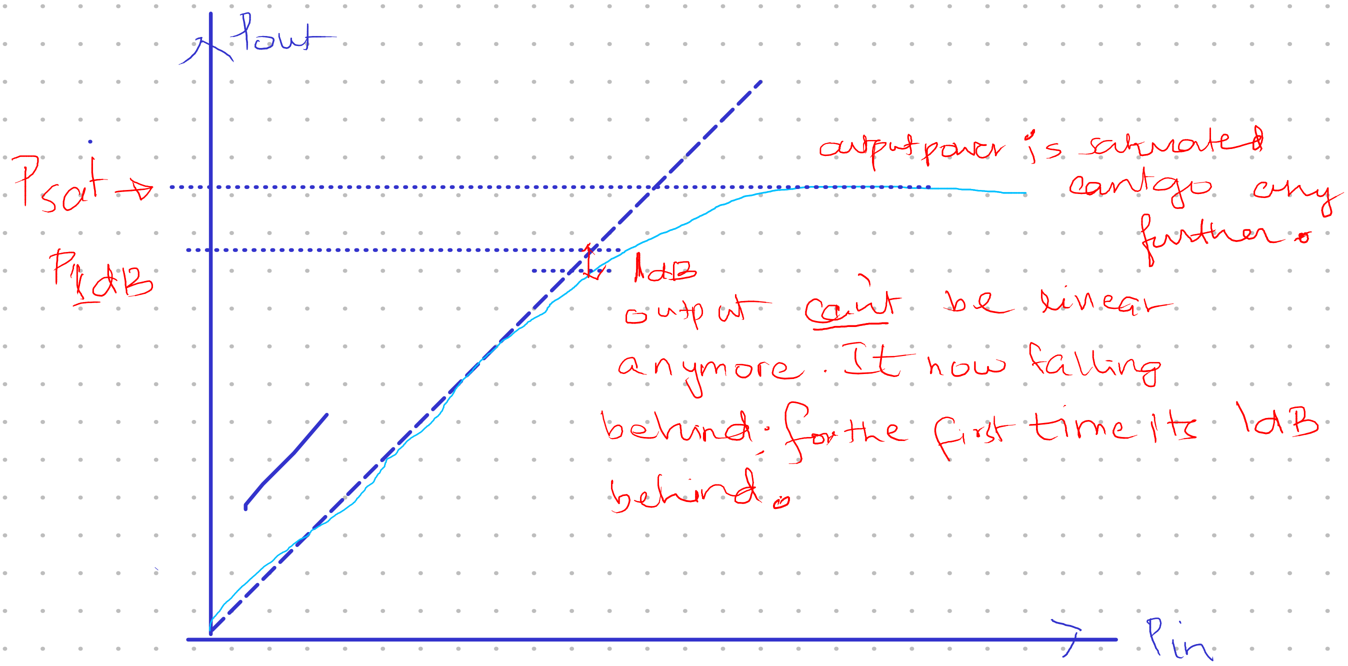
Notes:

1. Power measured in dBm
2. Gain measured in dB



Ex if the attenuation is 0dB,

i/p = −30 dBm o/p = 53 dBm gain = 53 − (−30)

= 53 + 30

Gain = $\boxed{83\,dB}$

?

Unit is 200 W

Remember this formula to calculate power in dBm.

$$\boxed{P(dBm) = 10 \log P(mW)}$$

$= 10 \log(200 \times 1000)$

$= 10 \log(200000)$

$= 10 \times 5.3$

$= 53\,dBm$

Why 40dB diff?

$= 38 - (-30)$

Gain $= 38 + 30 = 68\,dB$

Gain − Att = 68dB

Gain = 68 + Att = 68 + 11 = $\boxed{79\,dB}$

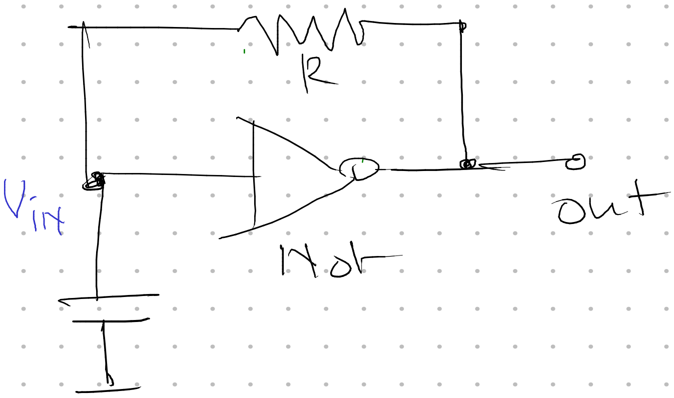
?

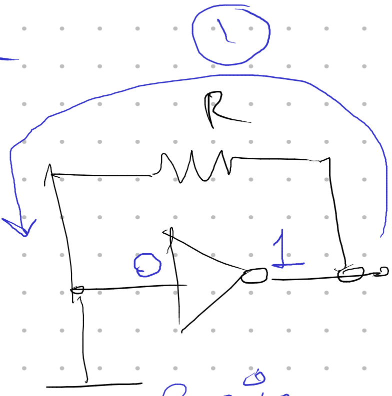
$$p(mW) = 10^{\left(\frac{P(dBm)}{10}\right)}$$

$$= 10^{\left(\frac{5400}{10}\right)} = 10^{540}$$

$$\log_{10}(P) = 540$$

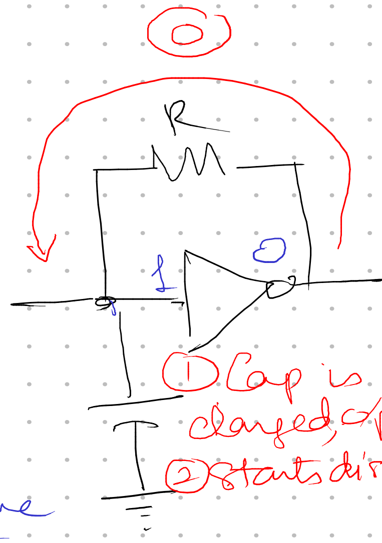
SIMPLE OSCILLATOR





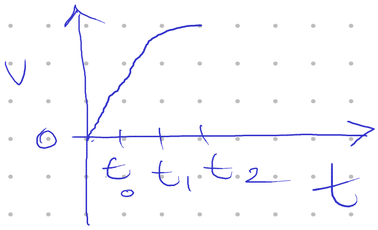
① Cap is discharged
② The High on the out charges it again

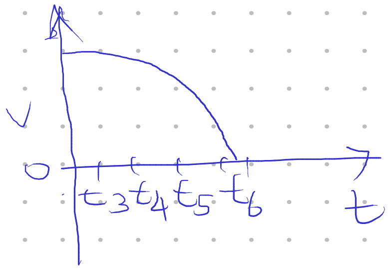
Situation ①



① Cap is charged, o/p = 0
② Starts discharge

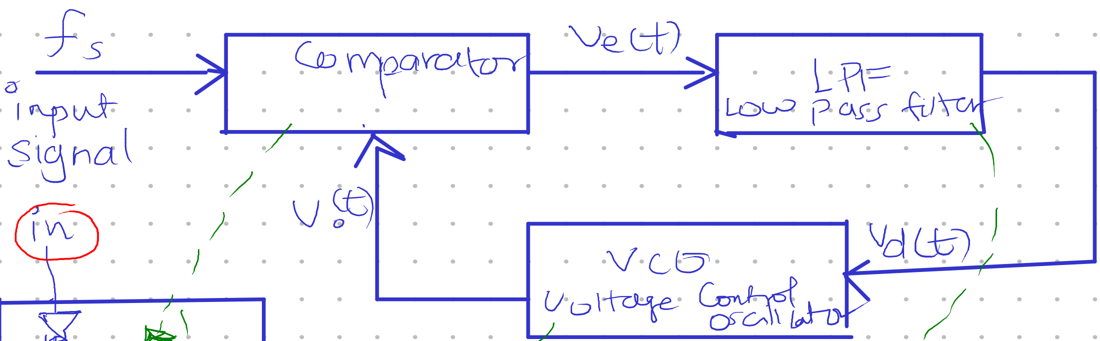
Situation ②

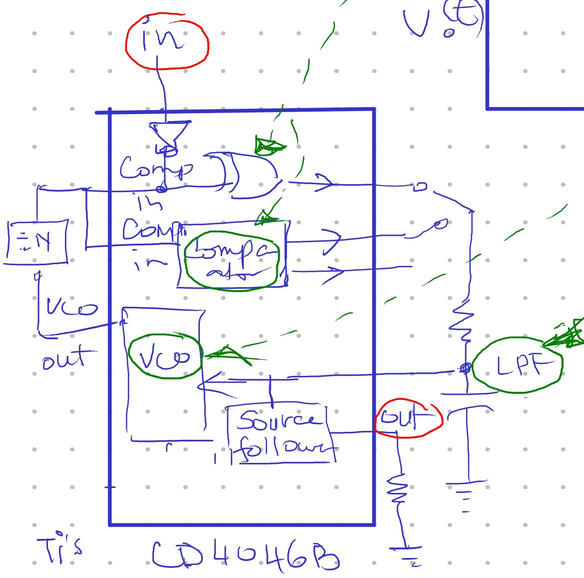




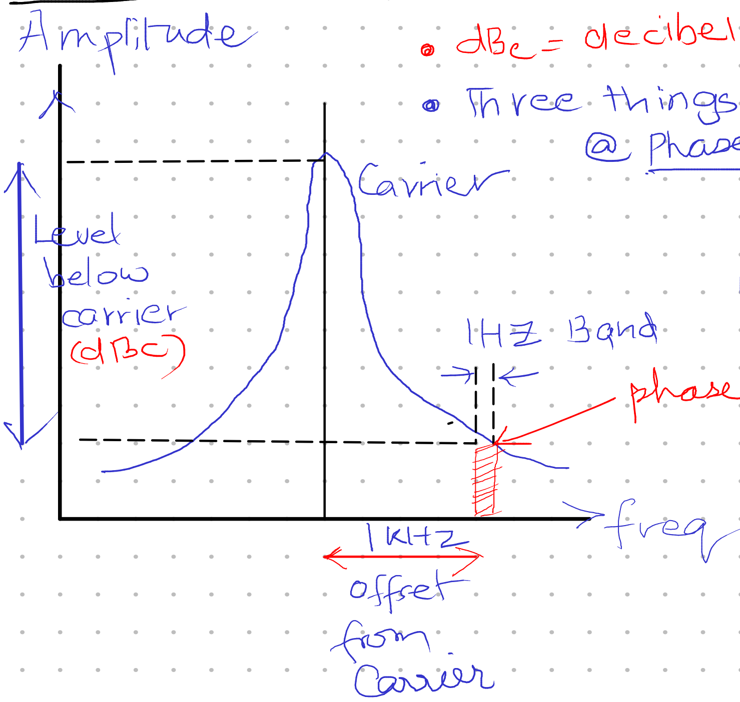
⊖ Cons :- Temperature variations cause instable output of the capacitor..

PLL Block Diagram





PHASE NOISE



- dBc = decibel below carrier
- Three things used:
  - (a) Phase noise amplitude: Relative to carrier so -dBc = Ex: -70 dBc
    70 dB below carrier
  - (b) Offset from carrier:
    Ex: 1KHz, 10KHZ, 100KHZ from carrier frequency
  - (c) Measurement Bandwidth:
    Measured in Bandwidth since noise is proportional to bandwidth of signal. 1HZ here.

