

Cobham Microwave

29 avenue de la Baltique
91953 Courtaboeuf, FRANCE

The most important thing we build is trust

COBHAM



Lessons learnt from ECI and business roadmap

Jean-Marc BUREAU
Laurent ETIENNE

Head of Materials & Process Dept., ECI Project Manager
Business Development Manager

- Short presentation of COBHAM GROUP and of COBHAM MICROWAVE
- Products portfolio and markets
- RF/Microwave Silicon Components and Hybrids
- ECI activities and results
- Other space RF / Microwave Hybrids

- Focused on Hi Rel Markets
- Employ some 12,000 people on five continents
- FSTE 100 company with annual revenue ~ £2bn
- Specialized in sub-systems, products and services that protect lives and livelihoods
- Capabilities increasingly centred around C4ISR*
- Acquired more than 100 companies in 12 countries, half of these in the last decade
- Transitioned to a single Cobham brand in 2009

*Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance



Sell technically differentiated products and services

Aviation Services

Avionics
& Surveillance

Mission Systems

Defence Systems

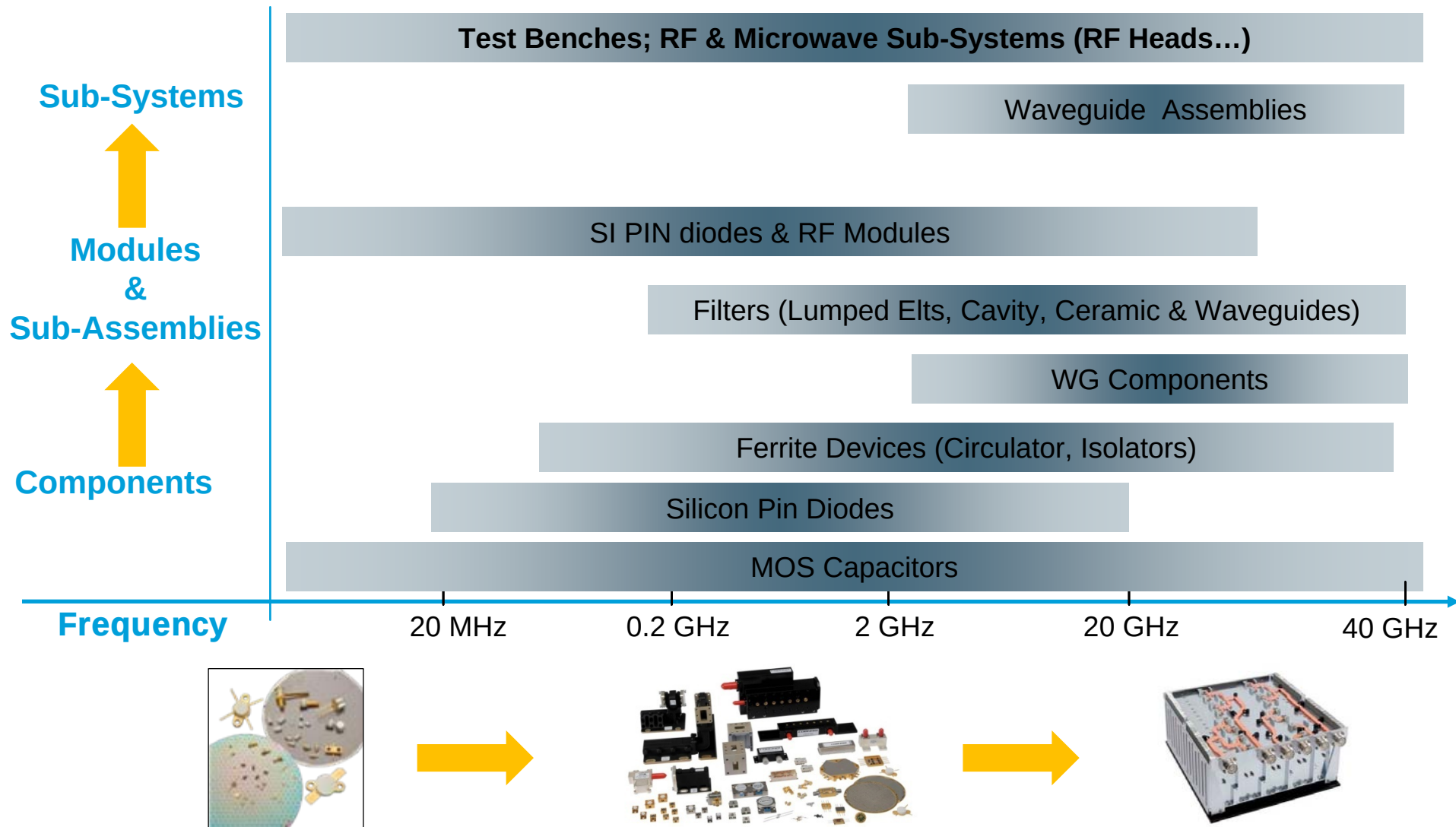


CHELTON TELECOM & MICROWAVE (formerly TEMEX MICROWAVE)

Based in France
250 employees, 35 M€



VERTICAL INTEGRATION



Prime Targets



Defense

- Ground, marine & airborne radars
- Battle field radios
- Identification & Navigation systems



Space

- Payloads:
 - Transceivers
 - MMIC decoupling (Mos)



