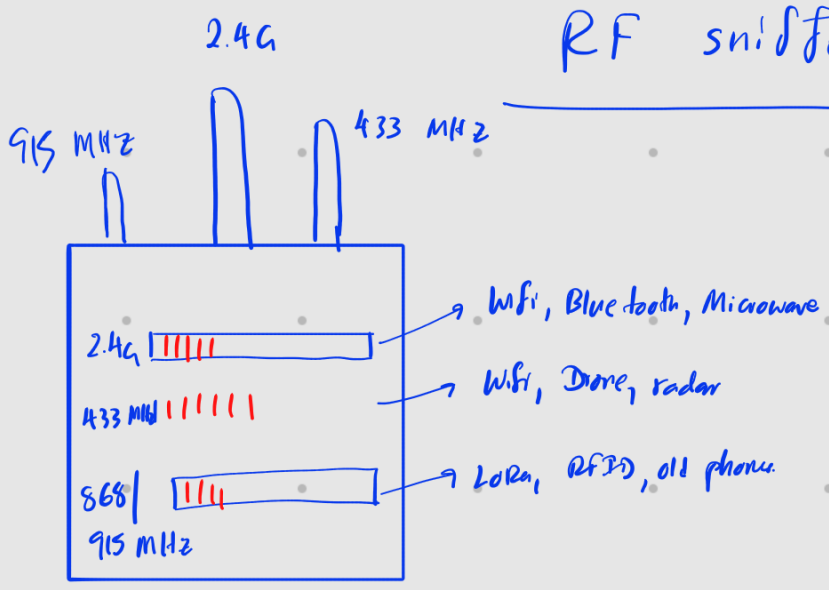
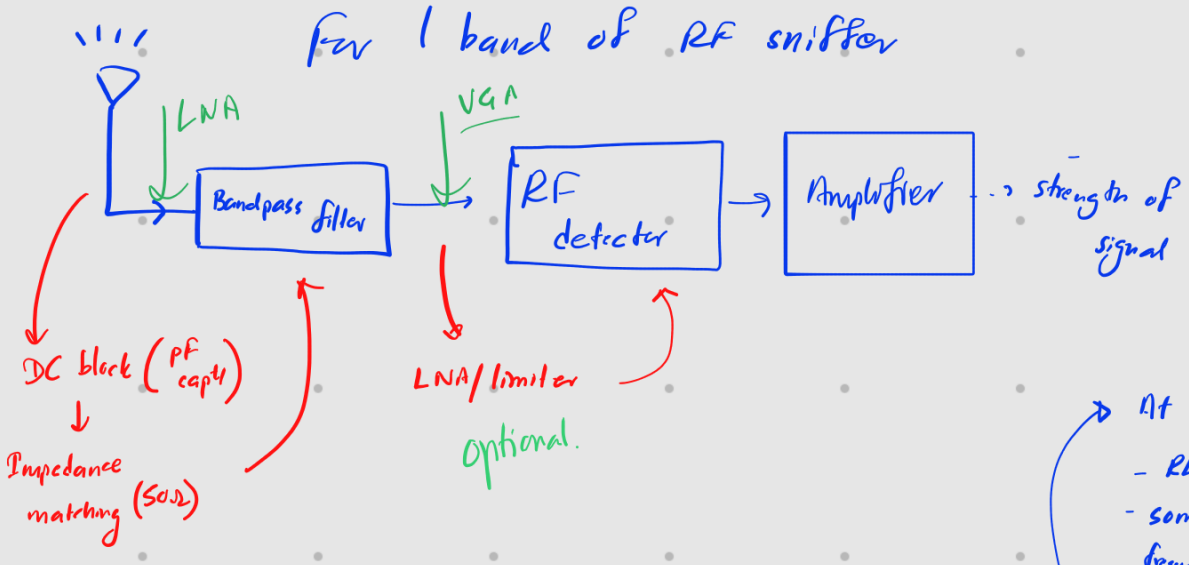
RF sniffer