One example of a unit is: -113 dBc/HZ at 100KHZ offset at 5GHZ

(a) (c) (b)

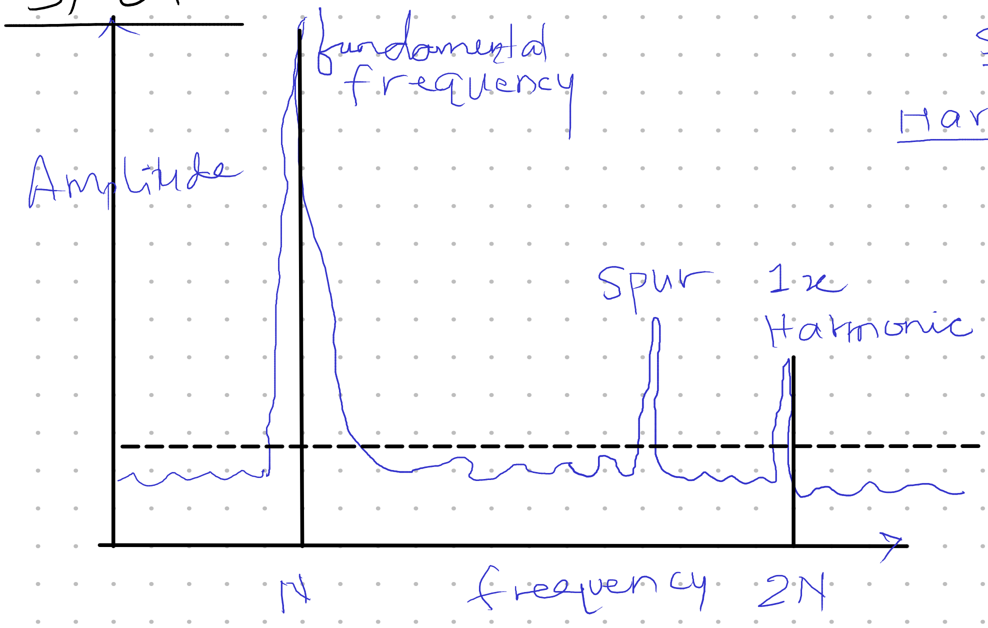
carrier frequency.

JITTER NOISE

Jitter noise or phase noise are essentially the same phenomenon represented differently.

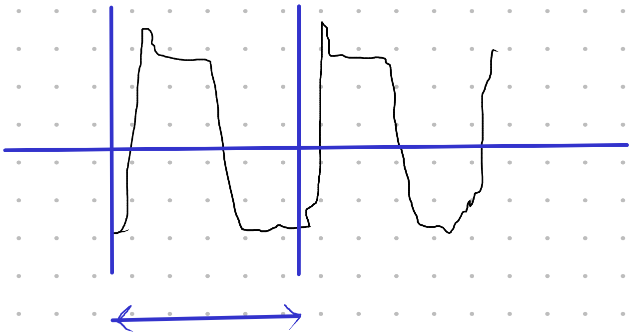
- Time domain → jitter noise
- Frequency domain → phase noise

SPURS



Spur: Any spurious peaks

Harmonic: Multiple of fundamental freq peaks that are unwanted.
Usually their levels will go down as the orders increase.



$P = \sim 60\,nsec = 60 \times 10^{-9}$

$f \Rightarrow \frac{1}{60 \times 10^{-9}} = \frac{1000}{60} = \boxed{16.67\ MHz}$

The actual device tree value is set to 20MHz.
I can try to lower this further.

The incoming clk to SPI = 82MHz
To enable seeing the SPI clock, do the following

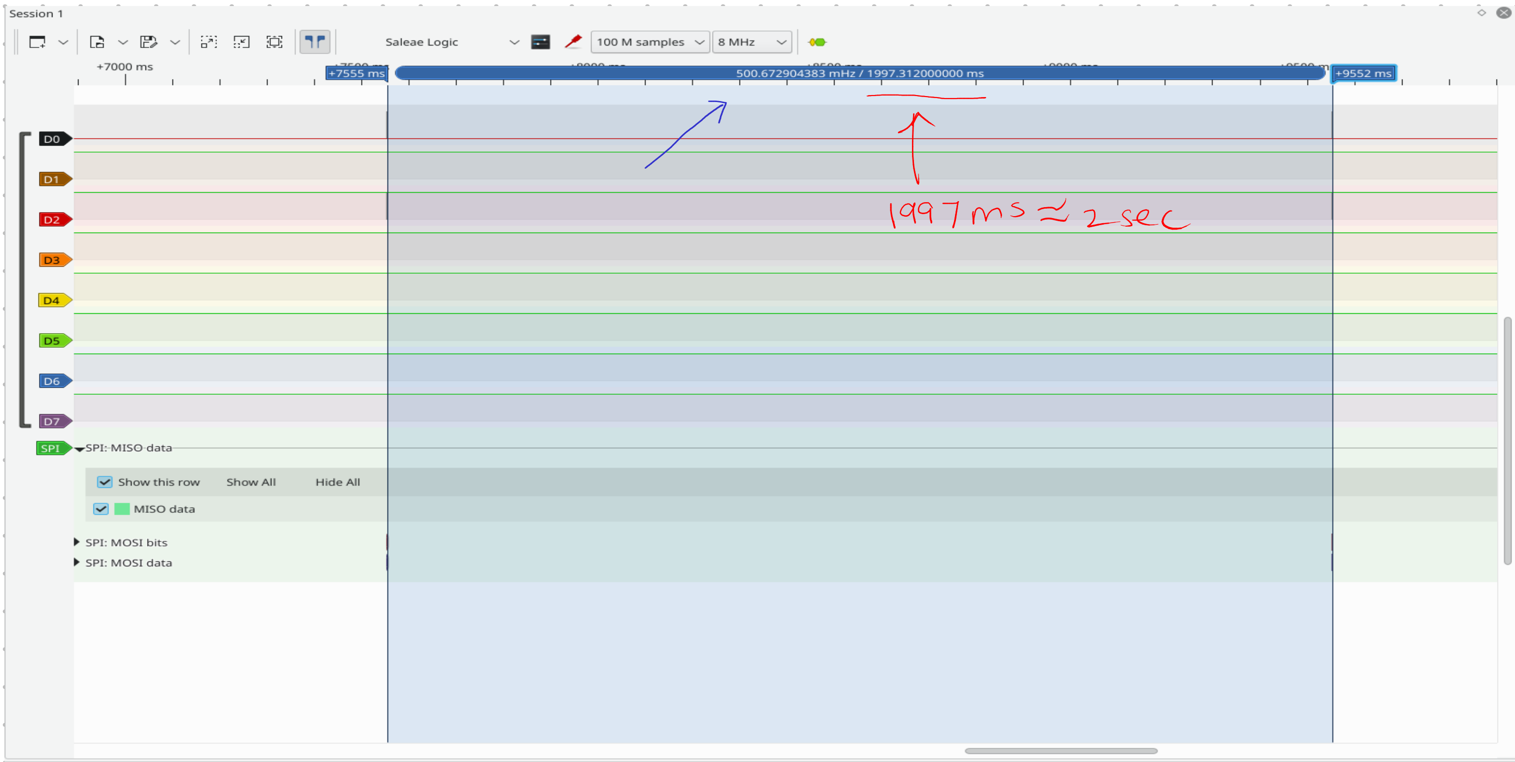
mount -t debugfs none /sys/kernel/debug/

cd /sys/kernel/debug/clk/clk_summary

This shows a full clk Hierarchy and shows that SPI0 runs at 82 MHz.

It is then further divided to get to 16 MHz after dividing by 5. $\frac{82}{5} = 16.4$ MHz.

If we divide $\frac{82}{82} = 1$ MHz. I can try this.



Data output :->

00	00	00	0D	0
00	00	15	FC	1
00	61	20	0B	2
00	C0	1F	7A	3
20	2A	3C	C9	4
15	59	65	68	5
0E	00	00	F7	6
55	02	88	26	7
00	80	00	25	8
30	00	89	84	9
00	00	00	03	10
00	00	00	22	11
00	00	00	01	12
00	30	08	00	13

observation 1: This matches with the 14 registers that we write.

2: All transactions have these going one after another and are all 14 transactions.

3: All 14 transactions burst are seperated by 2 sec interval.

1. prefix = 1BB

strcmp(prfx, 1BB, 3) = 1

!(1) = 0

if (0) ⇒ return pass

2. prefix = 1BF

strcmp(prfx, 1BF, 3) = 0

!(0) = 1

if (1) && (evaluate next prfx)

⇒ strcmp(prfx, 1BF, 3)

⇒ !(1) = 0

⇒ 0 & 0

⇒ 0

result = pass

3. prefix = 1BG

⇒ strcmp(prfx, 1BG)

!(0) = 1

⇒ && evaluate next step

⇒ strcmp(prfx, 1BF)

⇒ !(0) = 1

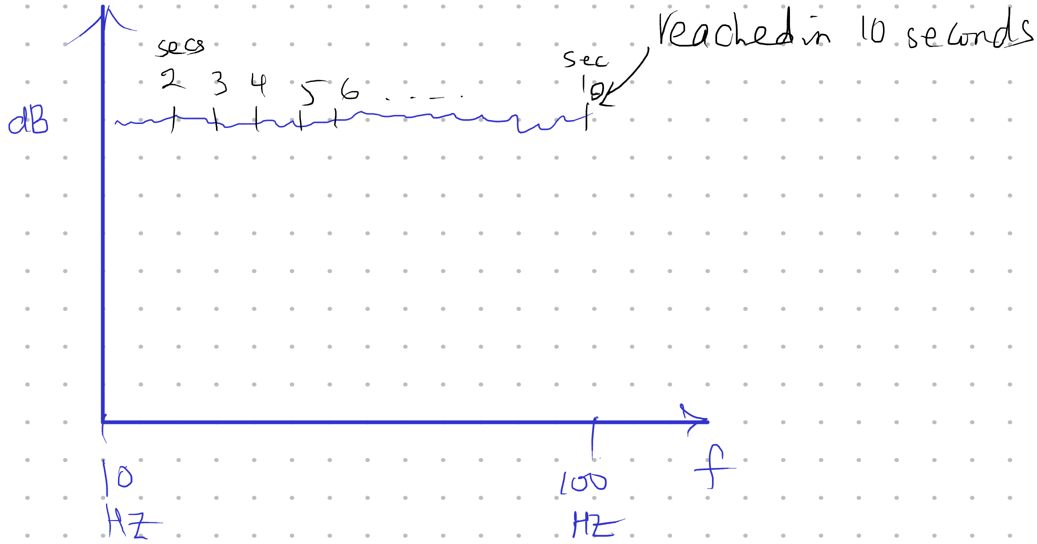
⇒ 1 & 1 ⇒ 1

result = "var range : OK"

FREQUENCY SWEEP

A freq sweep is usually done using a:
ⓐ start freq
ⓑ: stop freq
ⓒ. time duration

ex:- start at 10 HZ, end at 100 HZ and in 10 seconds.



Calibration

	Sensor Val	Idea
ct1	Raw(P_0)[0]	Enter P_i so that P_0 = [22 24 26 28 . . . 42] at different temperature & L Band freq
ct2	Raw(P_i) [1]	Enter P_i so that P_i = [-60 -55.5 -51 -46.5 . . -15] at different temperature & L Band freq
ct3		VVA for temperature compensation. Its the DAC value for the VVA.
ct4	Raw (T) [2]	At each temperature find Raw[2] and pgm to Ct4
Ct5	Raw (T) [6]	Bring 10MHz at level of -15dBm, -13dBm so that we get a 10MHz fault and clear. Then at different temperature, note Raw[6] and write to Ct5.
Ct8		
ct9		

Ct5

R C
[0 0]
[0 1]
...
[0, 5]
[1, 0]
[1, 1]
[1, 5]

Has 2 rows
6 columns
represented as: [2, 6].

fault

$$ct5 = \begin{array}{cccccc} 0,0 & 0,1 & 0,2 & 0,3 & 0,4 & 0,5 \end{array}$$

ct5 = [(1960, 1941, 1933, 1932, 1938, 1947),
(2095, 2086, 2081, 2078, 2082, 2089)]

1,0 1,1 1,2 1,3 1,4 1,5

clear

fault
clear

temperature (-40°C)

temperature5 (60°C)

$\boxed{\text{ctq}}$

"Calibration.cpp"

"dB" (power)

ctq [Atten-freq] [att-temp] [att-level];
[3], [6], [11]
L R C

Levels = [0, 4, 8, 12, 16, 20, 24, 28, 32, 36, 40];

temp = [-40, -20, 0, 20, 40, 60];
freq = [13750, 14125, 14500];

Command:

To write this cmd used as follows:

cmd = ctq.