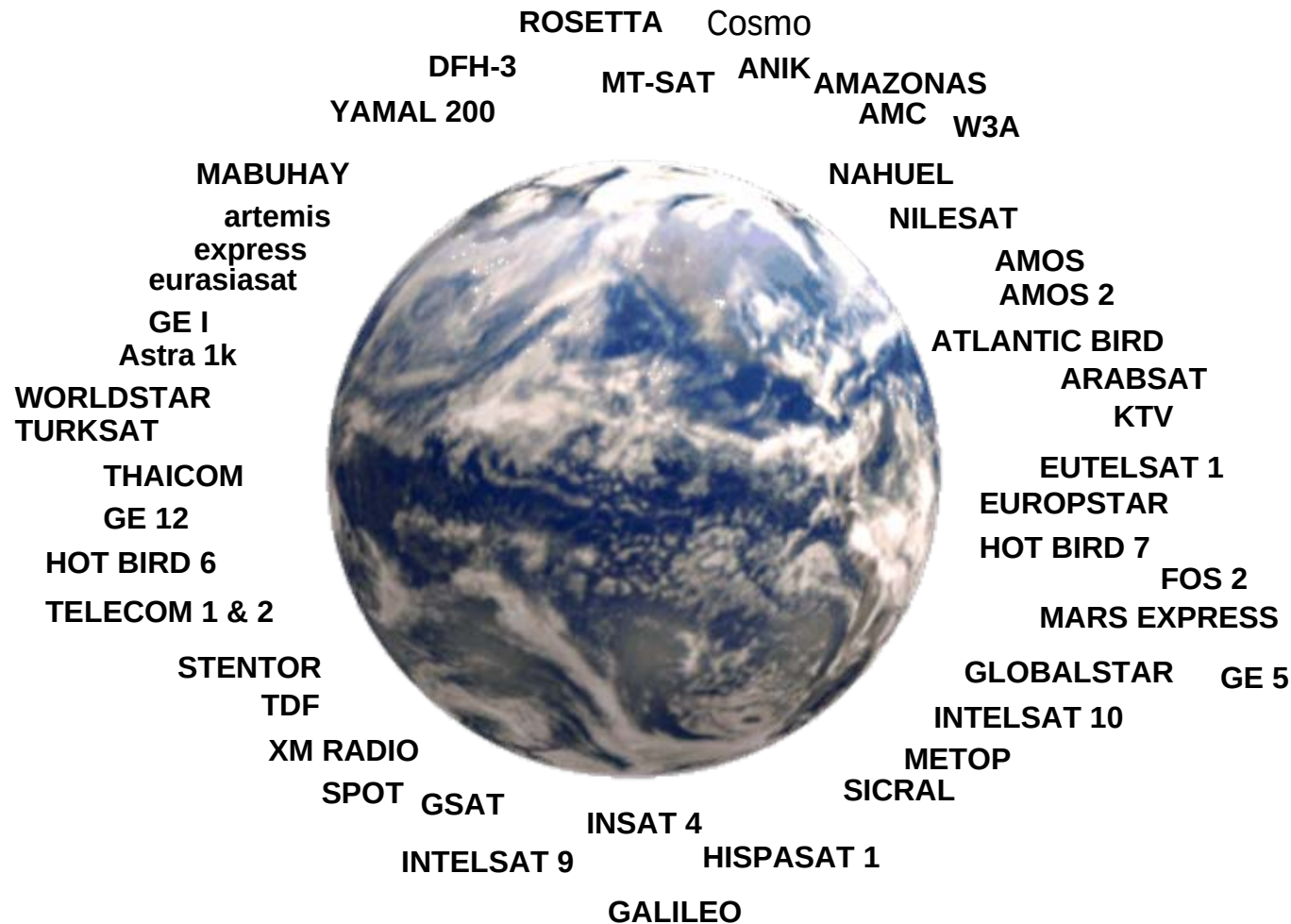
Medical

- Magnetic Resonance Imaging



High Rel Market

COBHAM MICROWAVE SPACE HERITAGE



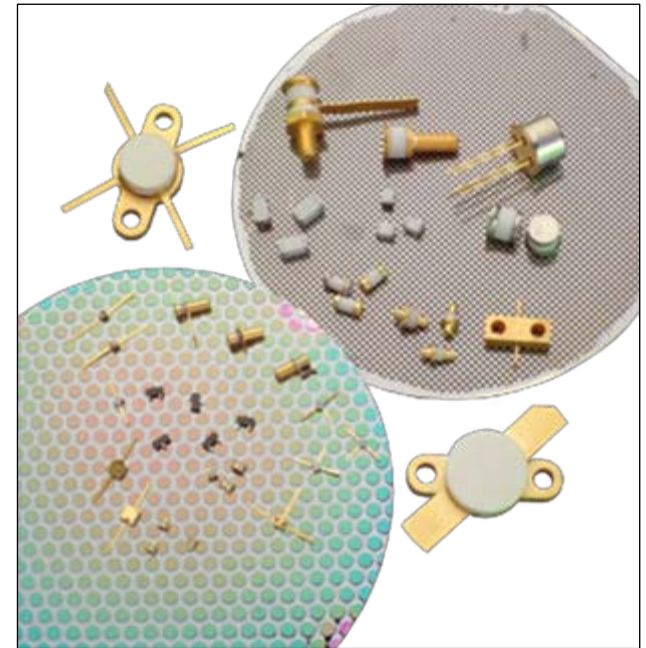
RF & MICROWAVE SILICON COMPONENTS

Wide Range of Products :

- PIN diodes : Low, medium & high voltage :
 - 50 V to 3000 V Vbr
 - Low R_s & low C_j
- Varactor diodes
 - 90V, 30 V & 20 V Vbr
- SRD & Multiplier diodes
- MOS capacitors
 - 50 ppm/°C stability

Large choice of Packages :

- Naked dies
- Ceramic
- Plastic
- Custom



RF & MICROWAVE SILICON COMPONENTS

Types	Applications	V_{br}	Junction Capacitance
PIN	High power switching	500 to 2000 V	Low C_j for a good isolation $C_j(50v)$: 0,15 pF to 3 pF
	Fast switching	150 to 400 V	$C_j(50v)$: 0,04 pF to 0,17 pF
	Ultra fast switching	30 to 100 V	$C_j(6v)$: 0,08 pF to 0,17 pF
	AGC, Attenuator		0,3pF to 0,10 pF
	Limiter	25 to 100 V	C_{j0} : 0,14 pF to 0,45 pF
Varactor	VCO (Voltage Controlled Oscillators)	30 V, Q-factor: 300 to 4500	$C_j(Vr4v)$: 0,4 to 100 pF
		45 V, Q-factor: 250 to 3000	$C_j(Vr4v)$: 0,4 to 100 pF
		20 V	$C_j(Vr4v)$: 1,2 to 15 pF
SRD	Frequency Multiplier	25 V to 30 V	$C_j(6v)$: 0,3 pF to 12,5 pF
MOS Cap	MOS Capacitor	Up to 500V	0,1 to 470 pF



RF & MICROWAVE SILICON COMPONENTS

COBHAM



ESCC5010 Generic specification

Sub-Families	Types	Spec.
Multipliers Varactors,	DH 267, 252, 256, 292, 294	5512/016
Tuning Varactors	DH 76 XXX	5512/023
PIN, Fast Switching	DH 50151 – DH 50157 DH 50201 – DH 50209 DH 50251 – DH 50256	5513/031 5513/033 5513/034
PIN, Ultra Fast Switching	DH 50033 – DH 50037 DH 50052 – DH 50057 DH 50071 – DH 50077 DH 50101 – DH 50107	5513/032 5513/036 5513/037 5513/038
MOS Capacitors	101M, 201M, 400M and 401M	5711/002

 **ESCC web site: <https://escies.org/public/escs/qpl/chelton.htm>**

Hi-Rel testing Capabilities

Screening and Qualification

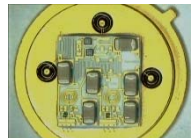
- Climatic chambers
- Life tests (HTRB, PBI,...)
- Die shear tests
- Pull tests
- Gross and fine leaks
- Vibration and acceleration tests
- PIND tests (Particle Impact Noise Detection)
- X-Ray, SEM, RGA ...



