



High-end Microelectronics Design

AMICSA 2025 - Lisbon Conan : a 130V Electronic Circuit-Breaker and Latch-up Current Limiter Controller

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Introducing Weeroc

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Analogue and Mixed Signal Integrated Circuits for Space Industry Bridging the gap between QMLV Microchips and COTS, serving agile software-defined platform & payload



Photodetector read-out : Weeroc ROC family

C:DM		
	Photomultiplier – MA-PMT	Silicon and Gaseous
Petiroc 2A	Maroc 3A	Skiroc 2A
Time of Flight measurement	Multi-anode PMT	PIN diodes, silicon strips, APDs
Citiroc 1A	Catiroc 1	Gemroc 1
Scientific instrumentation	PM matrices, large areas	GEMs, micromegas
Triroc 1A	Poproc	Psiroc
PET read-out	Fast photon counting, ToF	PIN diodes, silicon strips, APDs GEMs,
Liroc		micromegas
Lidar, photon counting, ToF		
Radioroc 2		
Dual modality read-out		
Temporoc		
Mixed signal, digital read-out		

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Application exemple : LIDAR





Europa Lander NASA Artist View



Atmo LIDAR Artist View

• ELSAROC : LIDAR read-out for Europa Lander (NASA / Hexagon)

• LIROC : SIPM read-out for space LIDAR

 MESCALIDAR : Atmospheric spaceborne LIDAR using LIROC (CNES / Airbus Defence & Space)



CONAN presentation

CONAN : a circuit breaker & current limiter controller

Package	BGA100 – 15x15mm. Pitch 1.27mm
Power rail	20V to 136V
LCL	From 0.5A to 12A current limitation (up to class 10)
Circuit breaker	OFF state redundancy (redundant power MOS in serial possible)
Telemetry	Upstream voltage, downstream voltage, current, temperature,
Heater control & status	8-heater controller and status monitor
ASIC control	Nominal and redundant serial bus





CONAN block scheme

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- Power Supplies & refs
 - Power Rail Live (20-136V)
 - 5V (Nominal & Redundant)
 - P_{heater} (10-15V)
 - All supplies, clock and ref built internally
- MOS driver & analog loop for regulation
- Telemetry (temperature, current, power line)
 - 5 Amplification lines, 5 ADCs
- Heater driver ans status monitor (10 to 15V)
- Digital core (DARE STD), telecommand, registers, state machine for device behaviour, communication lines nominal and redundant
- Auto-config on start-up (RLCL)
- Double Isolation between HV and core



EM fabrication





Plastic Packaging BGA, following ESCC9030 @SERMA microelectronics

CONAN behaviour and features

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- LCL mode
 - ON/OFF
 - Regulation on overcurrent
 - Trip-off on
 - Overcurrent after trip time
 - UVD on PRL or Pheater
 - Temperature

- RLCL mode
 - ENABLE/DISABLE
 - Regulation on overcurrent
 - Trip-off on
 - Overcurrent after trip time
 - UVD on PRL or Pheater
 - Temperature
 - Optional Restart after timer

SSB serial bus



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- SSB : Space Serial Bus = hardened SPI
- Nominal and redundant SSB paced at master SSB clock (internal oscillator sync on chip). Nominal and Redundant are independent.
- 1 read instruction = 10us. Possibility of oscilloscope mode on telemetry







CONAN Validation Tests

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Evaluation System Presentation