Simple block diagram

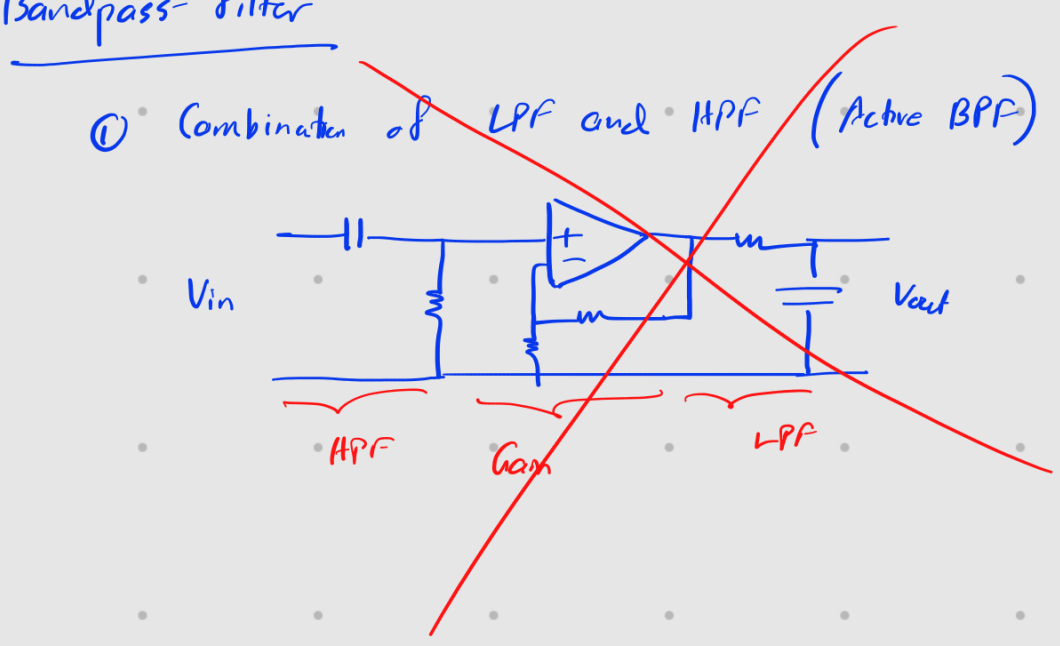
for 1 band of RF sniffer



At GHz, MHz scale,
- RLC parasitic
- some components' self resonance frequency (SRF)

Bandpass filter

① Combination of LPF and HPF (Active BPF)



Not possible for GHz, MHz

⇓

Soln for BPF

1) SAW
2) Microstrip
3) Cavity filters.

(2)

2.4 GHz

Normal RLC → Heavy parasitic loss
→ Low Q = Center frequency / Bandwidth

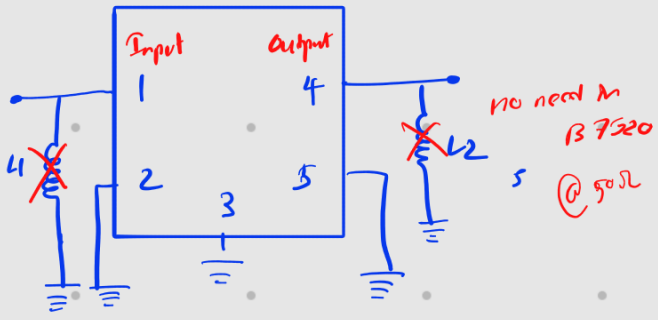
Active op-amp → Can't give enough gain-bandwidth @ GHz
→ RF op-amps - cost & noise code

SAW → Cost
→ Fixed response with sharp skirts
→ High insertion loss
→ Best @ interference rejection

3 pole microstrip hairpin → Not sharp as SAW
→ Low noise & insertion loss

B7520 - Qualcomm

SAW filter for 2.4 GHz band



L1 4.6nH
L2 0.96nH
} typical value

How this works?