RF & MICROWAVE HYBRIDS

Heritage:

- RF & microwave applications (30 years experience, Thomson-CSF)
 - Up to 18 GHz
 - Several packaging technologies
 - Defense markets, customer specifications
- Amplifiers
 - Cascadable, LNA and general purpose
- PIN diode limiters
 - Coaxial, 100 W input power
 - Waveguide: up to 15 KW pulse power
- PIN diode switches
 - SPNT up to 8 channels
- Schottky diode mixers
 - Double balanced, up to 18 GHz
- Passive hybrids:
 - Power dividers, couplers, transformers, ...



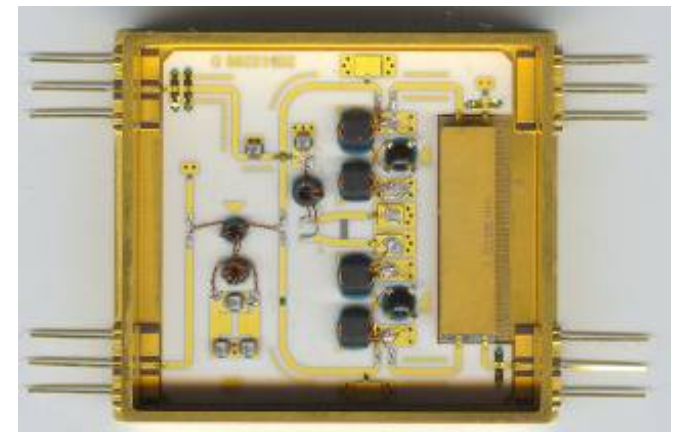
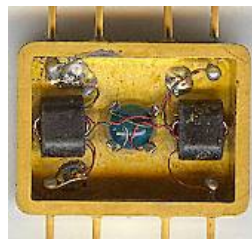
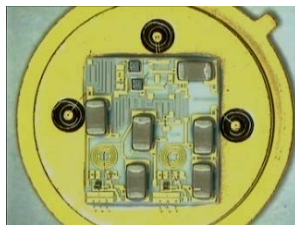
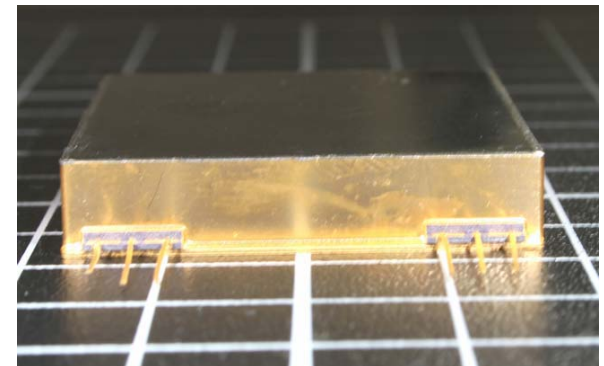
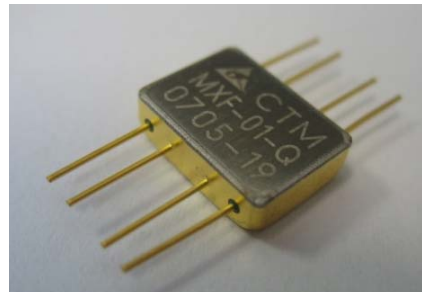
Design flexibility, high performance & reliability

RF HYBRIDS & ECI ACTIVITIES

PHASE 1 (2006-2008): 3 PROJECTS

DEVELOPMENT AND QUALIFICATION OF 4 EUROPEAN MICROWAVE HYBRIDS

- 1 Cascadable Amplifier (AGT-01)
- 2 Double Balanced Mixers (MXF-01 & MXF-02)
- 1 Image Rejection Mixer (MRF-01)

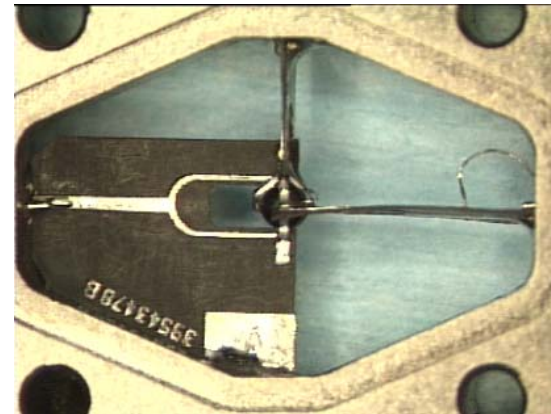
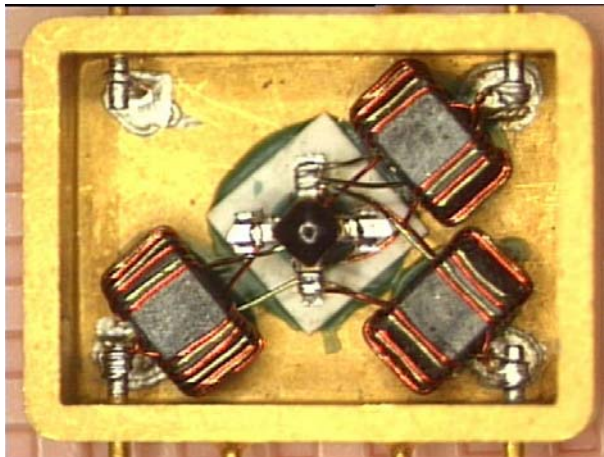


RF HYBRIDS & ECI ACTIVITIES

PHASE 2 (2009-2011):

DEVELOPMENT AND QUALIFICATION OF 2 EUROPEAN MICROWAVE HYBRIDS

- 1 Termination Insensitive Mixer (MXF-03)
- 1 Triple Balanced Mixer (MXC-01 in progress)



RF HYBRIDS & ECI ACTIVITIES

– OBJECTIVES & KEY ASPECTS:

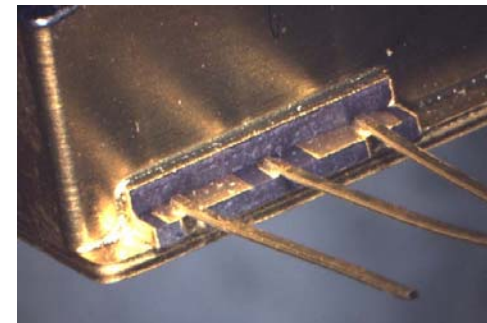
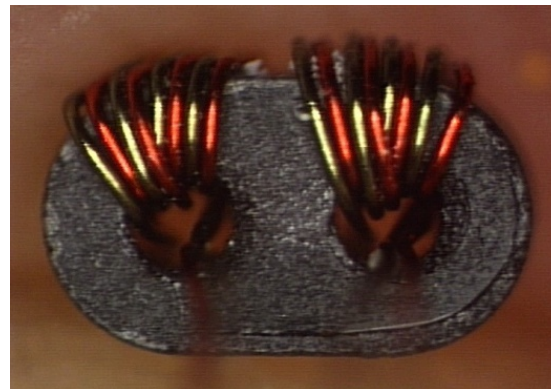
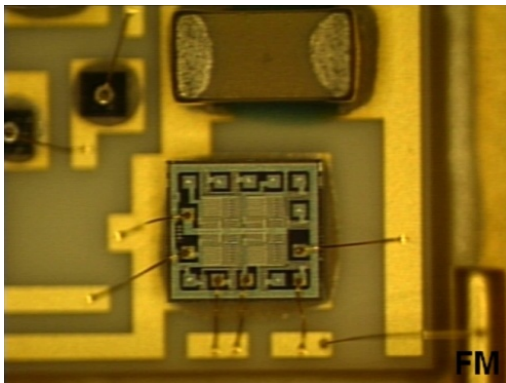
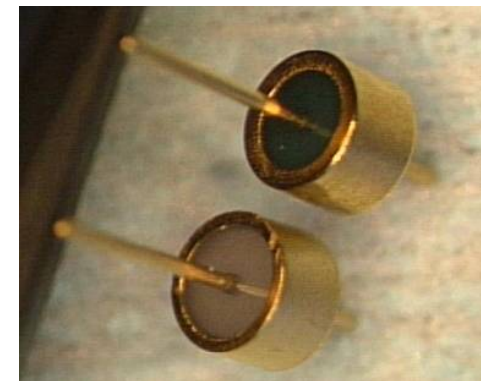
- Availability of EEE Components from European manufacturers
- Alternative to components available only from US -> ITAR free source
- Priority to European parts and technologies
- Design validation and qualification according to ECSS-Q-ST-60-05C
- Delivery of technical documents, full transparency with ESA
- Manufacturer validation (audit by ESA and CNES) -> Category 2
- Procurement, manufacturing, screening and lot testing according to ECSS-Q-ST-60-05C
- Introduction into EPPL
- Commitment for future manufacturing & procurements



RF HYBRIDS & ECI ACTIVITIES

COBHAM MICROWAVE UNIQUE SET OF PROCESSES:

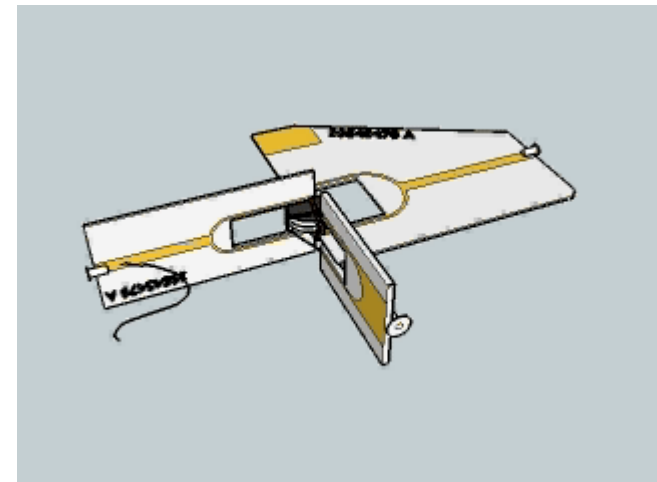
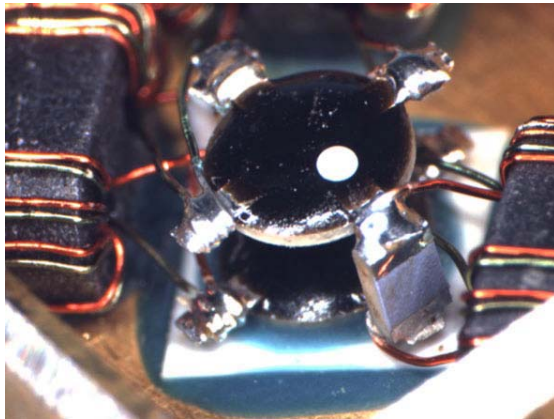
- Hermetic Kovar packages with matched glass or ceramic RF feedthroughs
- Ceramic & organic substrate attachment
- Bare chip attach and wire bonding (diodes and transistors)
- Ferrite core wire winding
- Adhesive and solder attachment of passive devices



RF HYBRIDS & ECI ACTIVITIES

COBHAM MICROWAVE UNIQUE SET OF PROCESSES:

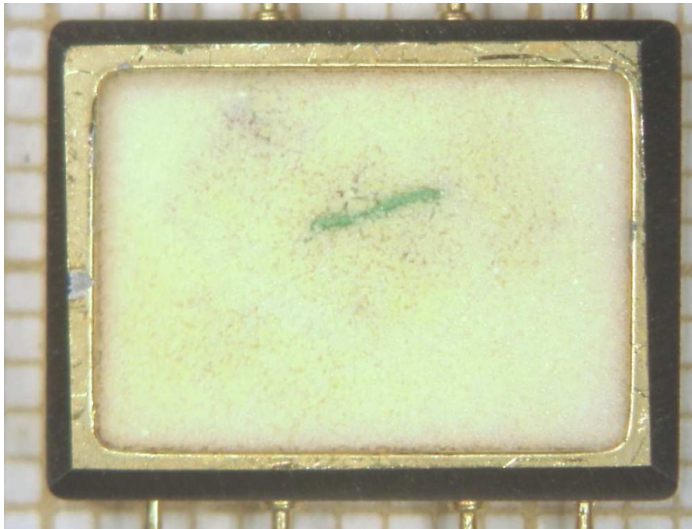
- Controlled atmosphere soldering (AuSn and soft solder)
- Manual iron soldering for assembly of complex 3D structures
- RF tuning



RF HYBRIDS & ECI ACTIVITIES

COBHAM MICROWAVE UNIQUE SET OF PROCESSES

Cavity filling with foam



Hermetic sealing (seam, electric, laser)