Screenshot

- Open source design
- Used as reference design

Undervoltage				Current limitation				
Undervoltage				Voltage drop		Rearm	ning	
IFC_VIN	N/A		290	Tripped		Leakir	ng	
IFC_VAPS1	N/A		746	IFC_ISHUNT		N/A		758
UVD_THRESHOLD_MAIN	0		128	IFC_VIN		N/A		290
UVD THRESHOLD APS1 0			0	IFC_VRED		N/A		281
				IFC_VOUT		N/A		284
OVD_TIME(_VALUE	•		•	CLM_THRESHOLD_CU	JRRENT	N/A		67
Overheat				CLM_THRESHOLD_N	W	3		67
Overheat				CLM_TRIP_OFF_TIME 100			612	
IFC_TEMP N/A	N/A 1023			CLM_RETRIGGER_TIME 0			0	
THM_THRESHOLD 63			63			1023		15
						1022		1022
				ECE_NOM_THRESHO		1025		1023
				LCL_RED_THRESHOLD)	1023		1023
Telemetry and other bits				Mosfet control				
Nominal bus alive	ve 🔄 Redundant bus alive 🔄 Device configured		Nominal is on	Nom	inal on	Nomina	l off	
Nominal parity error	Redundant parity error 🖉 Device initialised		Redundant is on	Redun	dant on	Redunda	nt off	
Clear SSB status Enable retrigger Retrigger enabled				A	ll on	All o	ff	

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Power consumption & repowering

Power Scheme			Current in Supply (mA)					
P5VN	P5VR	PHTR	PRL	P5VN	P5VR	PHTF	R P	'RL
(0	0	0 C					
(0	0	0 1		0	0	0	0,26
(0	0	1 C)	0	0	0,09	0
(0	0	1 1		0	0	0,09	0,26
(0	1	0 0)	0	3,69	0	0
(0	1	0 1		0	3,83	0	0,53
(0	1	1 C)	0	3,72	0,09	0
(0	1	1 1		0	3,85	0,09	0,53
	1	0	0 0)	3,69	0	0	0
	1	0	0 1		3,88	0	0	0,53
	1	0	1 C)	3,72	0	0,09	0
	1	0	1 1		3,85	0	0,09	0,53
	1	1	0 0)	1,85	1,74	0	0
	1	1	0 1		1,92	1,79	0	0,53
	1	1	1 C)	1,9	1,77	0,09	0
	1	1	1 1		1,93	1,8	0,09	0,53

- Power consumption is :
 - Below 4mA on 5V
 - Below 0,5mA on PRL
 - \rightarrow In specification (< 5mA)
- No repowering in all configurations
- Correct behaviour of Nominal and Redundant 5V



ON and OFF

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• Switch ON and OFF follow dV/dT specification, slow transition (500V/ms maximum)

Yellow : output Green : gate



Current limitation and trip-off

- Trip off after limitation (overload)
- Clamping in 100ns



Yellow : output Green : gate



Redundant transistor



- Redundant transistor driver is working in specification
 - Switch-on on overcurrent, regulation of nominal, switch off after trip

time

- Yellow : output
- Green : redundant gate
- Orange nominal gate



Telemetry : High voltage (PRL, Vred, Vout)

- Telemetry is working fine but :
 - Resistor bridges must be very precise with a large ratio
 - − Vdrop is calculated from telemetry Vout PRL → Strong impact of mismatch and offset



Trip-off adjustment

- Trip off time is measured identical with simulation (-2% due tu clock variation +2%)
- Hick-up trip off limitation has been tested and is working fine



Temperature Dependance



Test performed from -35°C to +110°C

	Max-Min	Max drift (%)	Temp dependance		
			(ppm/°C)		
P1V8	37mV	1,65%	177		
P3V3	115mV	3,55%	248		
Vref	4mV	0,58%	41		
Vref1V	22mV	2,17%	152		
VCO frequency	170kHz	1,65%	177		







P1V8 regulator output versus temperature



TID : References and Regulators



TID : High Voltage Regulators

ON boards have broken PRL3V3 amplifiers, Von is correct a s soon as test system has been recovered PRL3V3 remains dead for ON boards due tu event 1.



TID : Internal oscillator

• Frequency is not trimmed, no effect of irradiation (oscillator is trimmed by Vref1V which is not drifting with irradiation



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TID : Telemetry INL/DNL (temperature TM)

- ADC INL and DNL are stable with irradiation
- No SSB error detected by ATE during after irradiation





Conclusion on CONAN electrical tests

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- CONAN first EM prototype is working nicely, most of the features are in specification
- A few bugs and optimization to be addressed in QM
- Eval board with open FW and SW ready in a few days for early adopters
- ARTES-AT is finishing and next step of project will follow up to have EM/QM end of 2026 and QM/FM in 2027