433 MHz

Microstrip hairpin → Large PCB (:: 433 MHz)

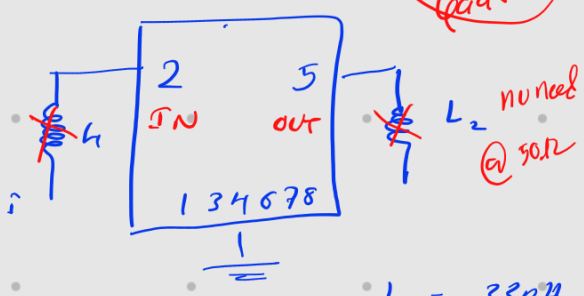
SAW → Moderate insertion loss

3 pole LC resonator ladder } → Best since supports high BW & steeper edges, expensive

LC ladder → Captures whole 433MHz with less tuning

433 MHz - SAW

B3710 Qualcomm

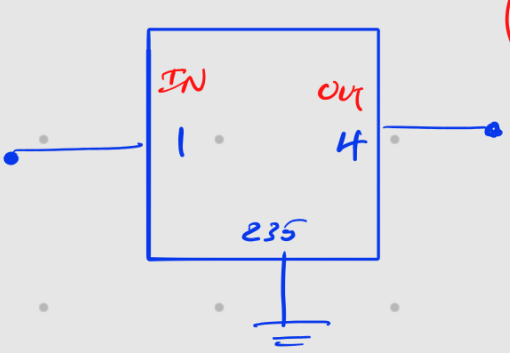


L_1 = 33nH

L_2 = 33nH

915 MHz → SAW → Good Q factor

B3710 - Qualcomm



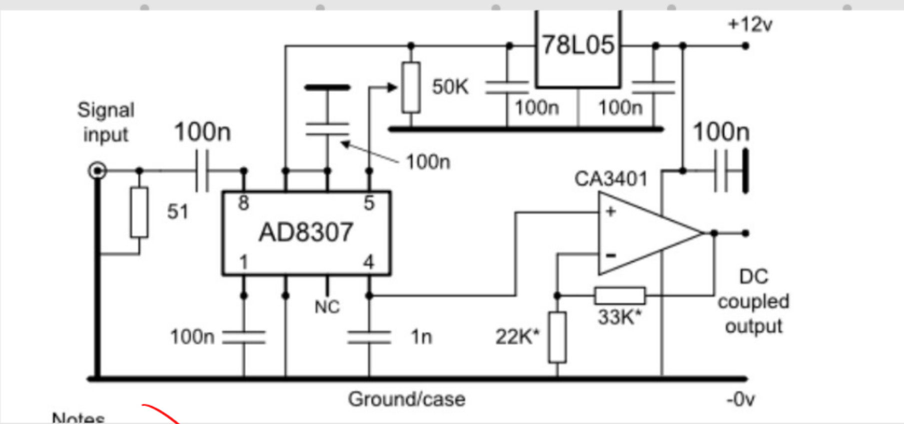
RF detector

- → Log detector (AD8318) → Best for 433 & 868/915 MHz
  Costly for 2.4GHz
- → Peak detector (LT5534) → Suits all 3, but moderate accuracy ✓
- → Passive envelope detector (HSMS-286x diode) → Less accuracy, but OK for 2.4GHz

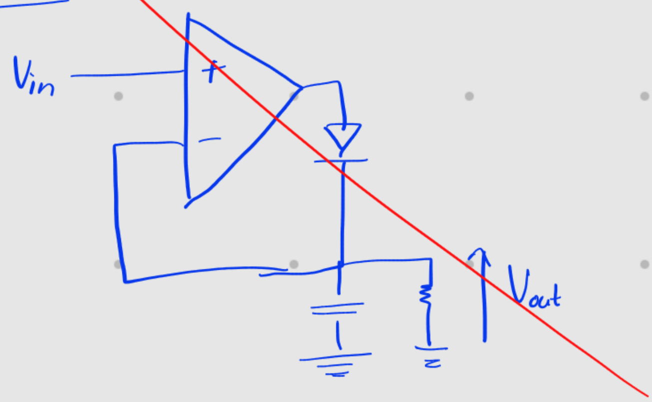
∴ log detector IC හම්බුනොත් දාමු
නැත්නම් peak detector ✓