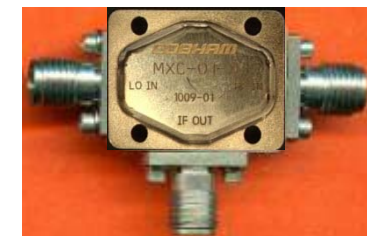
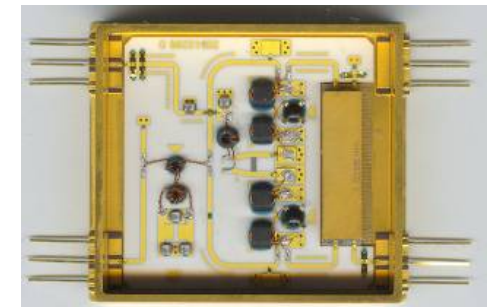
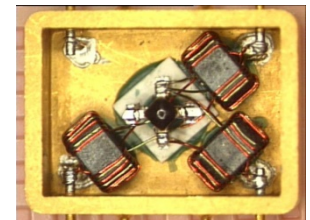
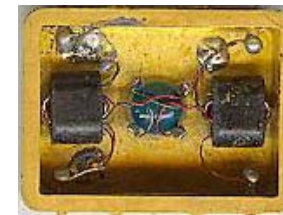
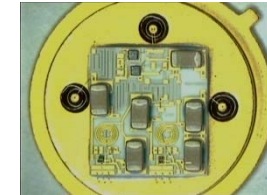
Controlled residual gas (RGA test)

RF HYBRIDS & ECI ACTIVITIES



COBHAM MICROWAVE QUALIFIED MODULES:

- Cascadable amplifier:
 - 2-500 MHz, general purpose
- Mixers:
 - Double balanced:
 - 0.5 To 500 MHz
 - 10 to 1500 MHz
 - Termination Insensitive
 - 0.001 to 3500 MHz
 - Image reject
 - 1.500 MHz to 1650 MHz with IF @ 90 to 190 MHz
 - Triple Balanced
 - 2 to 18 GHz: qualification in progress



4 Specific PIDs

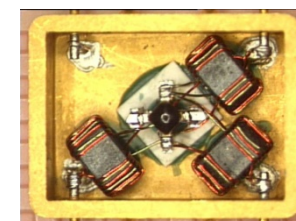
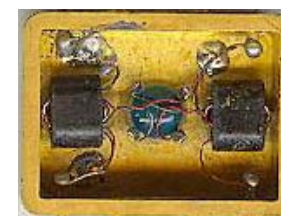
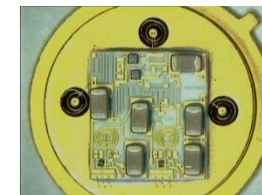
RF HYBRIDS & ECI ACTIVITIES



EPPL | European Preferred Parts List

Issue: 17

Issue Date: 2010-12-15

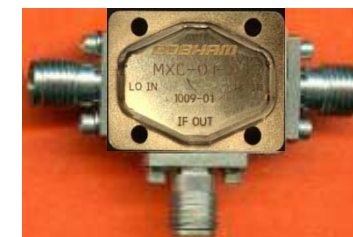
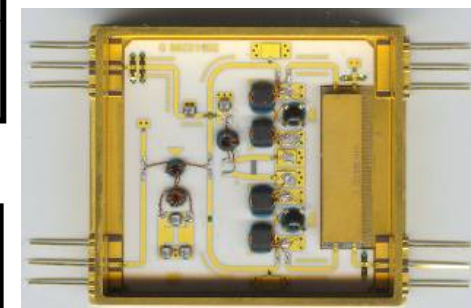


40 HYBRIDS | 02 THIN FILM

Part	Part Type	Description	Det Specification	Package	Manufacturer(s)	Remarks
2	AAT-01	Cascadable Amplifier (5-250 MHz) High Gain two stage 31 dB Medium output level +8.5 dBm Low VSWR < 1.3:1 Supply power range +8V to +15V	TR200368-178	TO-8	CHLTON TELECON & NICKOWAVE	

40 HYBRIDS | 99 MISCELLANEOUS

Part	Part Type	Description	Det Specification	Package	Manufacturer(s)	Remarks
2	NMF-01	Image Reject Mixer, variant V1=HF+LO, variant V2=HF+LO, LO to HF 1500 to 1650MHz=28 dB min., LO to HF 250 to 1510MHz= 35 dB min., Image Reject Ratio = 20 dB min., Hermetically Sealed, Ceramic Flatpack Package. Operating temperature range: -55 to +125 °C	TR200450-178D	FP	CHLTON TELECON & NICKOWAVE	
2	NMF-01	Double Balanced Mixer (0.5 to 500 MHz), Conversion Loss: 7 dB max., Isolation: LO to HF, LO to HF & midband: 35 dB min., HF to HF & midband: 25 dB min., Hermetically Sealed. Operating Temperature Range: -55 to +125 °C	TR200369-178 Issue A	FP	CHLTON TELECON & NICKOWAVE	
2	NMF-02	Double balanced Mixer 10 to 1500 MHz Operating temperature range: -55 to +125 °C	TR200370-178 Issue A	FP	CHLTON TELECON & NICKOWAVE	
2	NMF-03	Termination Insensitive Mixer (1 to 3500 MHz), Isolation: LO to HF and LO to IF: 20 dB min. and HF to IF: 18 dB min., SSB Conversion Loss (HF to IF [50MHz] port): from 7.8 to 9.8 dB max., 3rd order intermodulation ratio degradation @ IF VSWR 3: 1: 3 dB typ., Hermetically Sealed, Metal Flatpack package. Operating Temperature Range: -55 to +125 °C	TR200542-178 Issue B	FP	CHLTON TELECON & NICKOWAVE	



RF HYBRIDS & ECI ACTIVITIES

Design activity:

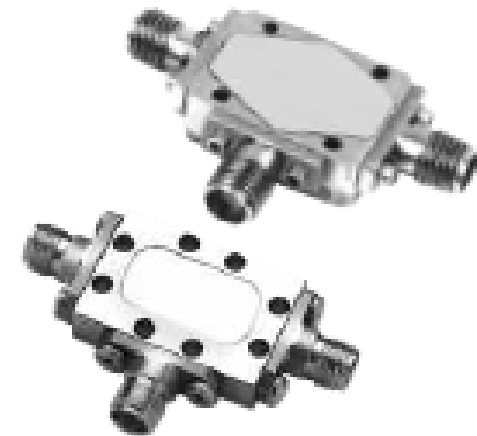
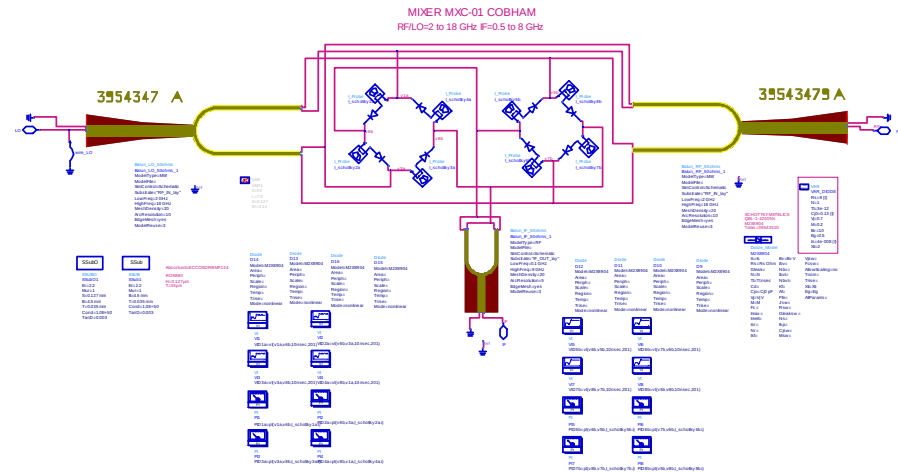
- Simulation, analysis
- Component evaluation, derating
- FMECA, WCA, reliability calculation
- Step stress tests, max ratings

Hybrid documentation:

- Detail specifications
- DCL, DML, DPL
- PADs
- HTIF

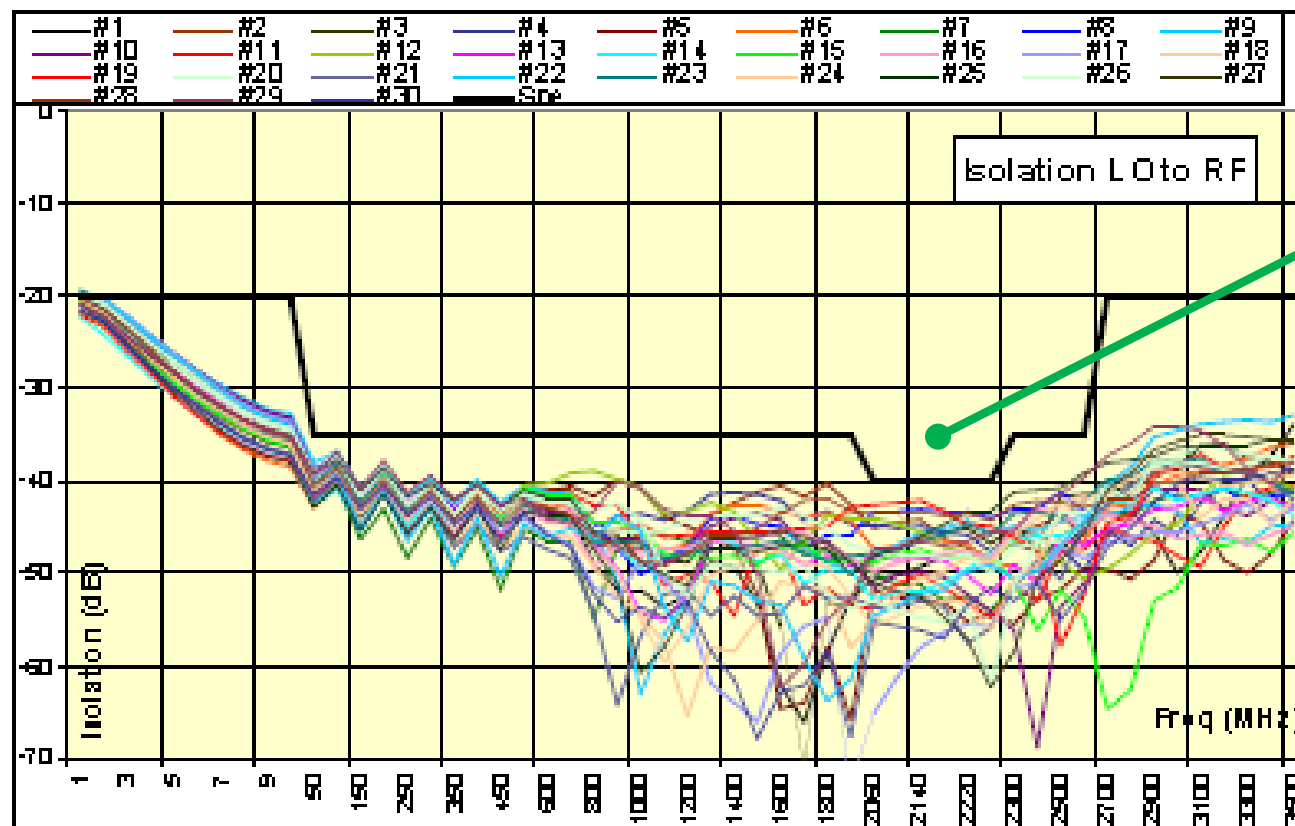
Customer oriented:

- Dialogue with the Agencies and Customers (Microwave CTB)
- Understanding of performance and integration needs
- Flexibility
- Specific tunings or measurements
- Management of specification amendments

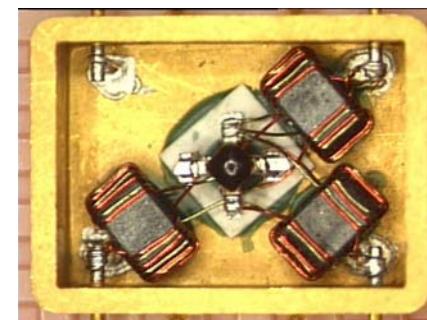


RF HYBRIDS & ECI ACTIVITIES

S/N of units



**Custom tuning
of MXF-03**



RF HYBRIDS & ECI ACTIVITIES

COBHAM QUALIFIED HYBRIDS PROGRAM SUCCESES:

– Mixers:

- Double balanced:

- 0.5 To 500 MHz : **MXF-01**: Galileo, Exomars
- 10 to 1500 MHz : **MXF-02**: Sentinel III
- + various programs

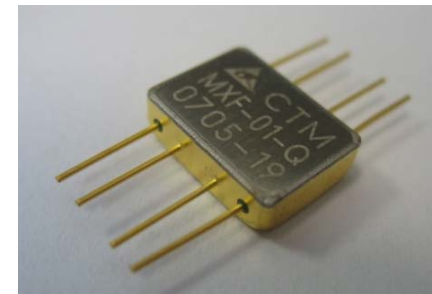
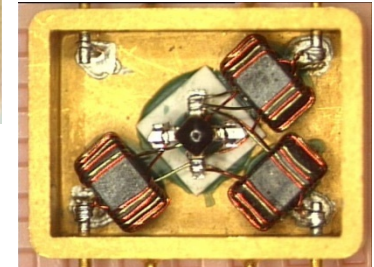
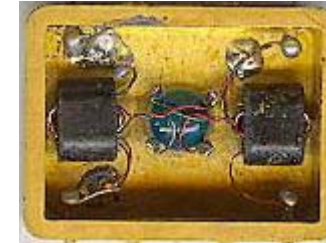
- Terminaison Insensitive

- 0.001 to 3500 MHz : **MXF-03**: Galileo, Exomars
- + various programs

- Triple balanced:

- 2-18 GHz : **MXC-01**: Sampling in progress for several programs (e.g. radar altimeters)

- As of today: more than 250 FM already shipped and more than 500 FM to come on existing programs (ie Galileo...)