IBUC ctq = freq, temp, power, level (Raw)

= 0, 0, 0, <0 – 4095>
= 0, 0, 1 = 2500 ← example
0, 0, 2 = 3000
3 = 3500
⋮ ⋮

This is available as:

power[0], freq[0], temp[0] = level
power[0], freq[0], temp[1] = level
, freq[0], temp[2] = level
⋮
power[0], freq[0], temp[5] = level
⋮

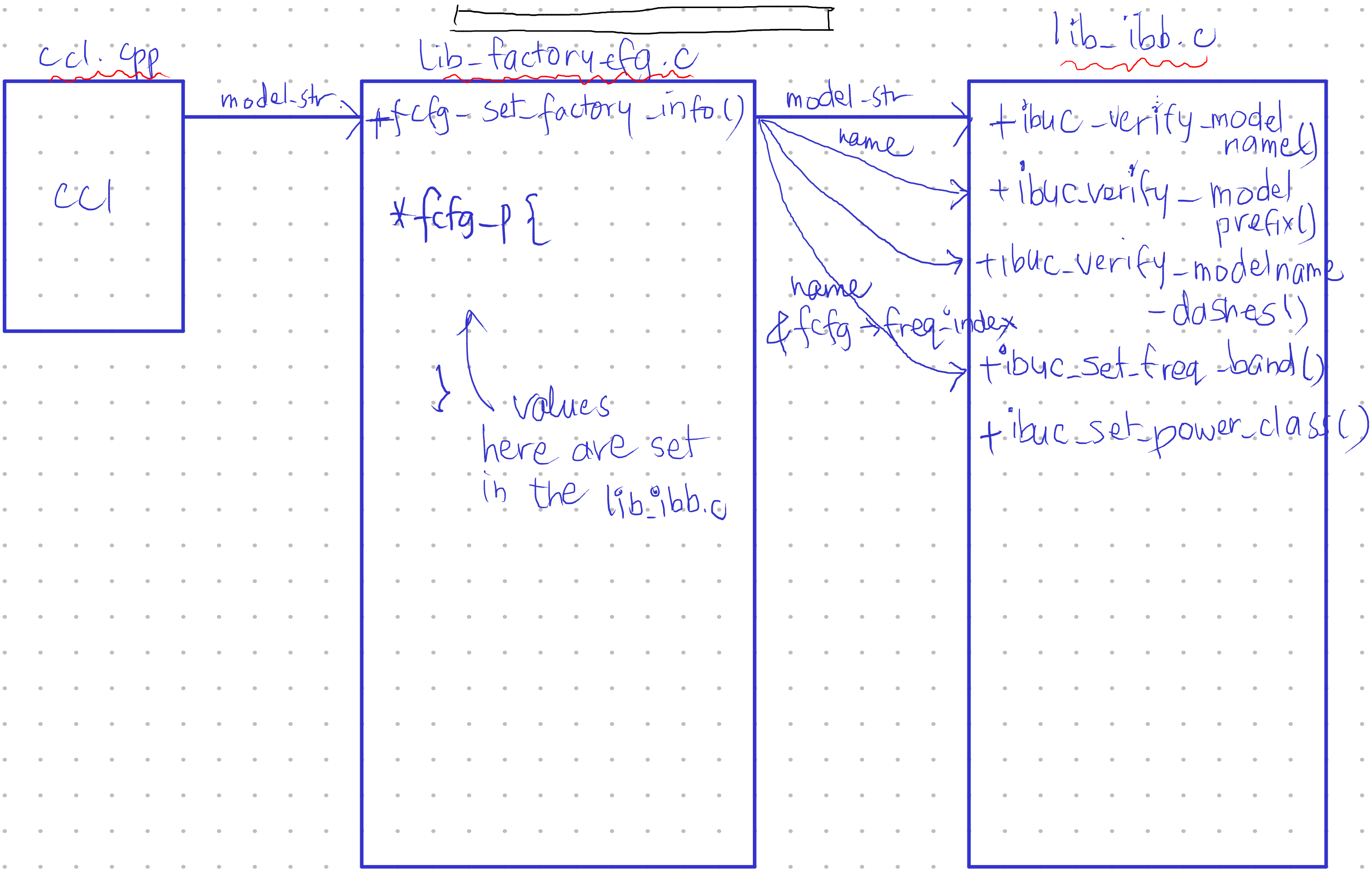
instead of

freq, temp, power

So we will just go through the way it is given and enter it all adding indexes as we move along.

So: p[0], f[0], t[0]
t[1]
t[2]
⋮
t[5]

FACTORY CFG



we should change the above to new way of doing using lookup table as in RX1+1.

BUGS

1. I need a seperate routine for IBA model number to set their voltage specification. See bare metal code
2. Diff the IBA version with IBR and see what all are added. See history.
3. RX1+1 does not show you read only user
4. Finish manual for RX1+1.
5. Testing heavy for RX1+1, IBUC3

   Test → Sensor Data –
   → webpages –
   → SNMP!
6. How to show a table in the Tkinter and save that as C#.
7. Reduce SPI bus speed.
8. Convert code of Quick Quote to Flask.
9. merge all code of RX1+1 to TX1+1 & IBUC3
10. move to latest kernel
11. Automate calibration of unit using an existing table or excel file. It should issue commands.
12. ~~I get a message: "failed to open pipe: No such file or directory" after I login to the IBUC> It just after the Password:~~
   ~~Actually this is due to the ibuc-core not starting.~~

* Diff ibr-baremetal with previous revision

1. TLS → new command added ? — Load switch is standard
2. FBS → new command added ? Allows band selection now.
3. atod.c : process_burst()

if fake RFBDS

previous

tx_power_input_mB = -3000

now

tx_power_input_mB = get_input_min + 2000 & so on...

— Before input min = -3000

-6000 + 2200 = -3800

Basically added

- get_min_mB()
- get_rated_power_mB()

4. CCF correction factor for sample port is not added.
5. KLD — Command added : keyline disable
6. OPC — Displayed output power correction.
7. TLS — Get or Set transmit load switch.
8. CCS — is added.
9. FBS — Frequency band selector is a command used for triband.
10. keyline : I forgot what is it?
11. System gain seem to depend on family 'R', 'A', 'G' family are supported.
12. Load switch has some extra logic for initialization.
13. statlog has a power_out_correction added to the output power.
14. input overdrive is added per family.
15. IBR and IBA model number are set differently (separately).

• TODO:- 1. Load switch needs to be added.

2.

Internal: 10 MHZ

1. cto table represents the 10MHz table, however it is not implemented because chamber 2,3 cannot calibrate the 10MHz detector. The chamber 1 can.

2. So we donot write the header that says that values of 10MHz output detector are valid.

3. we only use fault and clear threshold values.

4. It could be done in the future.

5. 10 MHZ part is a VCO. Its a VCXO it means it is not meant to vary a whole lot in it's spec. The VCO change only gives 1 ppm change that means a VCO chang of 2.5v (which is full scale) only changes freq of 1ppm ($\frac{10\ MHZ}{1\ ppm} = \frac{10 \times 10^6}{10^6} = 10\ HZ$).

6. So its basically meant for fine tuning 10 MHZ ± 10 HZ. over its lifetime it can change by 1ppb.

The final freq affected by the 10MHZ is multiple of 10 MHZ. So for a 12 GHZ = $\frac{12\ GHZ}{10\ MHZ} = \frac{12 \times 10^9}{10 \times 10^6} = \frac{12 \times 10^3}{10}$
$= 1.2 \times 10^3 = 1.2$ KHZ diff.

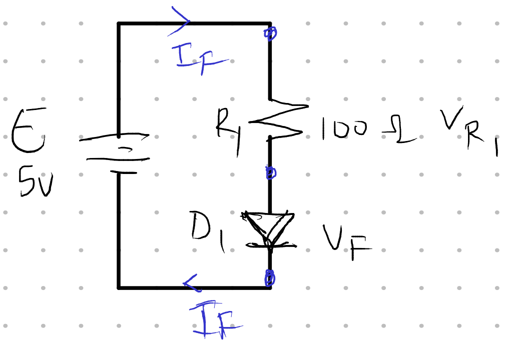
So a change of 1ppm changes 1.2 KHZ on final RF freq.

see the spec detail in buy-parts → folder and the manufacturer name is <?>.

7. The part we use is under \\old...\ Engineering\4. Buy Parts Data sheets\ Bliley Technologies\LNBNTL-10MEB-JCAB.pdf

8. The schematic is SCH-22880-0002 Rev C

9.



$E = (V_{R_1} + V_F)$

$= I_F 100 + V_F$

Solving :

① $V_{R_1} = 0$

$I_F 100 = 0$

$\Rightarrow V_F = E = 5V$

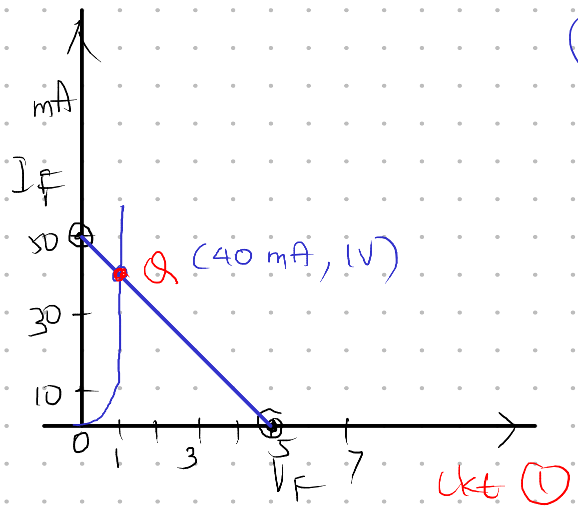
② $V_F = 0$

$E = I_F 100$

$5 = I_F \times 100$

$I_F = \frac{5}{100} = \frac{5\ V}{100\ \Omega} = \frac{5000\ mA}{100}$

$I_F = 50\ mA$



ckt ①

So $E = V_{R_1} + V_F$

$= I_F 100 + V_F$

$= (40\ mA \times 100) + 1V)$

$= 4000\ mV + 1V$

$= 4V + 1V$

$= 5V$

So it means that at 40 mA & 1V drop accross Diode the circuit will work properly.

So in ckt ① 40 mA will flow through the ckt and a drop of 1V will happen in the diode.

Lets say we take different values :

Assume $E = 10V$

$R = 100\ \Omega$

$E = V_{R_1} + V_F$

① Solving

① $V_{R_1} = 0$ $I_F \times 100 = 0$

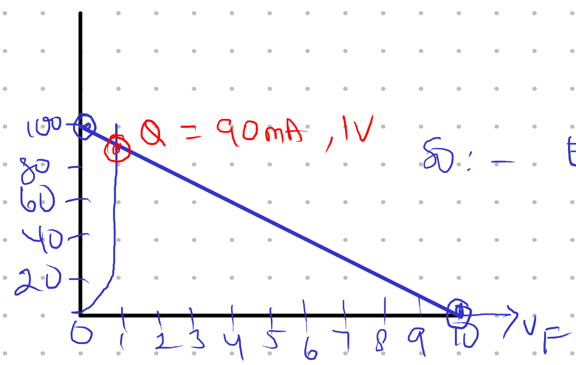
$V_F = E = 10V$

② $V_F = 0$, $E = V_{R_1}$

$E = I_F \times 100$

$\frac{10}{100} = I_F$ $I_F = \frac{10 \times 1\cancel{000}}{1\cancel{00}} = 100\ mA$

ckt ②



So :- $E = V_{R_1} + V_F = I_F 100 + V_F$

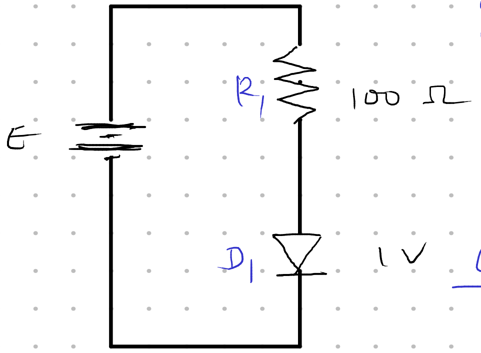
$= 90\ mA \times 100 + 1$

$= 9V + 1V$

$= 10V$

for ckt ② : 90 mA will flow accross the ckt and 1V will drop across the diode.

Q: Take a case here, we know $R_1 = 100\,\Omega$ and have a drop of $V_F = 1V$, Calculate E?



