**< RF front end components specifications of the available components >**

**========= TRx ======================**

**Antenna:** (reuse the lab dipole antenna) **meets the spec.**

Type: 900 MHz PCB antenna

Gain: 2 dBi

Impedance: 50 Ohm

Connector: u.FL

**==== RX ====================**

**Bandpass Filter (BPF):**

**LNA and Switch:**

**Mixer+LO+PLL+TCXO: moFeus meets the spec.**

RF Input Frequency: 30MHz–6GHz

RF Output Frequency: 30MHz–6GHz

LO Frequency: 85MHz–5400MHz

Input IP3 +23dBm

Absolute Pout: 15dBm

Phase noise: -135dBc/Hz at 1MHz

Bias voltage: 5 V

(\*alternative option for 2nd unit: Mini-Circuits ZAD-2 mixer with SigGen with ref sync as an LO)

(\* UCSD SigGen )

**TCXO: ( in the moFeus ) meets the spec.**

2.5 ppm precision TCXO

**< Required specifications of RF front end components >**

**========= TRx ======================**

**Antenna:**

Frequency range: 902-928 MHz (US)

Gain: typically 2-5 dBi

Polarization: linear or circular

Radiation pattern: omnidirectional or directional

Connector: typically SMA or u.FL

**==== RX ====================**

**Bandpass Filter (BPF):**

Center frequency: 915 MHz (US)

Bandwidth: 5-20 MHz

Insertion loss: <1 dB

Rejection at 2x and 3x frequency: >20 dB

Impedance: 50 Ohm

**LNA:**

Frequency range: 902-928 MHz (US)

Gain: >15 dB

Noise figure: <2 dB

Input IP3: >-10 dBm

Impedance: 50 Ohm

**Mixer:**

Frequency range: 902-928 MHz (US)

Conversion gain: >10 dB

Input IP3: >0 dBm

Noise figure: <10 dB

Impedance: 50 Ohm

**LO:**

Frequency range: 902-928 MHz (US)

Output power: >5 dBm

Output frequency stability: <1 ppm

Phase noise: <-110 dBc/Hz at 1 MHz offset

Spurious emissions: <-60 dBc

Power consumption: <100 mW

**TCXO:**

Frequency stability: <1 ppm

Temperature stability: <1 ppm/°C

Aging: <1 ppm/year

Frequency range: 10-40 MHz

Output waveform: sine or clipped sine

Output level: >1 Vp-p

Power consumption: <5 mW

**Ref)< specifications of RF front end components of** **nRF 52840 DK >**

**========= TRx ======================**

**Antenna:**

Type: 2.4 GHz PCB antenna

Gain: 2 dBi

Impedance: 50 Ohm

Connector: u.FL

**==== RX ====================**

**Bandpass Filter (BPF):**

Type: Mini-Circuits BLP-25.4+

Center frequency: 2.4 GHz

Bandwidth: 25 MHz

Insertion loss: 1.5 dB

Rejection at 5 GHz: >30 dB

Impedance: 50 Ohm

**LNA and Switch:**

Type: Skyworks SKY13351-385LF

Gain: 17 dB

Input IP3: +5 dBm

Noise figure: 1.5 dB

Impedance: 50 Ohm

**Mixer:**

Type: Analog Devices ADL5350

Frequency range: 2400-2500 MHz

Conversion gain: 8 dB

Input IP3: -1 dBm

Noise figure: 10 dB

Impedance: 50 Ohm

**PLL and LO:**

Type: Silicon Labs Si4463 EZRadioPRO

Frequency range: 2400-2483.5 MHz

Output power: +15 dBm

Output frequency resolution: 61.035 Hz

Phase noise: -92 dBc/Hz @ 100 kHz offset

Spurious emissions: <-70 dBc

**Rx IF Filter: meets the spec.**

minicircuits SLP-10.7+ QTY 2

(DC~11MHz, IL:0.75 2fo:41dB, 3fo:~50dB )

minicircuits SLP-30+ QTY 1

(DC~32MHz, IL:0.55 2fo:47dB, 3fo:~77dB )

minicircuits SLP-50+ QTY 1

(DC~48MHz, IL:0.7 2fo:48dB, 3fo:~67dB )

minicircuits SLP100+ QTY 1

(DC~98MHz, IL:0.58 2fo:48dB, 3fo:~75dB )

**Rx IF Amplifier (OP-AMP or AGC):**

**ADC: Max19517 close to the spec.**

♦ Low-Power Operation (74mW/Channel at 130Msps)

♦ Guaranteed 2A Output Current

♦ Operate from 2.6V to 5.5V Supply

Input resistance 4kohm

♦ Adjustable Output from 0.8V to VIN (MAX1951)

♦ Dynamic Range: 59.8dBFS SNR at 70MHz, 82dBc SFDR at 70MHz

♦ Input Common-Mode Voltage Range: (0.4V to 1.4V)

♦ Very High Analog Input Bandwidth (> 850MHz)

Diagram, schematic

Description automatically generated

NA (dBm/Hz) = –1 dBFS (dBm) + SNR (dBc) – fS/2 (dBHz).