OTHER RF SPACE HYBRIDS

CAPABILITY TO PROVIDE ALSO:

- VCOs
- Attenuators
- Switches
- I&Q modulators
- Dividers
- Couplers

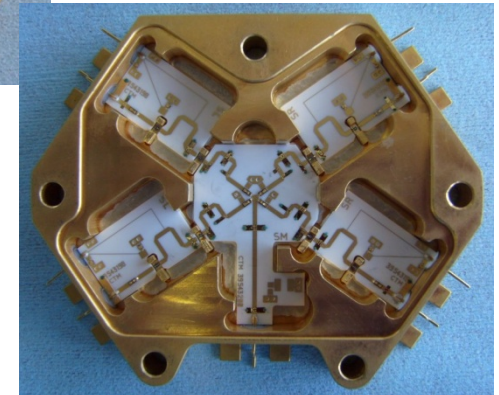
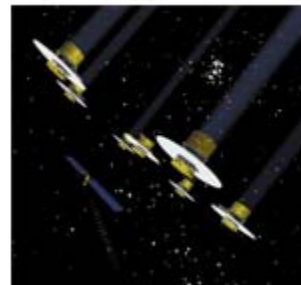
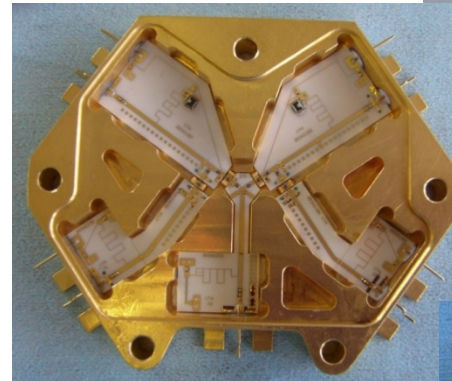
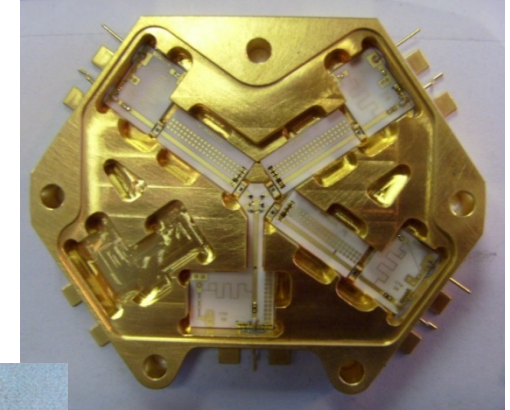
FLAT-PACK, PIN OR CONNECTORIZED PACKAGES

CIRCUIT TYPE APPROVAL / LAT TAILORING DEPENDING ON THE DEGREE OF SIMILARITY

OTHER SPACE RF HYBRIDS

PIN Diode Switches:

- Frequency : 2000 to 2300 MHz
 - Isolation : > 50 dB
 - Switching speed : < 10 μ s
 - Phase stability : < 1°
 - Bias voltage : +5V (20 mA)
-12V
- SP2T (*low power, pseudo absorptive*)
 - Insertion loss : < 0.6 dB
 - Input power : 0 dBm
 - SP2T (*high power, absorptive*)
 - Insertion loss : < 1 dB
 - Input power : + 37,5 dBm
 - SP4T (*high power, reflective*)
 - Insertion loss : < 1.2 dB
 - Input power : + 37,5 dBm

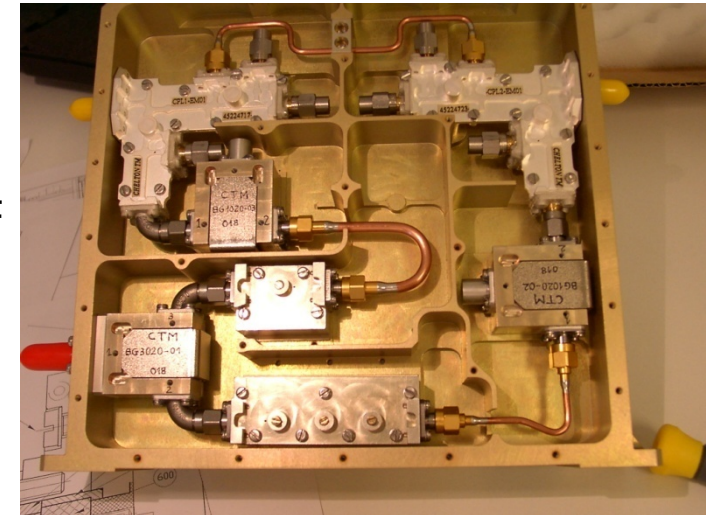
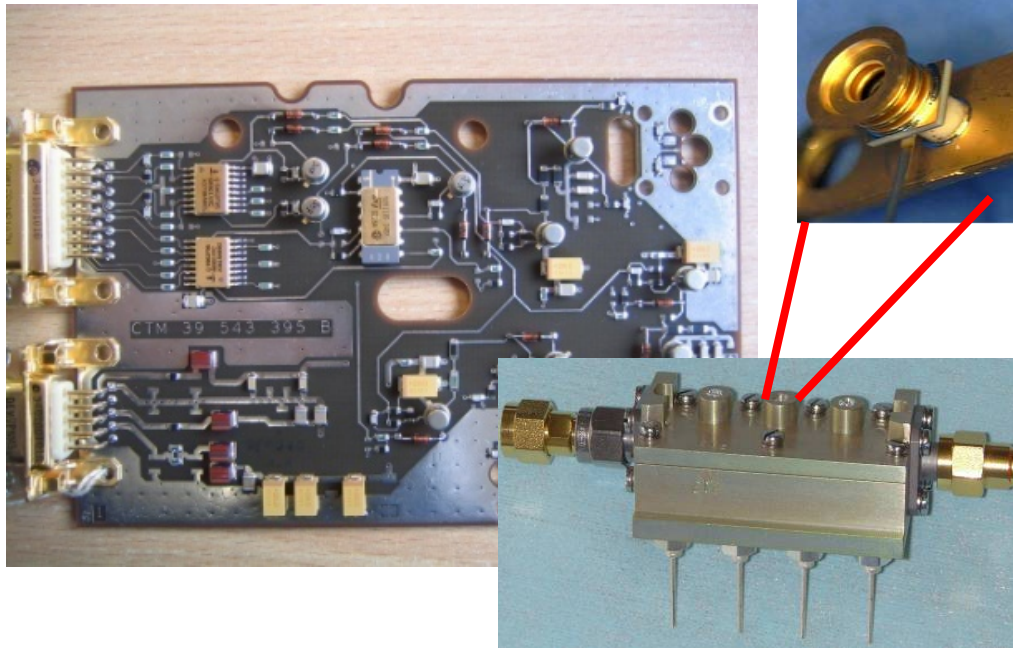