Ans:- $E = V_R + V_F$

$E = IR_1 + 1$ =

Case 1: $I_{R_1} = 0$

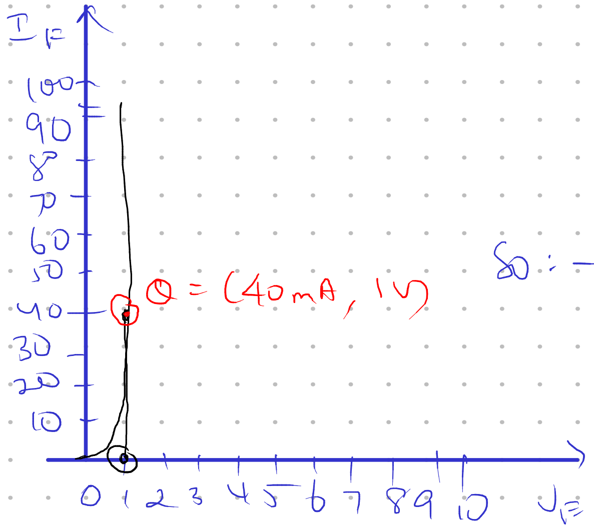
$E = 1$

Case 2: $1 = 0$

$E = IR_1$

$E = I \times 100$

$I = \frac{E}{100}$

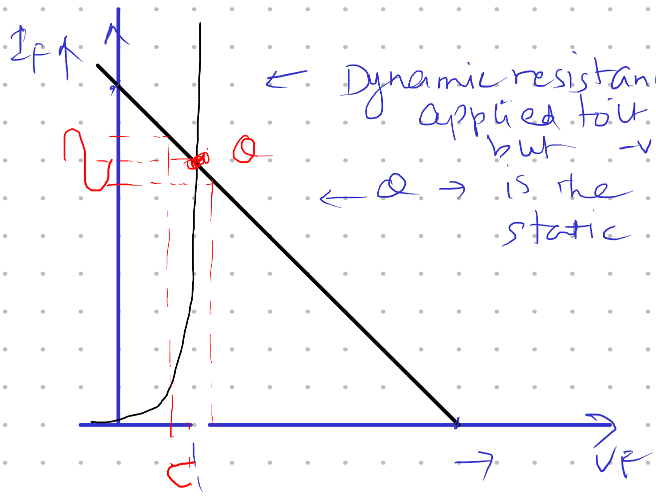


So:- $E = (40mA \times 100) + 1$ ← At Q point

$= 4V + 1V$

$\boxed{E = 5V}$

So to solve the equation, we would need $E = 5V$



← Dynamic resistance of a diode since AC voltage applied to it. Changes in voltage are seen on o/p but -ve values are clipped.

← Q → is the static resistance because only static voltage applied.

↑ o/p voltage clipped.

Unix programming

	U	G	O
R			1
W			1
X			0
			5

The Linux programming interface:

```
m = umask(077);
  Open the file.
umask(m);
```

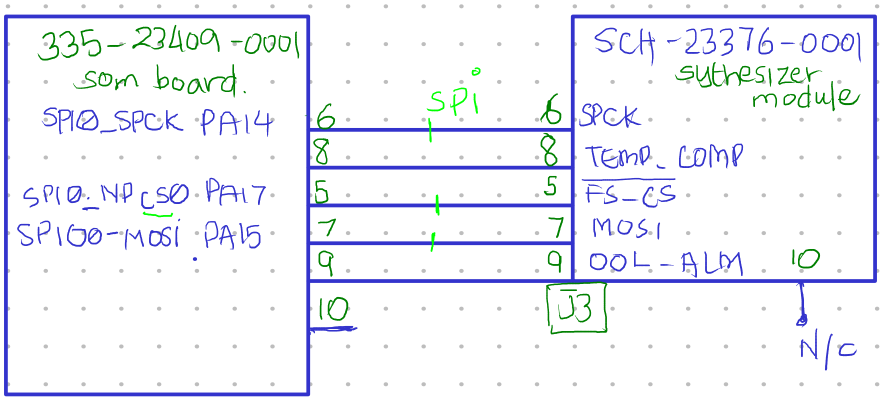
So the sequence goes this way:

1. set umask(x), x being whatever value we want to set
2. Open the file and set the umask again.
3. That should set it accurately.

Its not possible to know the mask and change it at the same time.

Be very mindful of this nuance. It can cause a lot of confusion. Follow the sequence properly for a proper operation. See the final result and make sure that the value is set correctly for the opened file. It should be 077.

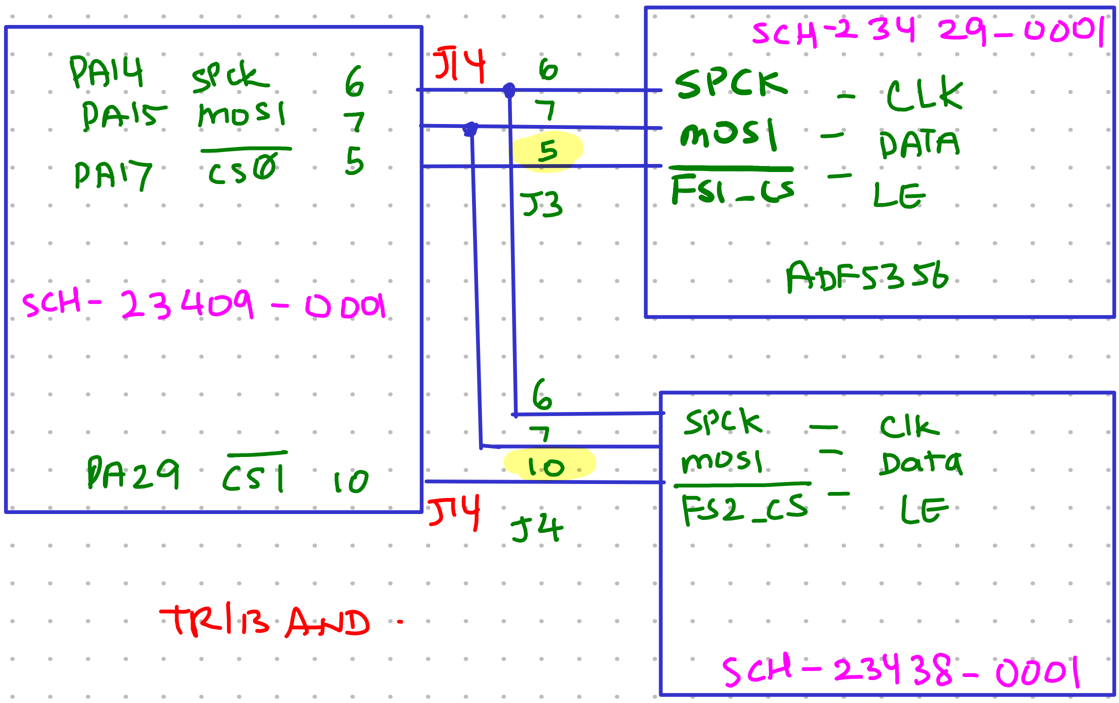
All are primary function & approp I/O.



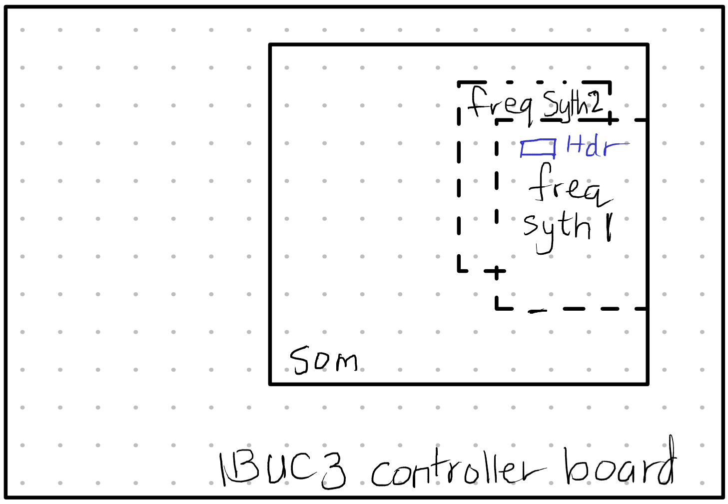
335-23376-0001

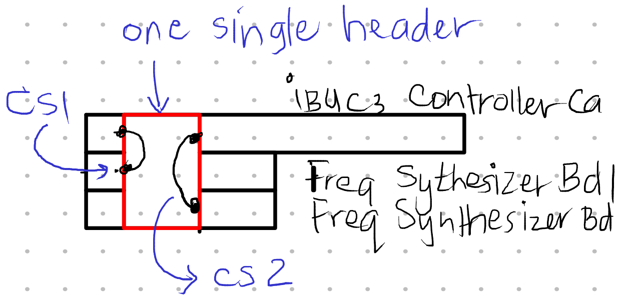
ASD (Assembly level drawing)

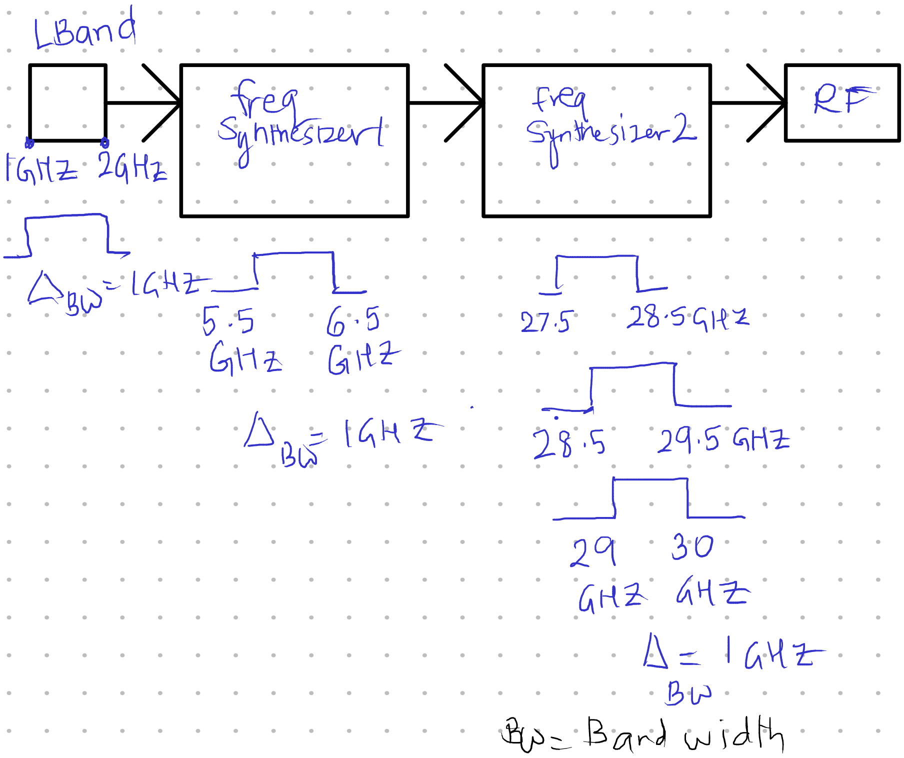
SINGLE BAND



TRIBAND.







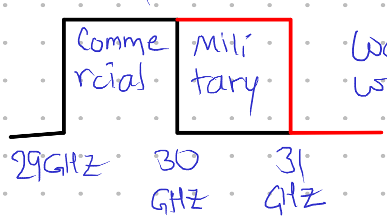
At the input the bandwidth is 1GHz. At the first stage the output multiplied by 5 or 6 times. Then the stage 2 times the freq by 5-6 times overall we get 30 times freq multiplication.

This allows multiple bands transmitted. So we can do 1-3 or more bands But only one is operation at any time.

The floor noise is very low at input and we don't multiply signal that much. So the phase noise remains within limit.

If we were to connect the LBand directly to the output then the phase noise is amplified 30 times and can get a lot worse. We keep these things in check.
Also in some divider ckts the divider also lowers the phase noise, we donot want to lower the phase noise below the floor phase noise. That actually increases the floor phase noise.

Lastly we are working on military band of IBUC3 also.

