PrecisionWave AG
Swiss RF Solutions

Success Story (V2)

miniCODIR Software Defined Radar

miniCODIR is a programmable Software Defined Radar (SDR) in the X-band for various applications like drone or bird tracking, perimeter intrusion detection, and scientific purposes. Chirp bandwidths up to 150 MHz and the capability for generating arbitrary chirps enable maximum versatility. miniCODIR was developed in collaboration with armasuisse Science and Technology (S+T) as a part of a scientific project. All rights of miniCODIR are held by our partner.

System Description

Based on our embedded SDR platform, miniCODIR is a simple, yet powerful standalone software-defined radar. It is designed to provide maximum versatility for your cognitive radar implementations. FPGA-based DSP algorithms enable future implementations for varying use-cases.

Radar data post-processing may be performed by a co-processor on the SDR itself, with enough power for most customer-specific applications. Alternatively, data streaming to a post-processor is supported out-of-the-box.

We selected a well-established and open-source driven API called “libIIO” for data streaming and radar parameter configuration. libIIO is widely used and supported out-of-the-box by the most popular signal processing software.

miniCODIR supports two operational modes: “FMCW” and “arbitrary TRx”.

FMCW Mode

A signal generator in the FPGA generates chirp signals with real-time adaptable radar parameters such as pulse repetition frequency, chirp-interleave mode, chirp bandwidths, and sweep times.

The received echo signal is mixed down by direct conversion with a time-delayed reference chirp.

TRx Mode

A signal generator in the FPGA is capable of generating arbitrary signals such as noise signals or non-linear modulated chirp signals with up to 80 MHz bandwidth. TX waveforms are loadable from the Linux user space.

Received echo signals are processed with a double-heterodyne receiver optimized for maximum dynamic range and excellent receiver noise figure.

Lightweight design meets maximum performance

Benefits & Highlights of our Solution

- 1 Tx / 2 Rx antennas
- Channel coherent signal processing
- Rx direction of arrival estimation
- Dual chirp generator
- 2 W output power
- System-on-chip with FPGA and ARM processors
- Co-processors for range doppler processing
- Free DSP resources for future extensions
- Onboard Linux allows standalone applications
- Open-source API for data streaming and control
- Three-stage ultra-low phase noise clock generator with OCXO or GPS as reference
- Multi-device synchronization with GPS
- All-in-one hardware solution

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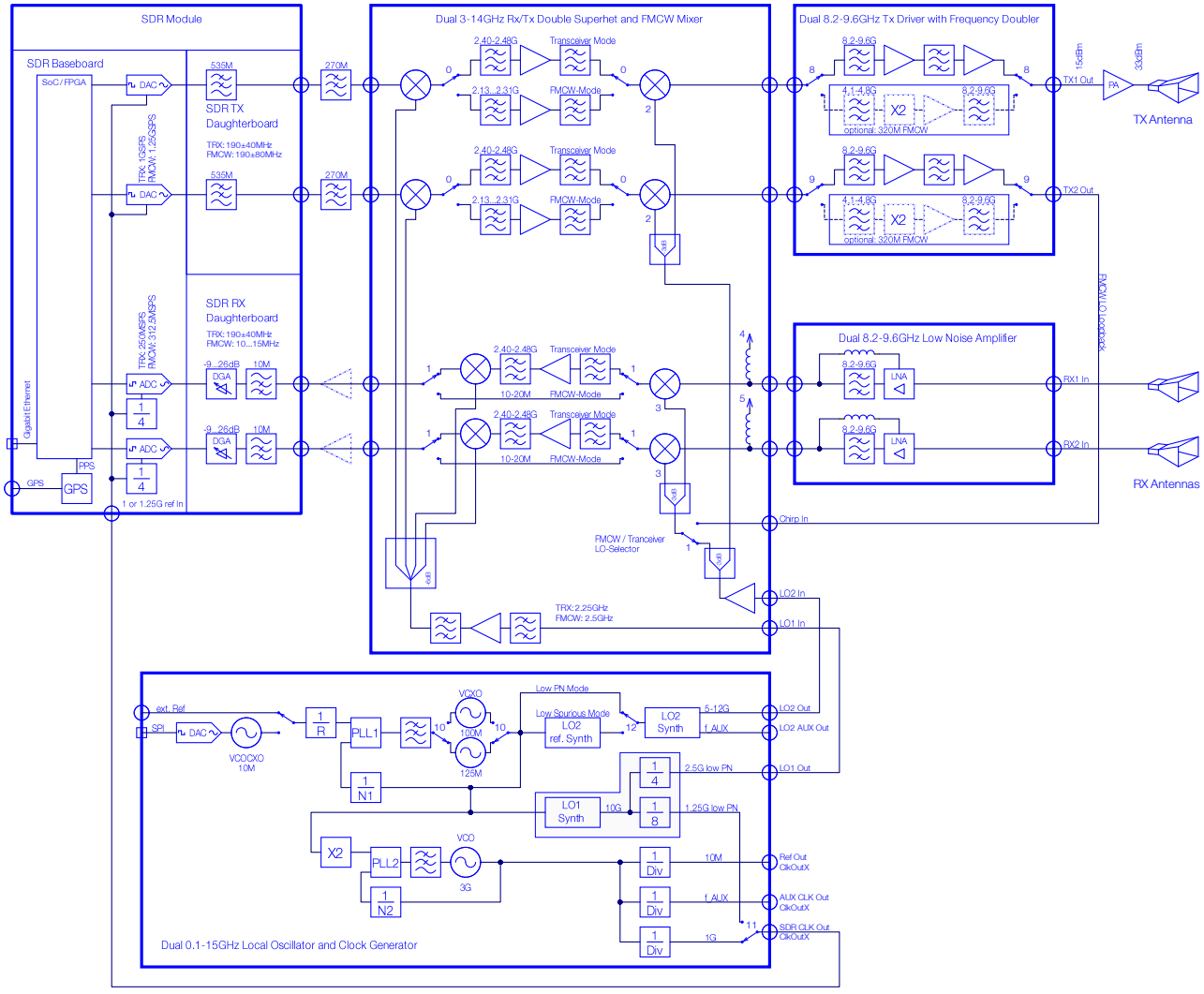
Functional Diagram



