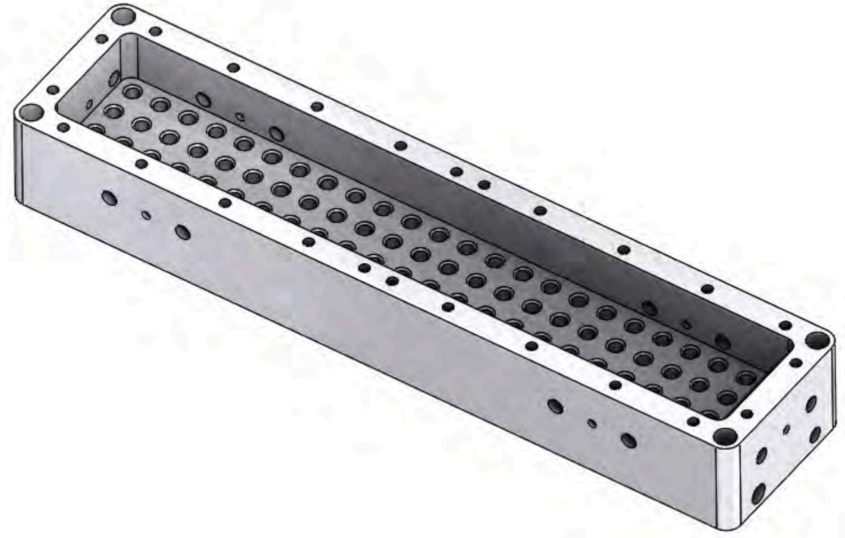


X microwave

Combined Drop-in Blocks







Compatibility Among Many Vendors

Supporting Modular Drop-ins

ANALOG DEVICES

IDT Integrated Device Technology

qorvo

AVX A KYOCERA GROUP COMPANY

KEYSIGHT TECHNOLOGIES

NEL FREQUENCY CONTROLS, INC. Your Silent Partner

Custom MMIC

MACOM Partners from RF to Light

pSemi A Murata Company

DLI DIELECTRIC LABORATORIES

knowles

Mini-Circuits

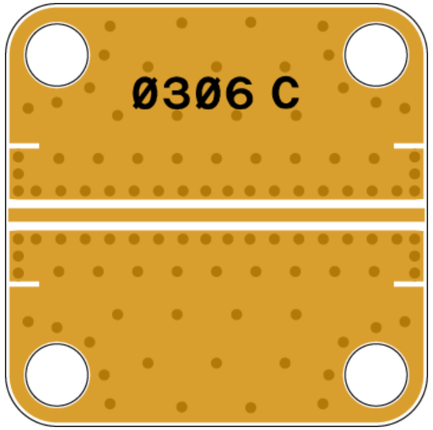
Modular Building Blocks

Wholistic View

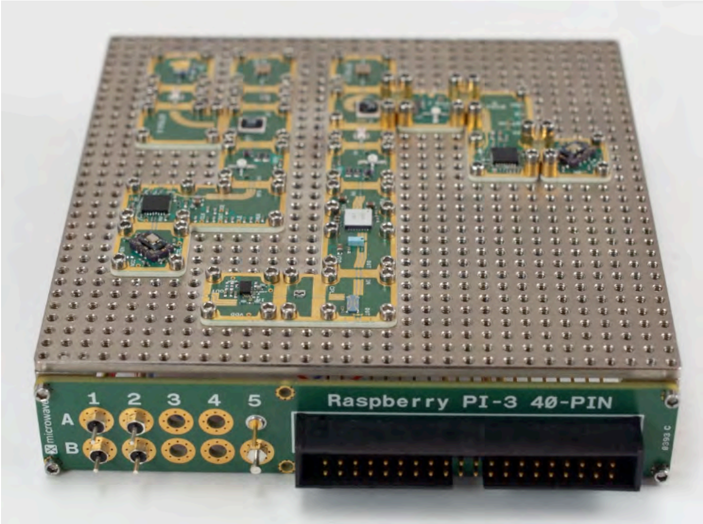
- Evaluation Platform
- Design Methodology
- Manufacturing Process

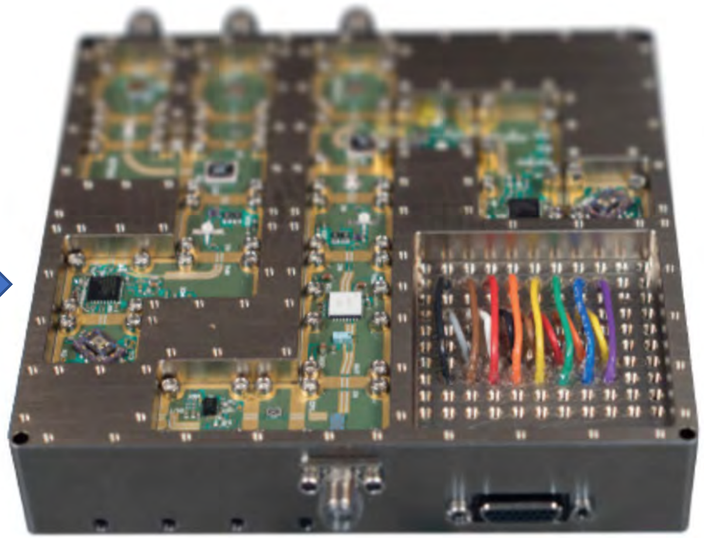
Start your Own Design Today!