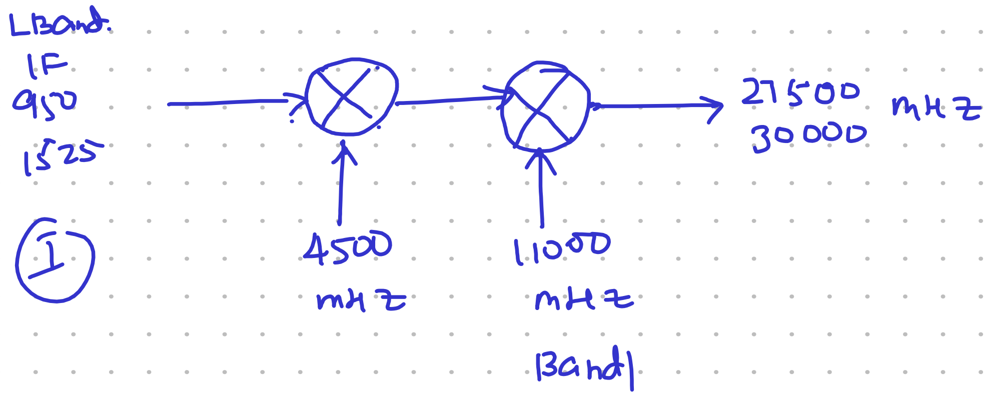


"Dual Band"

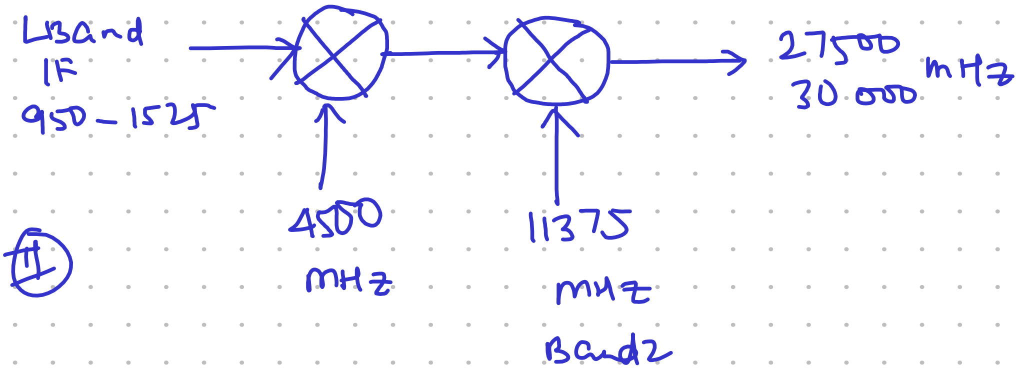
We can achive this using above configuration wherein the synthesizers ares cascaded.

Modems transmit in a slice of ~100MHz and so multiple modems can transmit in different slices but all the data can travel in the same band. All data, hence, travels simultaneously.

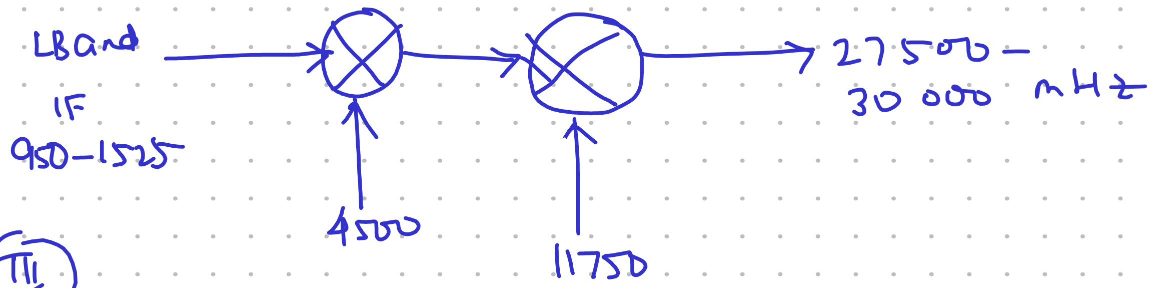
Triband only applies to Ku-band 5 (27.5 - 30.0GHz)



I



II



III

I $\rightarrow$

$$\begin{aligned} &IF_1 + LO \\ &4500 + 950 = 5450 \text{ MHz} \\ &4500 + 1525 = 6025 \text{ MHz} \end{aligned}$$

LO is doubled so. LO = 2 x 11,000 = 22,000

$$\left.\begin{aligned} &5450 + 22000 = 27450 \text{ MHZ} \\ &6025 + 22000 = 28025 \text{ MHZ} \end{aligned}\right\} \text{Ku-Band Band1 Triband.}$$

$IF_2 + 2(LO) =$

II.

$IF_1 + LO =$

$$\Rightarrow \left.\begin{array}{l} 4500 + 950 = 5450 \\ 4500 + 1525 = 6025 \end{array}\right\} IF_2$$

$\Rightarrow IF_2 + 2(LO) =$

$$\Rightarrow \begin{array}{l} 5450 + 2(11375) = 5450 + 22750 = 28200 \\ 6025 + 2(11375) = 6025 + 22750 = 28775 \end{array}$$

Ku - Band 2
Triband

III.

IF_2 is the same:

$$\Rightarrow \begin{array}{l} 5450 + 2(11750) = 5450 + 23500 = 28950 \\ 6025 + 2(11750) = 6025 + 23500 = 29525 \end{array}$$

Ku - Band 3
Triband

TODO:

1. I have to add support for cmds specific to Triband.
2. webpages need to support Triband.
3. How to monitor the SPI bus to ensure that the CS works as needed. Check the both channels and make sure SPI bus is working for both synthesizer.
4. Read upon the SPI ref manual of SAMA5D27
5. Check the kernel code to see if the SPI CS are toggled based on the device we address.
6. Are the CS pins correctly mapped in pincontroller to each GPIO as CS for SPI. in the device tree, kernel and the Reference manual?

TODO

Commands added are:

1. KLD – keyline disable.
2. FBS – Freq Bandselect.
3. CIF – change input freq.
4. TLS – Tx load switch.

For these following variables are added.

(1) Kl_disable — Not there

(2). input_min_mB
(3). input_max_mB } → "factory_cfg"
→ input_valid

(4). pout_correction_mB
pout_correction_valid } " cfg

(5). tx_load_switch — cfg

(6). band_select — cfg

(7). cfg_input_freq. — Not there

Calibration Table

(1). CT1 table uses 3 tables now

(2). CT3 table uses 3 " "

TODO (1) input freq = set at startup, load_variables_from_fram()

idx
0 — 1000 – 2000 MHZ
1 — 950 – 1950 MHZ

Tools: • pytest
• Boost C++ test.

Testing

Python

1. Write the manufacturing info
2. Make sure it is there.
3. Read the cal file from excel file and parse it. Create a csv file and keep it ready.
4. Use csv to program the unit and calibrate it.
5. Start testing each command from there by each module seperately each time.
6. Once all commands are tested, start SNMP test.
7. Now start stress testing. Run unit for long time.
8. Now run the web test part.
9. Now run the compound test, Testing different scenarios.
10. Lastly test each module using C++ unit test. Run the programs seperately from python. May require recompilation.
11.

Quiz F.10 :

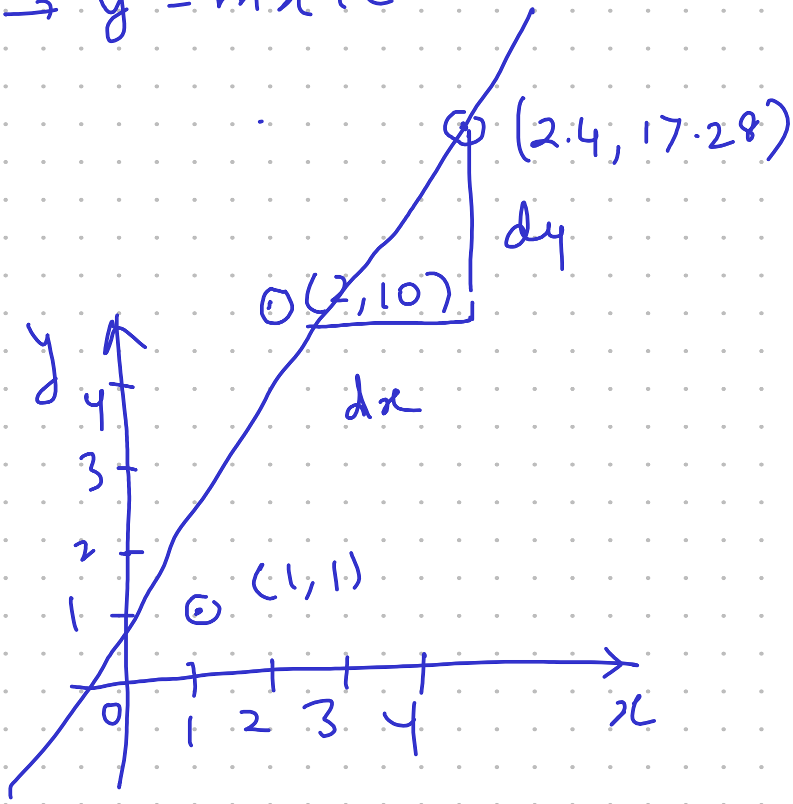
(2)

$y = 3x^2 - 2 \rightarrow y = mx + c$

$x = 1$

$x = 2$

$x = 2.4$



$x = 1, \; y = 3 - 2 = 1$

$x = 2, \; y = (3 \cdot 4) - 2 = 12 - 2 = 10$

$x = 2.4 \quad y = (3)(2.4)^2 - 2 = \quad 3(5.76) = 17.28$

$$\frac{dy}{dx} = \frac{17.28 - 10}{2.4 - 2} = \frac{7.28}{0.4} = 18.2$$

slope = 18.2

④ ⓐ $y = 4x^3 + x^2 - 6x - 3$

$$\frac{dy}{dx} = 4 \cdot 3 \cdot x^2 + 2x - 6 - 0$$

$$= 12x^2 + 2x - 6$$

$$\frac{d^2y}{dx^2} = 12 \cdot 2x + 2$$

$$= 24x + 2$$

$$\frac{dy}{dx} = 0 \quad , x = ?$$

$$12x^2 + 2x - 6 = 0$$

$$12x^2 + 2x = 6$$

$$2(6x^2 + x) = 6$$

$$6x^2 + x = 3$$

$$x(6x + 1) = 3$$

$$x = 3 \quad \text{or} \quad 6x + 1 = 3$$

$$6x = 2$$

$$x = \frac{2}{6}$$

$$x = \frac{1}{3}$$

⑤.

