

EURIPIDES Forum 2010 in Paris

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MiniMEMS

High-Reliability, High-Power & High-Speed RF Tuning Applications Based on Miniaturised MEMS Switched Capacitors



TECHNOLOGY & INNOVATION

Standard MEMS

MiniMEMS

	Standard MEMS	MiniMEMS Goals
Beam size	250x100 μm^2	20x10 μm^2
Gap	2 μm	0.25 μm
Capacitance ratio	30-150	3-30
Switching time	> 1 μs	200 ns
Reliability	< 10^{12}	> 10^{11}
Power handling	< 5 W	5 W

** for fixed-fixed beam devices

- **Miniaturization of RF-MEMS allows:**
 - ✓ Faster switching time at standard actuation voltage
 - ✓ Improved mechanical/thermal stability
 - ✓ Improved repeatability of fabrication process and relaxed packaging conditions
 - ✓ Improved reliability
- **MiniMEMS will develop two routes for the miniaturised MEMS fabrication process :**
 - ✓ A secure and low-risk fabrication process using standard MEMS with Si and GaN technologies, compliant with short time-to-market transfer to foundry;
 - ✓ The challenging but very promising miniaturization route

PROJECT OBJECTIVES & WORK PLAN

ADAPTIVE RECEIVER (TR6) (Working frequency: 11 GHz)		
Function level: Tunable Filter		
Tuning range.	200-500 MHz (5 bits resolution)	
Losses	3-5 dB	
BW (3dB)	10 MHz (high-Q filter), 100-1000 MHz (medium-Q filter)	
Selectivity	20 dB @ 28 MHz from f_c (high-Q), 20 dB @ 0.3-1 GHz from f_c (medium-Q)	
Size	2 x 4 x 1 cm^3	
Power consumption	< 20 mW	
System level: Adaptive receiver		
Integration	Hybrid	Monolithic
Substrate	-	GaN
Tuning range.	200-500 MHz (5 bits resolution)	200-500 MHz (5 bits resolution)
Gain	13-15 dB	13-15 dB
Noise Figure	3-4 dB	3-4 dB
Limiters	Power handling: 2W Loss: 1 dB VSWR > 15dB Flat leakage: 20dBm	Depends on the robustness of the GaN LNA
LNA	Gain: 19 dB Flatness 2 dB Noise figure: 2 dB Power consumption < 50 mW (5V)	Gain: 19 dB Flatness 2 dB Noise figure: 2 dB

- **Component level: MiniMEMS switched capacitors**
- **Functional level:**
 - ✓ Tunable (multi-bits) matching/ filtering circuits on Si / GaN substrates for frequency-agile (multi-band) LNA
 - ✓ Phase-shifting cells (3-/6-bit) for X-Band reflect array antennas
- **System level: Demonstrators**
 - ✓ Partial reflect array antenna for weather Radar
Replacing mechanically scanned parabolic reflector antennas for reliability, agility and low cost
 - ✓ Partial reflect array antenna for wake vortex detection
 - ✓ Adaptive receiver for ATM applications
 - Hybrid integration (external limiter and LNA)
 - Monolithic integration of tunable filter and the LNA on the same GaN substrate

PARTIAL REFLECT ARRAY (VAI) (Working frequency: 9,3-9,8 GHz)	
Function level: Phase Shifter	
Phase range	0-360°
Phase increment	3°
Insertion loss	< 1 dB
Switching time	< 500 ns
Power handling	20 W (peak), 2 W (average)
Reliability	> 10^{11} cyc.
System level: Partial Reflect Array	
Size	~250 mm x 250 mm (corresponding approx. to 450 radiating elements and 15 phase shifters)
Element	TBD
Polarization	Two orthogonal polarizations with matching main lobes
Side lobes	< -30 dB
Cross-pol.	< -35 dB

PARTIAL REFLECT ARRAY (TR6) (Working frequency: 11 GHz)	
Specifications: Phase Shifter	
Size	12 x 12 mm^2
Phase range	0-180°
Phase increment	3 bits
Dispersions	Phase: 6°(rms) Amplitude: 0.6 dB (rms)
Insertion loss	< 0.8 dB
Switching time	< 500 ns
Power handling	0.2 W average (4 W peak)
Reliability	> 10^{11} cyc.
Specifications: Partial Reflect Array	
Size	Diam ~ 60mm for a hexagonal sub-array of 19 phase-shifters Total Diam ~ 200 mm (7-9 sub-arrays)
T° range	-40°C/+60°C (storage: -55°C/+70°C)
Polarization	Linear
Cross-pol.	-20dB

APPLICATIONS & MARKET FIELDS

Targeted applications and markets

- ✓ Weather radars
- ✓ Wake vortex detection radars
- ✓ Air Traffic Management
- ✓ RF wireless communication systems, consumer electronics