⇒ Log ✓

Log detector



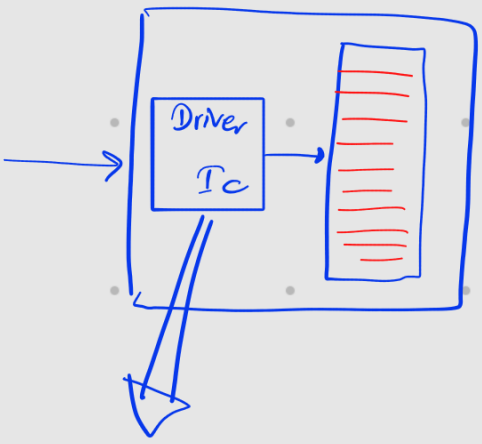
Peak detector



Level indicator

can use an LED bargraph

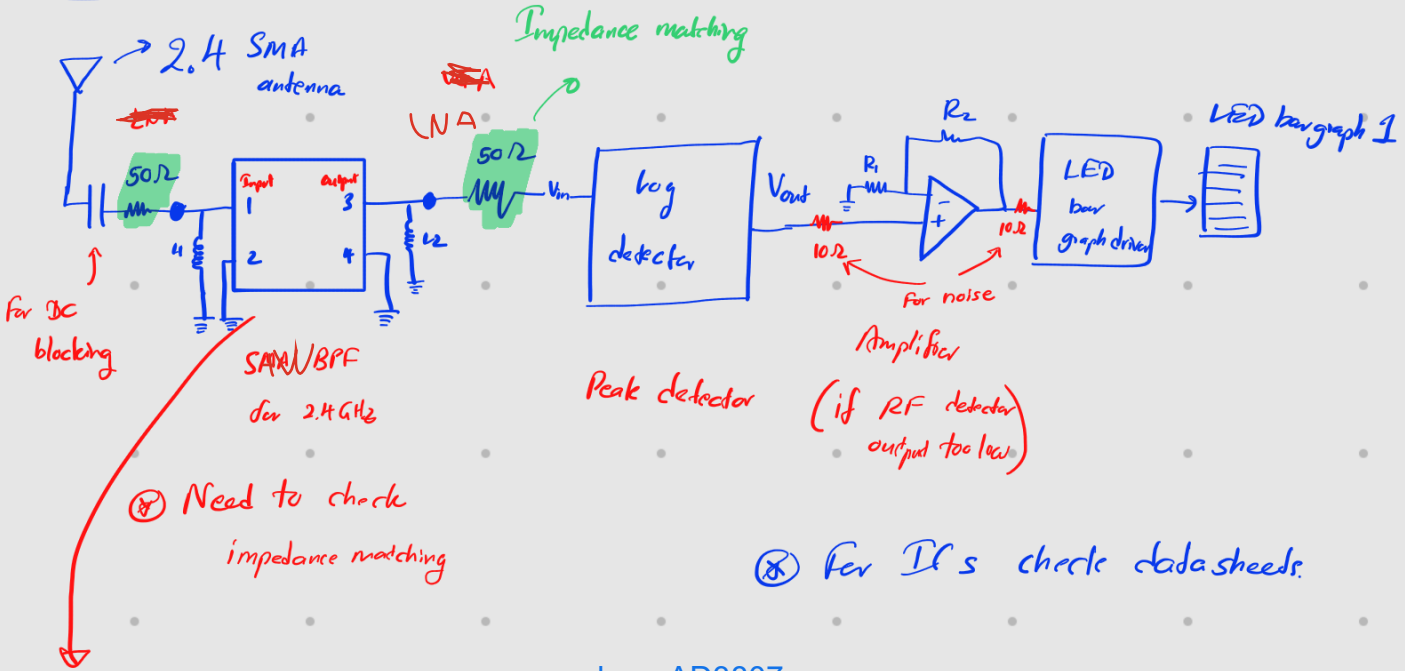
RF detector output



LM3914 — for linear voltage output

LM3915 — for log voltage outputs

Rough schematic



⊗ Need to check impedance matching

⊗ for ICs check datasheets

OR microstrip filter

log - AD3807

ANT -> FILTER -> LNA -> VGA -> ENVELOPE DETECTOR -> LM3914 -> LED

LG

HI

CD

TSR

Characteristics to consider in filter design

1) Cutoff frequency → For BPF f_{lower} & f_{higher}
2) Bandwidth
3) Pass band ripple → Variation in gain inside the passband
4) Stop band attenuaⁿ → How much unwanted frequencies are suppressed
5) Roll-off rate → Sharpness of transition.
6) Noise figure (NF)

⊛ In this context

RF signal → Device → Relative intensity
- → No need sharp accuracy