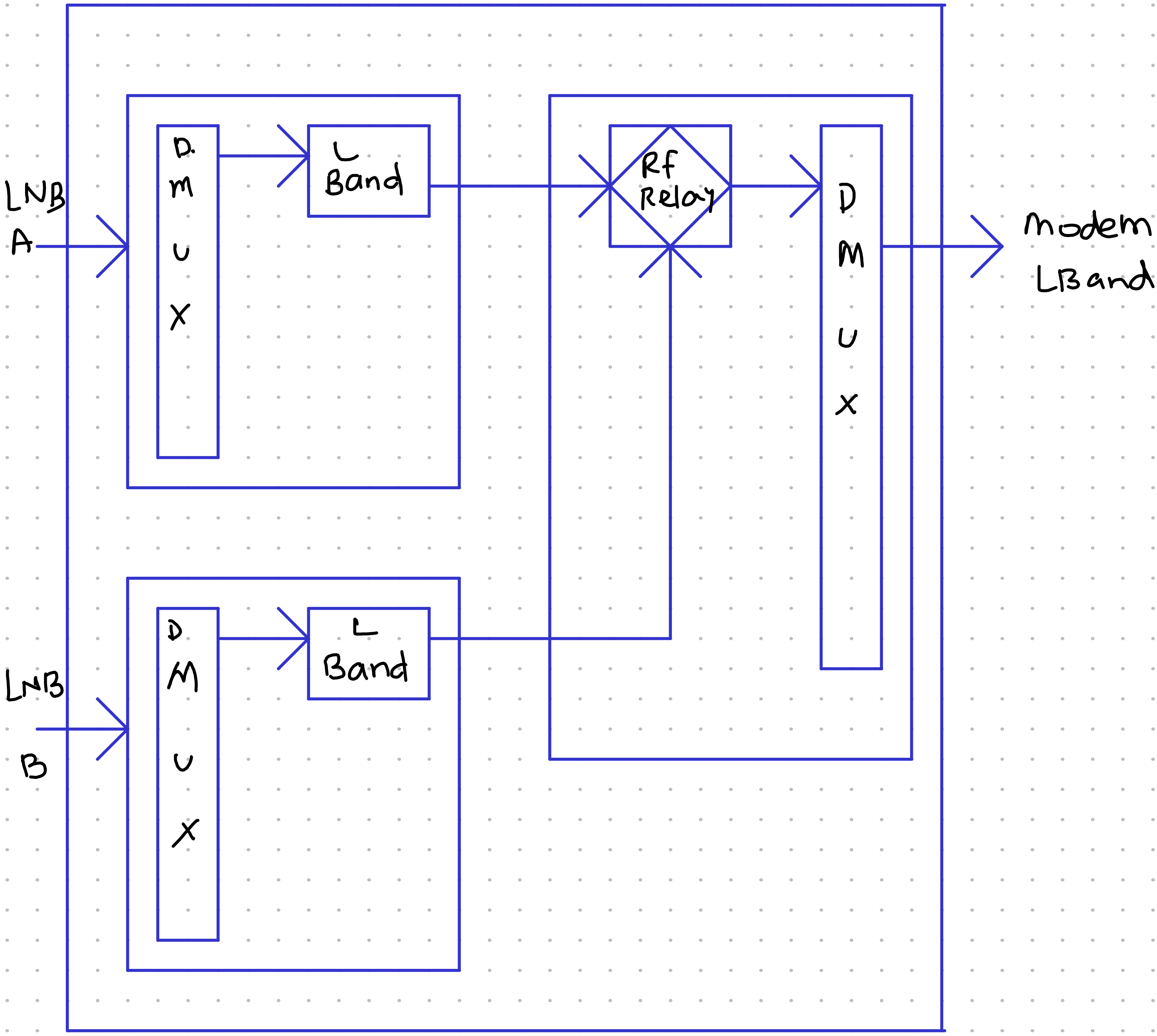
ⓐ. $y = x^4 \cos x$

$$= x^4 \frac{dy}{dx} \cos x + \cos x \frac{d4}{dx} x^4$$

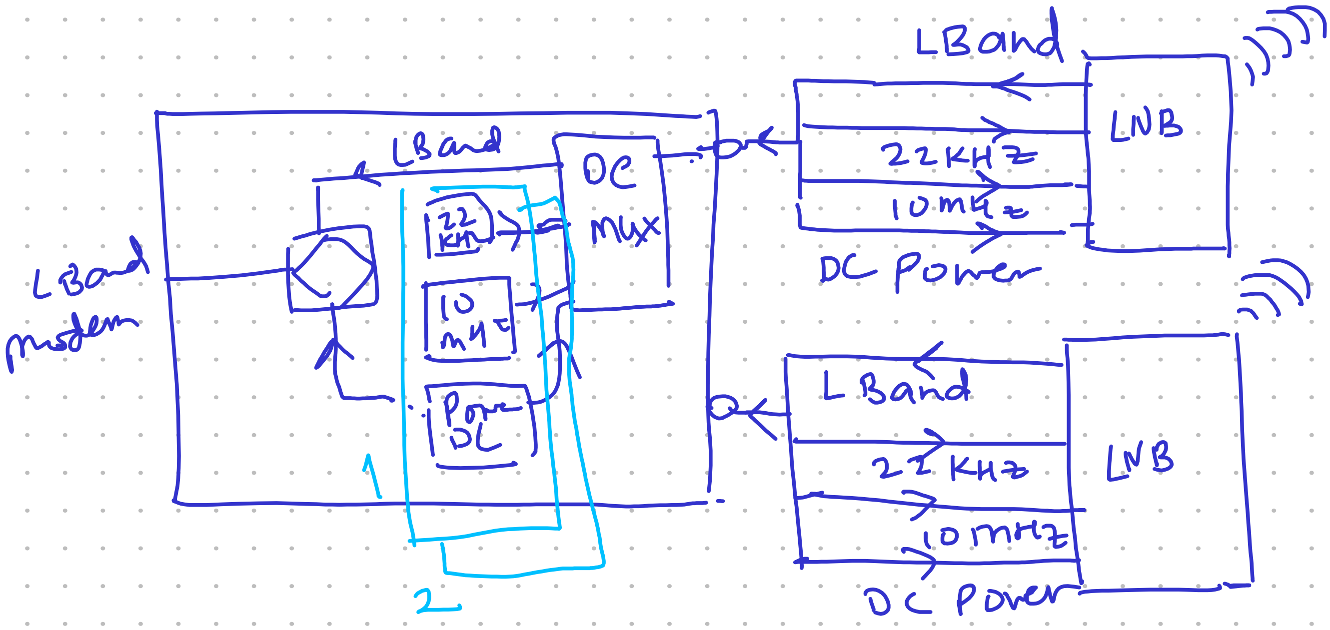
$$= x^4 \sin x + \cos x \, 4x^3$$

ⓑ. $y = x^2 \ln x$

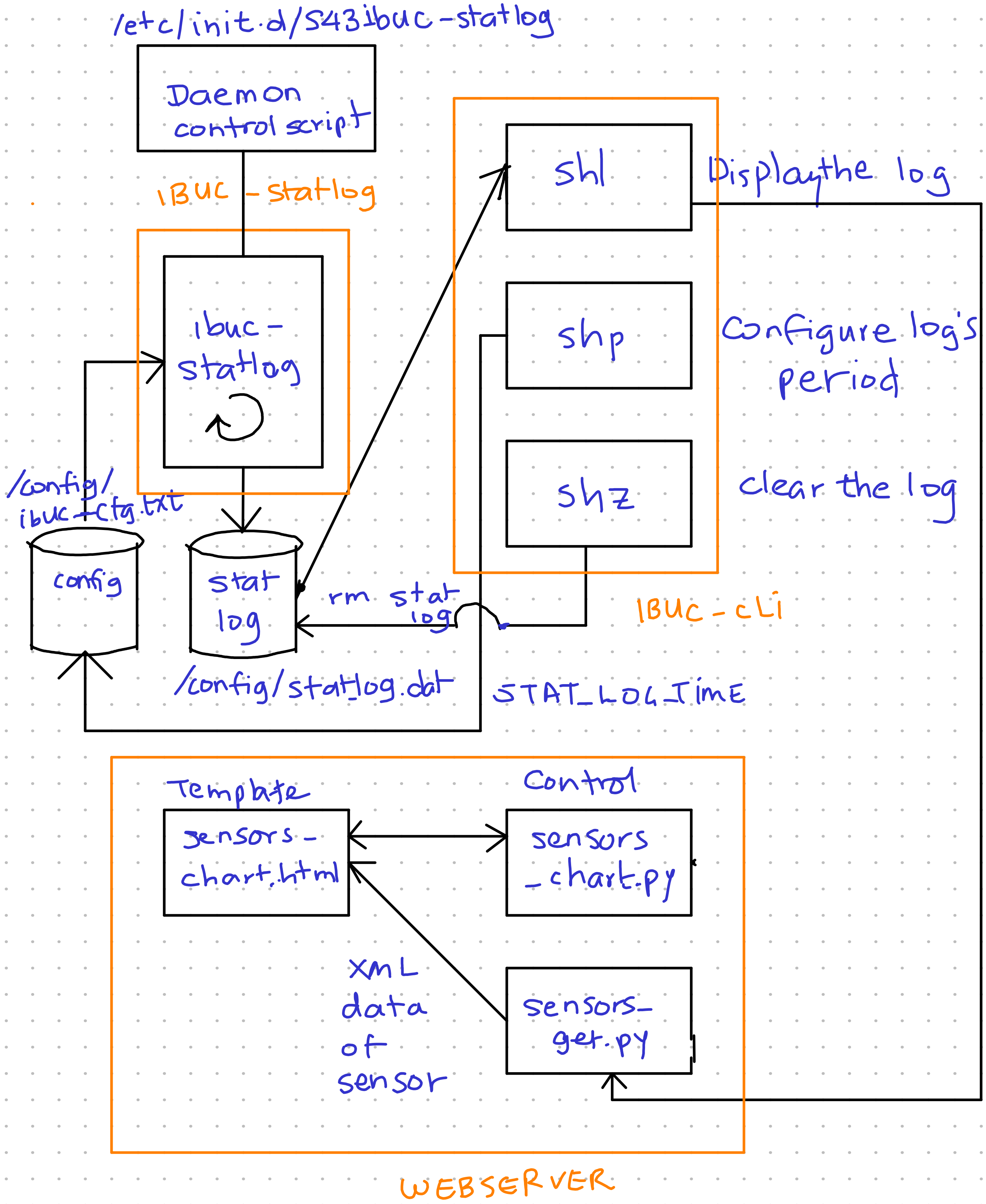
$$= x^2 \frac{dy}{dx} \ln x + \ln x \frac{dy}{dx} x^2$$



Rx 1+1 system.



LBand
LNB
22KHz
10MHz
DC Power
LBand
DC
Mux
22 KHz
10 MHz
Power DC
LBand modem
1
2
LBand
22 KHz
10 MHz
DC Power
LNB


/etc/init.d/S43ibuc-statlog
Daemon control script
IBUC - statlog
ibuc-statlog
/config/ibuc-cfg.txt
config
stat log
/config/statlog.dat
rm stat log
shl
Display the log
shp
Configure log's period
shz
clear the log
IBUC - CLI
STAT_LOG_TIME
Template
sensors_chart.html
Control
sensors_chart.py
XML data of sensor
sensors_get.py
WEBSERVER

times

Trignometry identities.

(I) $\cos f_1 \times \sin f_2 = \frac{1}{2}\left(\sin(f_1 - f_2) + \sin(f_1 + f_2)\right)$

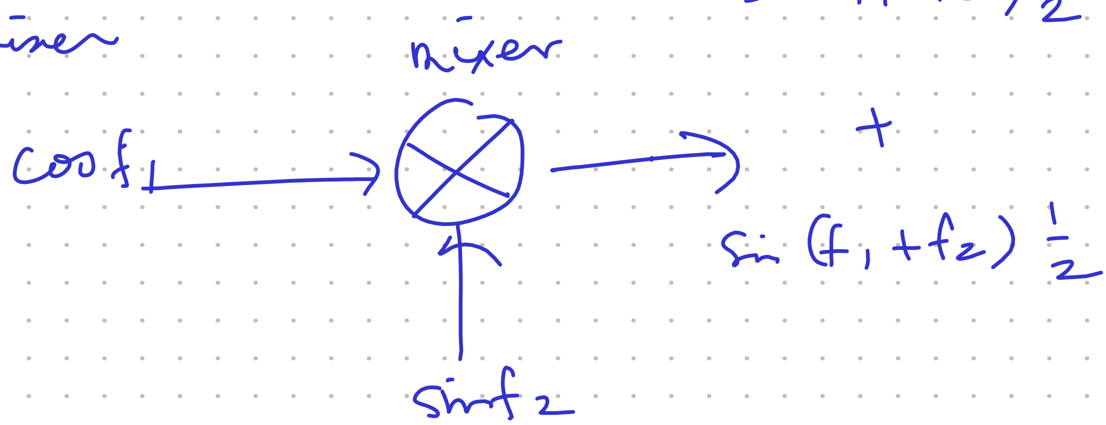
freq1

freq2

sin of diff of freq

sin of sum of freq

two freq are multiplied as in a mixer



(II) $\cos f_1 \times \cos f_2 = \frac{1}{2}\left(\cos(f_1 - f_2) + \cos(f_1 + f_2)\right)$

freq1

freq2

cosine though

diff

sum

but of cosine

HYPERBOLIC identities

$$\sinh x = \frac{e^{x} - e^{-x}}{2}$$

$$\cosh x = \frac{e^{x} + e^{-x}}{2}$$

$$\tanh x = \frac{e^{x} - e^{-x}}{e^{x} + e^{-x}}$$

Hyperbolic identities

$$\sinh x = x + \frac{x^3}{3!} + \frac{x^5}{5!} + \dots$$

$$\cosh x = 1 + \frac{x^2}{2!} + \frac{x^4}{4!} + \dots$$

$$\sinh^{-1} x = \ln\left\{x + \sqrt{x^2+1}\right\}$$

$$\cosh^{-1} x = \pm\ln\left\{x + \sqrt{x^2-1}\right\}$$

$$\tanh^{-1} x = \frac{1}{2}\ln\left\{\frac{1+x}{1-x}\right\}$$

Inverse hyperbolic in terms of Log.