Prisma & Proba III programs

OTHER SPACE RF HYBRIDS

Switch:

- Tx & Rx SPST + Driver
 - Frequency : 5 GHz +/- 50 MHz
 - Insertion loss : < 0.4dB
 - Isolation : > 95 dB, target 100 dB
 - Input power : 40 W peak, 115 μ s @ 412 Hz PRF



Full duplexer with:

- Switches
 - Couplers
 - Circulators/isolators
 - Filters
- (all from Cobham Microwave)

Radar Altimeter for Jason, Poseidon, Sadko and Sentinel3 missions...

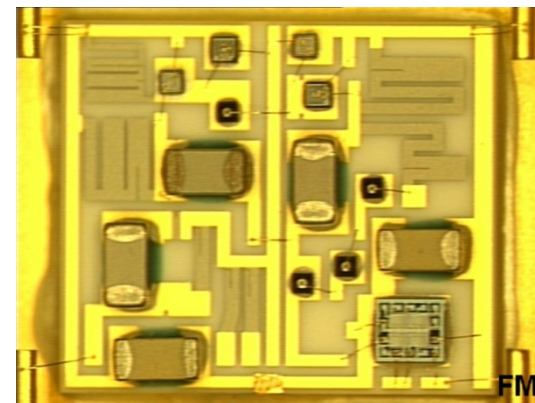
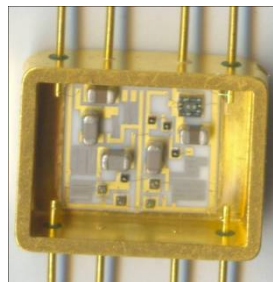
OTHER SPACE RF HYBRIDS

PIN Diode Switch Drivers

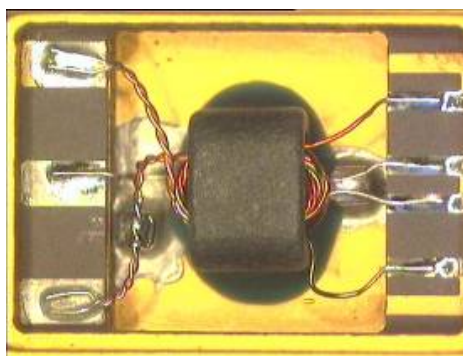
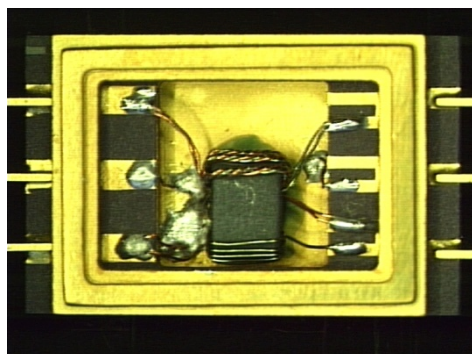
- TTL or HCMOS
- Flat pack package

Transformers (EPPL in progress)

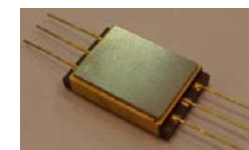
- 2 to 1200 MHz
- Ratio: 1:1 & 1:4
- Flat pack package, metal/ceramic
- Analog/Digital adaptor



Prisma & Proba III programs



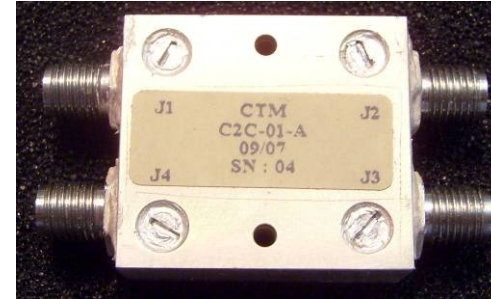
Artes & Artemis programs



OTHER SPACE RF HYBRIDS

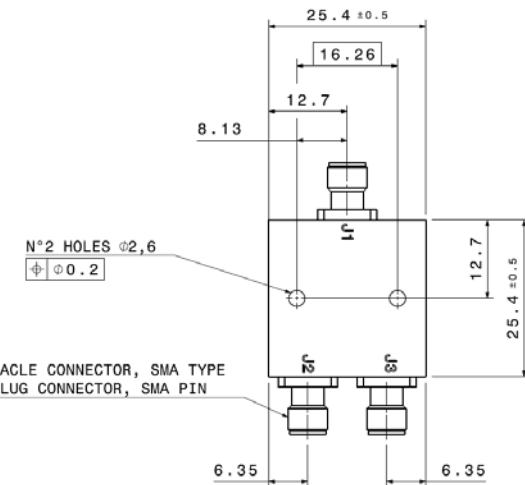
Customer specification

- Coupler
 - US part replacement in very short time
 - 3 dB, hybrid coupler
 - VHF & HUF band
 - **Rascom program**



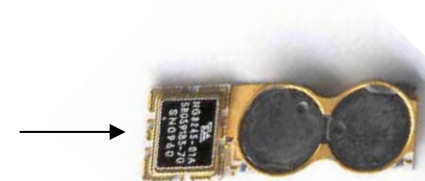
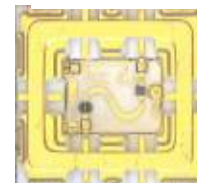
In development

- 3 dB Coupler
 - X band
 - 10 to 20% BW
 - With or without internal load
- Directional coupler
 - X band
 - 30dB main coupling
 - Low loss: < 0,15 dB
 - According to ECSS-3404



CIL

- Circulator Isolator Limiter
- S band
- ASAR program



SPACE RF & MICROWAVE HYBRIDS