Internally, miniCODIR is partitioned into five independent functional modules that may be easily replaced.

Let us know your requirements for your custom radar. Our engineering team will be happy to support you!

Radar Key Specification

Parameter	Mode	Value	Unit
Number of RF channels		1 Tx, 2 Rx	
Frequency range		8.2-9.6 9.2-10.6	GHz GHz
Tx output power	with PA	33	dBm max.
	without PA	18	dBm max.
Chirp bandwidth	FMCW	160	MHz
	TRX	80	MHz
Chirp length	FMCW	235.93	µs
Pulse repetition frequency	FMCW	4.2386	kHz
Chirp deviation	FMCW	593.4	GHz/s
Frequency resolution per meter	FMCW	3.959	kHz/m
Range resolution per bin	FMCW	1.205	m/bin
Instrumentation range	FMCW	1110	m max.
Doppler speed	FMCW	33.65	m/s max.
A/D converter sampling rate	FMCW	250	MSPS
	TRX	312.5	MSPS
A/D converter resolution		14	Bit
D/A converter sampling rate	FMCW	1250	MSPS
	TRX	1000	MSPS
D/A converter resolution		16	Bit
Reference CLK outputs		0.1-15	GHz
RF/CLK port impedance		50	Ω
RF port reflections (S11)		-10	dB max.
Supply voltage	19'' Rack	85-265	V AC
	w/o Rack	10-15	V DC
Power consumption		60	W
Streaming interface		1000BASE-T	Ethernet

Not finding what you want to know? Don't hesitate to ask our experts for further details.

Typical Electrical Performance Data

Measurement conditions unless otherwise noted:
TRX mode f_{IFout} = 190 MHz, FMCW mode f_{IFout} = 11 MHz
f_{RF} = 9.44 GHz.

Values defined in a range are depending on Rx gain settings.

Parameter	Condition	Value	Unit
Rx input intercept point (IIP3)	FMCW	1.6	dBm
	TRX	2.9	dBm
Rx input power	FMCW	-26.7...-6	dBm max
	TRX	-34.5...-6	dBm max.
Rx relative noise spectrum density	FMCW	-145...-136	dBFS/Hz
	TRX	-144...-132	dBFS/Hz
Rx effective noise spectrum density	FMCW	-152...-125	dBm/Hz
	TRX	-162...-139	dBm/Hz
Rx Noise figure	FMCW	22...49	dB
	TRX	11.8...35	dB
Rx spurious free dynamic range	FMCW P_{in} = -50 dBm f_{if} = 5...1000 MHz	60	dBc min.
	TRX P_{in} = -50 dBm f_{if} = 5...1000 MHz	70	dBc min.
Tx Phase noise	f_{Offset} = 10 Hz	-66.3	dBc/Hz
	f_{Offset} = 100 Hz	-82.1	dBc/Hz
	f_{Offset} = 1 kHz	-95.6	dBc/Hz
	f_{Offset} = 10 kHz	-103.3	dBc/Hz
	f_{Offset} = 100 kHz	-102.3	dBc/Hz
	f_{Offset} = 1 MHz	-122.1	dBc/Hz
	f_{Offset} = 10 MHz	-141.6	dBc/Hz
Tx RMS jitter	f_{Offset} = 0.012-20 MHz	86.7	fs

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Mechanical: Compact All-in-one Rack Version

miniCODIR is delivered in a 19" rack-mountable chassis including an AC power supply, fuses, and cooling fans.

Internally, each module housing is milled from bare-Aluminum to guarantee optimal heat transfer and RF shielding.

Not fitting to your needs? miniCODIR can also be delivered in other form factors or as bare modules. Please contact us for custom solutions.

19'' rack version as all-in-one solution: X-band radar, PSU, fuse and thermal management

A transportable, ruggedized case is available: it perfectly fits your next field study

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