$$\coth x = \frac{1}{\tanh x}$$

$$\operatorname{sech} x = \frac{1}{\cosh x}$$

$$\operatorname{cosech} x = \frac{1}{\sinh x}$$

further Identities

$$\cosh x + \sinh x = e^{x}$$

$$\cosh x - \sinh x = e^{-x}$$

$$\cosh^2 x - \sinh^2 x = 1$$

$$\operatorname{sech}^2 x = 1 - \tanh^2 x$$

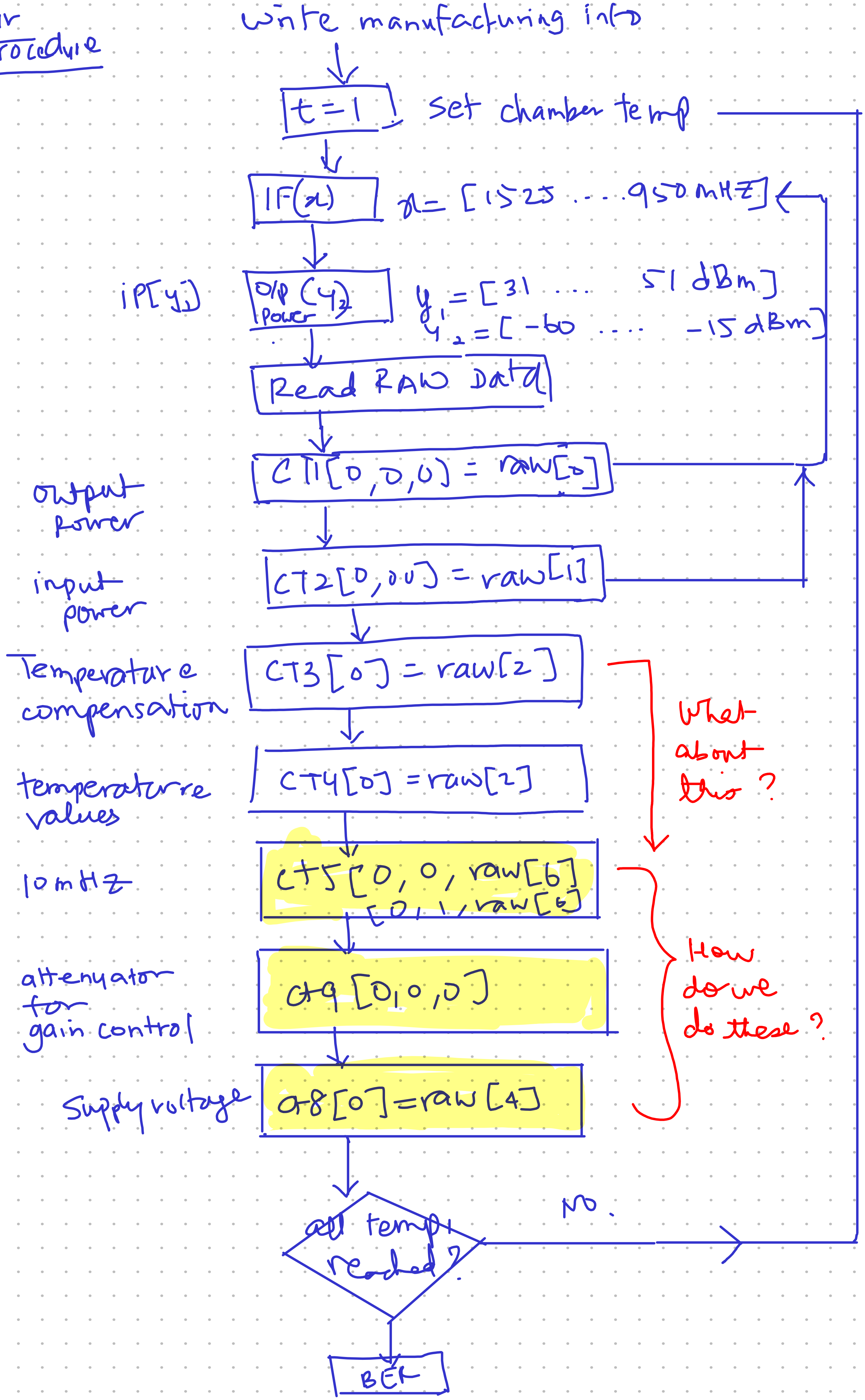
$$\operatorname{cosech}^2 x = \coth^2 x - 1$$

$$\cos\theta = \cosh j\theta$$

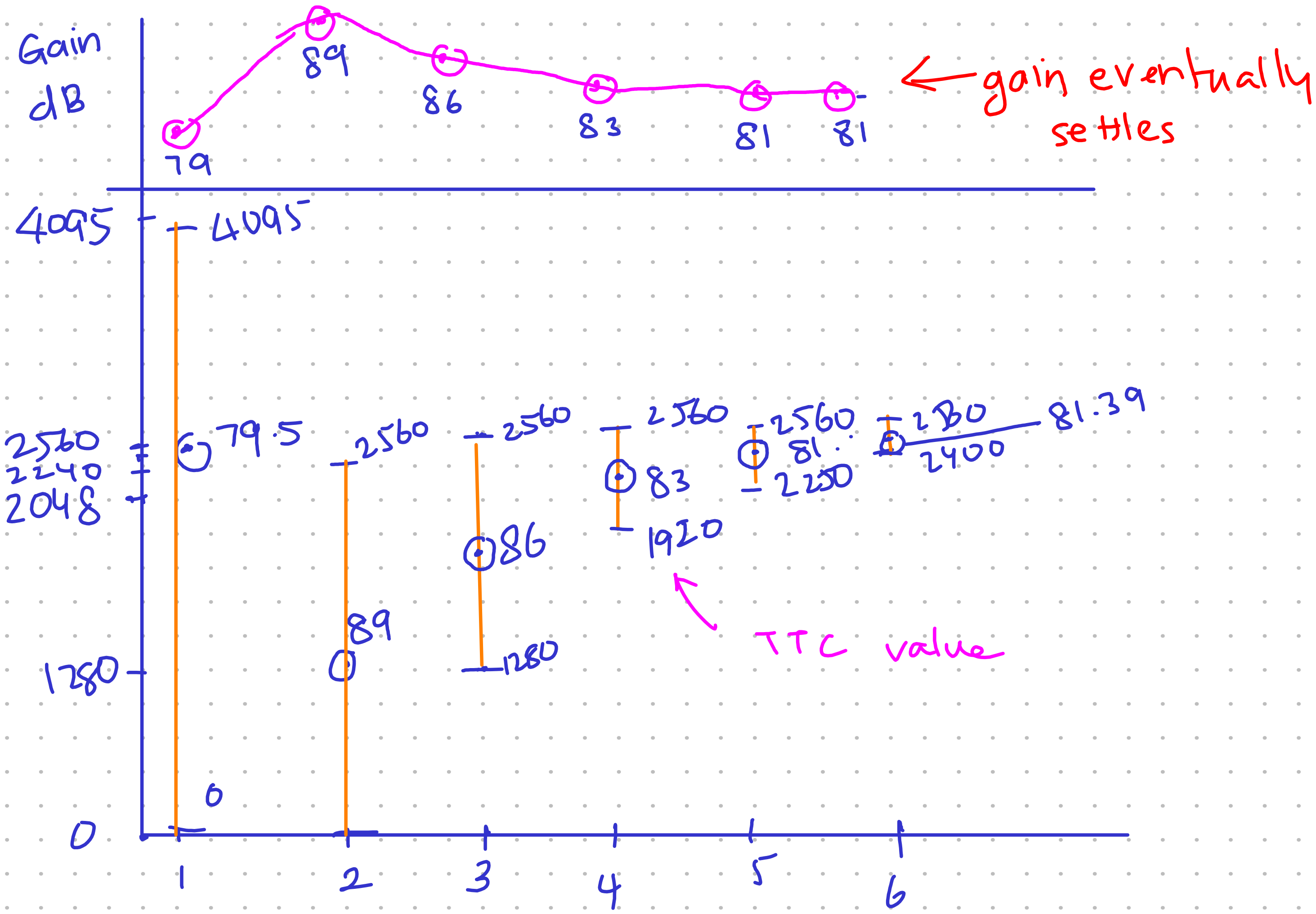
$$\sinh j\theta = j\sin\theta$$

$$\cosh x = \cos jx$$

Our procedure



CT3 Calibration procedure

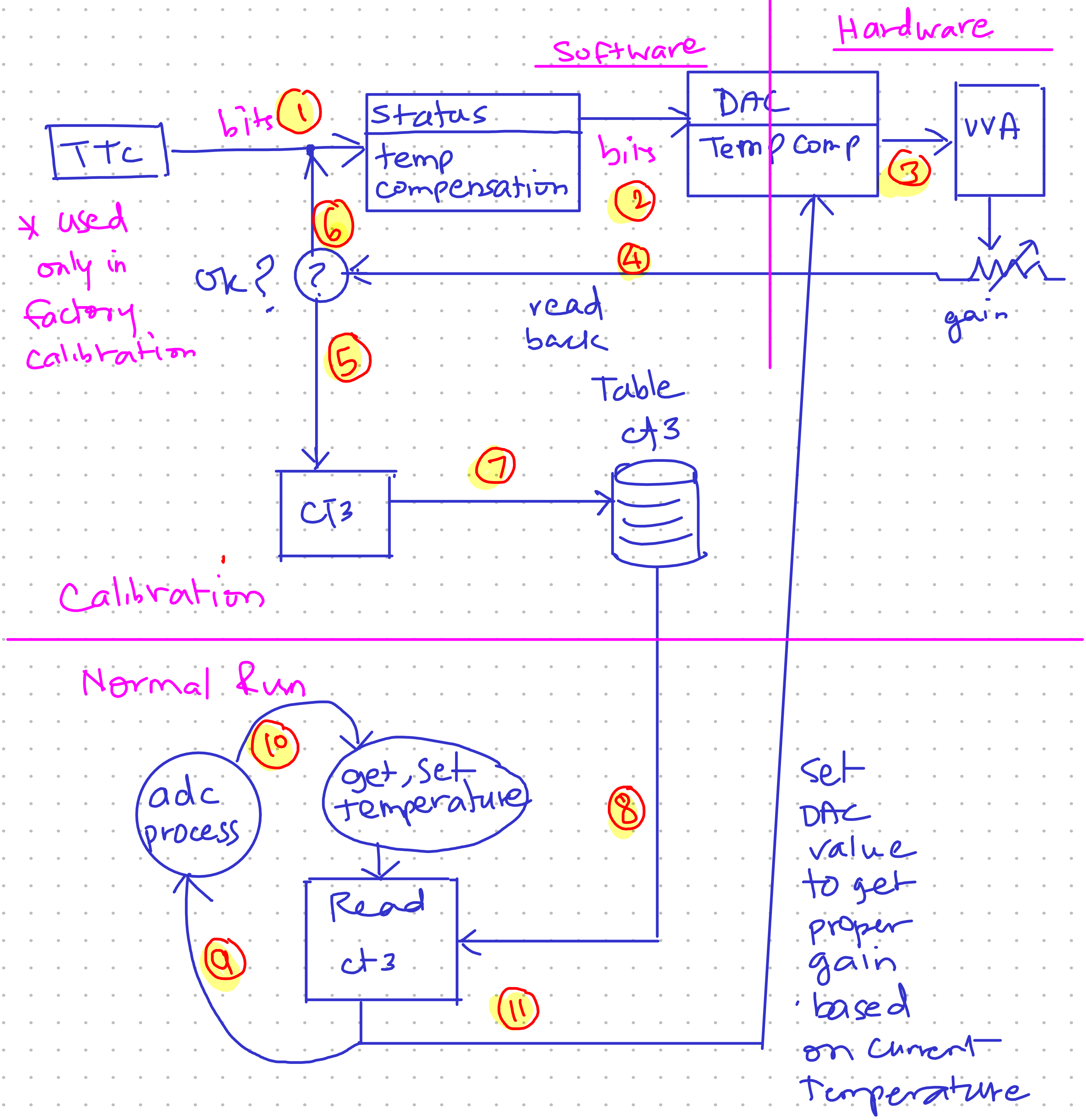


⊗ The ATE tries to set different TTC values. Specifically tries a low, mid high value and sees the desired gain. Then changes the band to get closer to desired gain. It then gets the TTC value and sets to CT3.