- → Sharp skirts not necessarily required

Proposed design

ගාන අඩුයි ☺

PCB material – FR-4

$\varepsilon_r = 4.4$ $\quad f_0 = 2.45$ GHz

$h = 1.6$ mm $\quad$ FBW = 6%

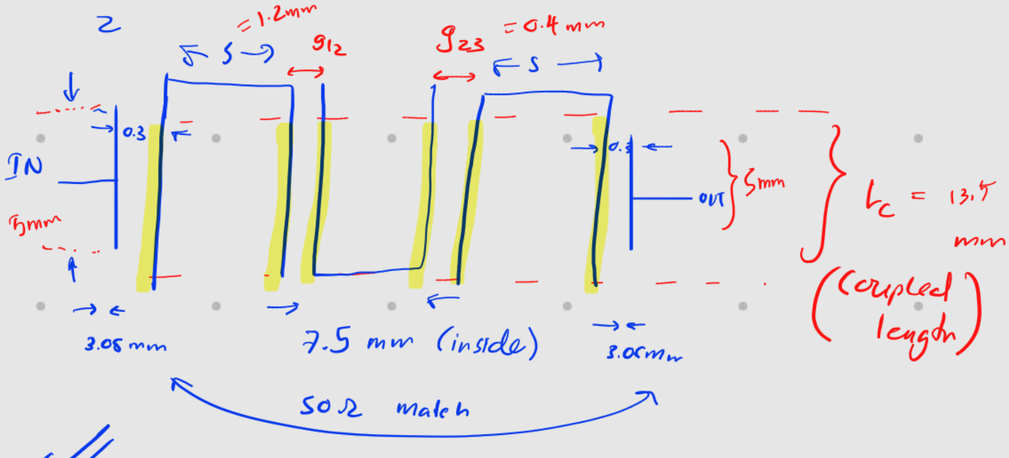
50Ω → 3.08 mm width

Resonator line → 1.24 mm (80Ω)

$\frac{\lambda_g}{2} = 34.7$ mm @ 2.45 GHz

$\frac{\lambda_g}{2} = L_c$

$\approx 3 \quad = 2(L_{leg}) + L_{base}$



resonator overlap

Lowpass (lumped module) parameters

$g_0 = 1 = g_4$

$g_1 = 1.5963 = g_3$

$g_2 = 1.0967$

$Q_{e1} = Q_{e3} = 26.6$

$M_{12} = \frac{FBW}{\sqrt{g_1 g_2}} \approx 0.046$

$M_{23} \approx 0.046$

Chebyshev table ($n = 3$)

$g_0 = 1.0316 = g_4$

$g_1 = 1.1474 = g_3$

Possible Q's

1) Why RB filter? → low insertion note
→ To learn ⊛⊛

2) Why hairpin? → less area
→ narrowband friendly

3) Why 3-pole hairpin?
→ For higher orders more parasitic effect