Pin FS = (1)^2/2/4k = -39dBm

NA(dBm/Hz) = -40dbm -59.8dBc – 68.13 = -167.93

F = 1+10E((-167.93+174)/10) = 5.05

NF = 10log10(5.05) = 7.03dB

**======== Tx ==========================**

**Tx IF filter:** same with Rx IF filter **meets the spec.**

**Tx DAC & IF mixer/PLL:** DDS Synthesizer(AD9850)

125 MHz Clock Rate

On-Chip High Performance DAC and High Speed Comparator

DAC SFDR:  > 50 dBc @ 40 MHz AOUT

DAC SFDR:  > 77 dBc @ 40 MHz+/-200KHz AOUT

32-Bit Frequency Tuning Word

Simplified Control Interface: Parallel Byte or Serial Loading Format

Phase Modulation Capability

3.3 V or 5 V Single-Supply Operation

Low Power: 380 mW @ 125 MHz (5 V)

**Rx IF filter:**

Center frequency: 1-10 MHz

Bandwidth: 100-500 kHz

Insertion loss: <3 dB

Impedance: 50 Ohm

**Rx AGC or OP-AMP?**

**ADC:**

Resolution: 8-12 bits

Sampling rate: 1-10 MS/s

Input range: 0-1 V

SNR: >60 dB

Power consumption: <10 mW

**IQ modulator/demodulator:?**

**======== Tx ==========================**

**Tx IF filter:**

**DAC:**

Resolution: 8-12 bits

Sampling rate: 1-10 MS/s

Input range: 0-1 V

SNR: >60 dB

Power consumption: <10 mW

**Rx IF Filter:**

Type: Mini-Circuits SLP-152+

Center frequency: 455 kHz

Bandwidth: 30 kHz

Insertion loss: 2.2 dB

Rejection at 2x and 3x IF: >25 dB

Impedance: 200 Ohm

**Rx IF Amplifier (OP-AMP):**

Type: Analog Devices AD8532

Gain: 3 dB

BW: 3MHz

Input bias current: 2 pA

Output current: 40 mA

Power supply voltage: 3.3 V

Impedance: 50 Ohm

**ADC and DAC:**

Type: Analog Devices AD7380

Resolution: 16 bits

Sampling rate: 1 MSPS

Input range: 0-2.5 V

SNR: >90 dB

Power consumption: 16.5 mW

**Modulator:**

Type: Analog Devices ADL5375

Frequency range: 2200-2700 MHz

Output power: +5 dBm

Gain control: 30 dB

Harmonics: <-20 dBc

Power consumption: 390 mW

**======== Tx ==========================**

**Tx IF filter:??**

**Tx Mixer+LO+PLL+TCXO: moFeus meets the spec.**

RF Input Frequency: 30MHz–6GHz

RF Output Frequency: 30MHz–6GHz

LO Frequency: 85MHz–5400MHz

Input IP3 +23dBm

Absolute Pout: 15dBm

Phase noise: -135dBc/Hz at 1MHz

Bias voltage: 5 V

(\*alternative option: mini-circuit ZFM-4H-S+ with SigGen with modulation with ref sync as LO or just SigGen with modulation )

(\* SigGen in the UCSD lab )

**TCXO:(in the moFeus ) meets the spec.**

2.5 ppm precision TCXO

**PA: (** ← SigGen with modulation input can cover a unit )

Part# : ZX60-V63+

Gain: 21.9 dB typ. at 0.05 GHz, 15.4 dB typ. at 6 GHz

Bandwidth: 0.05 to 6 GHz

IP3  : 34.2 dBm typ. at 0.05 GHz,  33.3 dBm typ. at 0.8 GHz

Output Power @ 1 dB compression:17dBm

NF: 3.7dB

DC Supply Voltage : 5.0 V

Supply Current : 69mA

**Tx RF Bandpass Filter (BPF):** none yet

**Tx Mixer(upconverter ):**

Frequency range: 902-928 MHz (US)

Conversion gain: >10 dB

Input IP3: >0 dBm

Noise figure: <10 dB

Impedance: 50 Ohm

**PLL:**

Frequency range: 902-928 MHz (US)

Frequency resolution: <100 Hz

Lock time: <10 ms

Phase noise: <-100 dBc/Hz at 1 MHz offset

Reference frequency: 10-40 MHz

Reference frequency stability: <1 ppm

Power consumption: <50 mW

**TCXO:**

Frequency stability: <1 ppm

Temperature stability: <1 ppm/°C

Aging: <1 ppm/year

Frequency range: 10-40 MHz

Output waveform: sine or clipped sine

Output level: >1 Vp-p

Power consumption: <5 mW

**PA:**

Frequency range: 902-928 MHz (US)

Output power: up to 1 W

Power gain: >20 dB

Efficiency: >50%

Impedance: 50 Ohm

**Tx RF filter:**

Center frequency: 915 MHz (US)

Bandwidth: 5-20 MHz

Insertion loss: <1 dB

Rejection at 2x and 3x frequency: >20 dB

Impedance: 50 Ohm

**Tx Mixer(upconverter ):**

**PA & Switch:**

Type: Skyworks SKY66112-11

Output power: +15 dBm

Gain: 25 dB

Input power: 0 dBm

Power supply voltage: 1.8-3.6 V

Power consumption: 28 mA

**Tx Bandpass Filter (BPF):**

Type: Mini-Circuits BLP-25.4+

Center frequency: 2.4 GHz

Bandwidth: 25 MHz

Insertion loss: 1.5 dB

Rejection at 5 GHz: >30 dB

Impedance: 50 Ohm

Isolation: >30 dB

Impedance: 50 Ohm