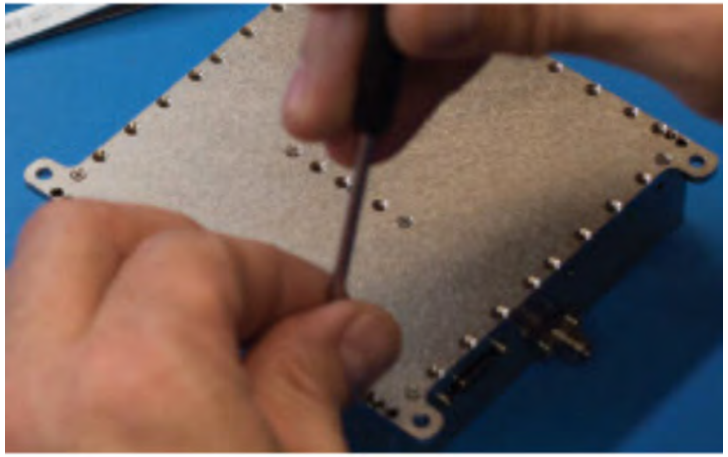
- 8 mil + 30 mil Rogers 4003 (49 mil stack-up)
- 17 mil RF Trace
- 0404 block = 0.54” x 0.54”



First Prototype = Production Assembly







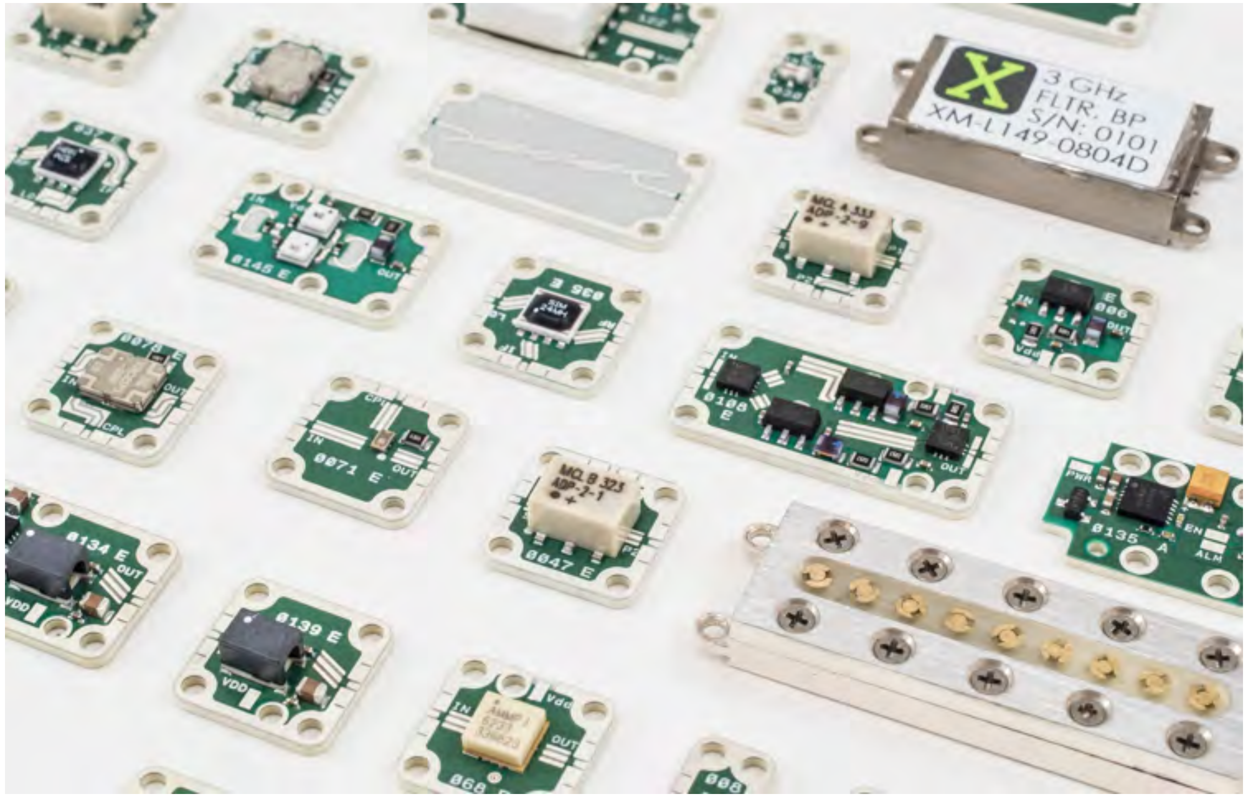
Simulate....Prototype....Production

Required Tools:

X microwave

Thank you!

Erik Luther
Vice President – X-Microwave
erik.luther@xmicrowave.com



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