Q: Why we need a range of values for TTC and get only one value for gain ?

Ex:- TTC = 0 → 2560 → 4095

but Gain = 79.54 dB


Software
Hardware
TTC
bits
1
Status
temp compensation
bits
2
DAC
Temp Comp
3
VVA
4
gain
read back
ok?
?
6
5
* used only in factory calibration
Table ct3
7
CT3
Calibration
Normal Run
10
adc process
get, set temperature
8
Read ct3
9
11
Set DAC value to get proper gain based on current Temperature

Green LED:	Flashing RED	Solid RED
• TPT=0 • cm1= 0X6E0 cm2 = 0X091C cms = 0X00FA • TA2=1	cm1=0X00FA TA2=0	cm2=0X00FA
1	2	3

1. Basically we are making TA2=1 which masks all LEDs and the LED become Green

2. cm1 = 0X00FA
   ↳ makes all configurable alarm as minor
   then TA2=0, turns off supression and the LED blinks red.

3. finally we make cm2=0X00FA which makes all configurable alarm as major.
   then TA2=1, turns off suppression and LED stays RED.

$$\frac{d\theta}{ds} = \frac{1}{R} = \frac{\frac{d^2y}{dx^2}}{\left\{1 + \left(\frac{dy}{dx}\right)^2\right\}^{3/2}}$$

So: $$R = \frac{\left\{1 + \left(\frac{dy}{dx}\right)^2\right\}^{3/2}}{\frac{d^2y}{dx^2}}$$

Differential applications

(32)

$$y^2 = \frac{x^3}{4} \quad \text{at} \quad \left(1, \frac{1}{2}\right)$$

$$y = \sqrt{\frac{x^3}{4}} = \frac{x^{3/2}}{2}$$

$$\frac{dy}{dx} = \frac{3x^{1/2}}{2 \cdot 2} = \frac{3}{4}x^{1/2} \quad \text{at } 1, \frac{1}{2} = \frac{3}{4}$$

$$\frac{d^2y}{dx^2} = \frac{1}{2} \cdot \frac{3}{4} \cdot x^{-1/2} = \frac{3}{8}x^{-1/2} = \frac{3}{8}$$

$$R = \frac{\left\{1 + \left(\frac{3}{4}\right)^2\right\}^{3/2}}{3/8}$$

$$= \frac{\left(1 + \frac{9}{16}\right)^{3/2}}{3/8} = \frac{\left(\frac{16+9}{16}\right)^{3/2}}{3/8} =$$

$$= \left(\frac{25}{16}\right)^{3/2} = \left(\frac{5}{4}\right)^3 \times \frac{8}{3} = \frac{125}{64} \times \frac{8}{3} = \frac{125}{8 \times 3} = \frac{125}{24}$$

$$R = \frac{125}{24}$$

Converting dBm to watts and get "pp"

① -14 dBm ⇒

$$-14 = 10\log_{10}(P_0)$$

$$\frac{-14}{10} = \log_{10}(P_0)$$

$$-1.4 = \log_{10}(P_0)$$

$$P_0 = 10^{-1.4}$$

$$= \frac{1}{10^{1.4}}$$

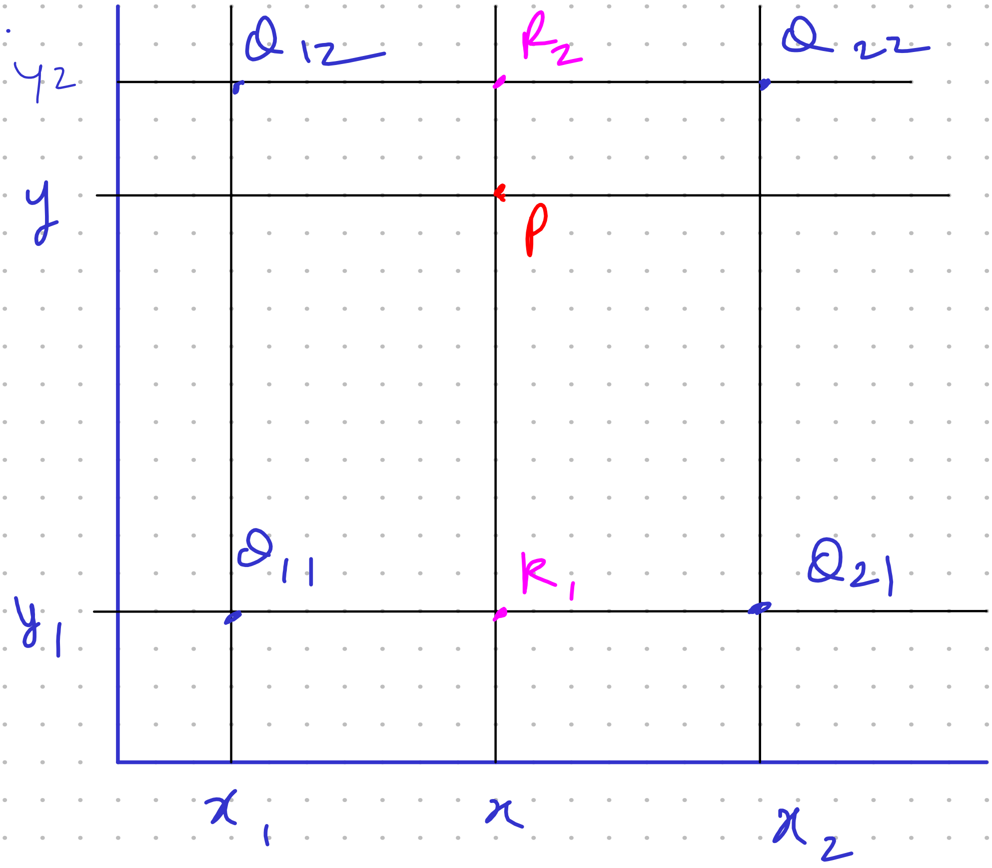
$$P_0 = \frac{1}{25.12}\ W$$

$$P_0 = 0.039\ W$$

$$P = I \cdot V \cdot \cos\theta$$

$$= I \cdot V$$

⇒ I is unknown
V → can't be known
P ⇒ known.



$$R_1 = Q_{11}\frac{(x_2 - x)}{(x_2 - x_1)} + Q_{21}\frac{(x - x_1)}{x_2 - x_1)}$$

$$R_2 = Q_{12}\frac{(x_2 - x)}{(x_2 - x_1)} + Q_{22}\frac{(x - x_1)}{(x_2 - x_1)}$$

$$P(x, y) = R_1\frac{(y_2 - y)}{(y_2 - y_1)} + R_2\frac{(y - y_1)}{(y_2 - y_1)}$$

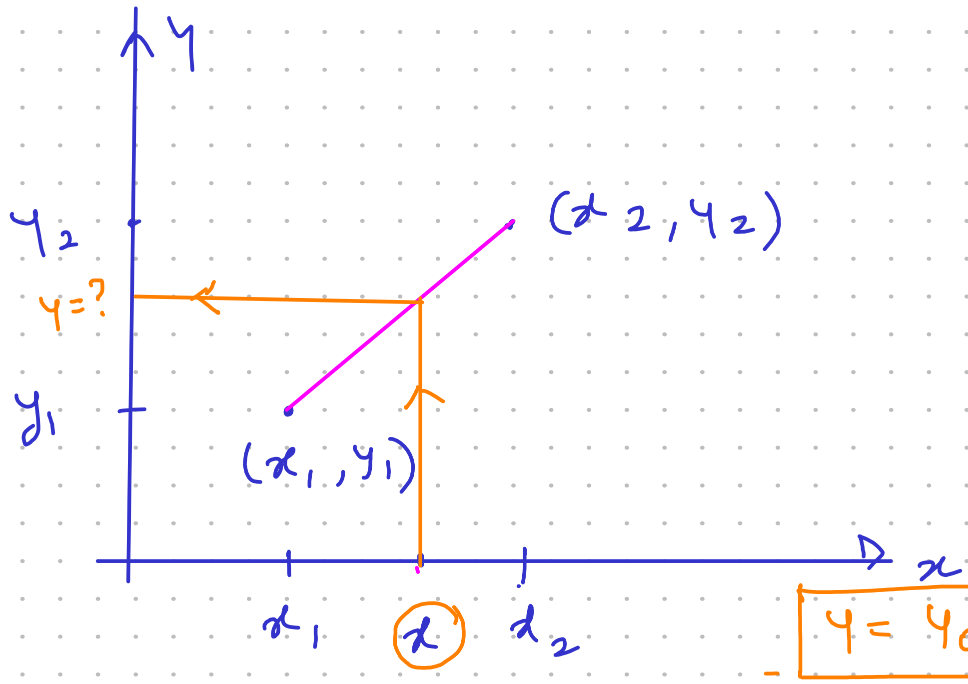
Not sure about above ?

Linear Interpolation

For linear interpolation, we need to know the value of x and the $(x,y)_1$ & $(x,y)_2$ cordinates. We find corresponding value of y wrt x.

So:

$$y = y_1 + \frac{(x-x_1)(y_2-y_1)}{x_2-x_1}$$



Crux

$$\boxed{y = y_{off} + (\Delta x \cdot m)}$$

Ex: $x = 4$, $P_1(2, 4)$ $P_2(6, 7)$, with x_1, y_1 over $(2, 4)$ and x_2, y_2 over $(6, 7)$

$$y = \underbrace{4}_{y\text{ offset}} + \frac{\overbrace{\boxed{(4-2)}}^{x\text{ delta}}\overbrace{(7-4)}^{\text{Slope}}}{(6-2)}$$

$$= 4 + \frac{2(3)}{4}$$

$$= 4 + \left(\frac{3}{2}\right) = \frac{8+3}{2} = \frac{11}{2} = \underline{5.5}$$

- $\boxed{\text{Partial Differentiation}}$

$z = (4x - 2y)(3x + 5y)$ page 671. $\boxed{7}$

$\frac{\partial z}{\partial x}$ & $\frac{\partial z}{\partial y}$

$\frac{\partial z}{\partial x} = (4x - 2y)(3) + (3x + 5y)(4)$

$\frac{\partial z}{\partial y} = (4x - 2y)5 + (3x + 5y)(-2)$

$\rightarrow \quad 12x - 6y + 12x + 20y$

$\frac{\partial z}{\partial x} \rightarrow \quad 24x + 14y$

$\frac{\partial z}{\partial y} \Rightarrow \quad 20x - 10y - 6x - 10y$

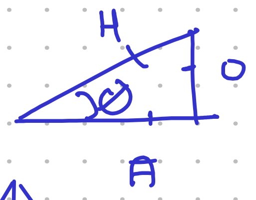
$\rightarrow \quad 14x - 20y$

Meaning of Tone

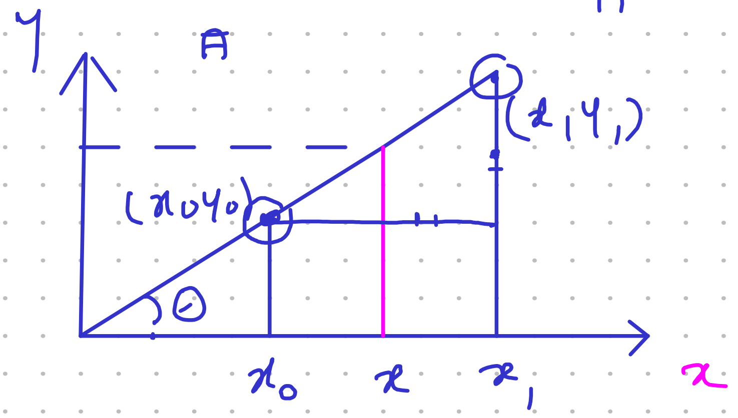
A simple tone will have one frequency while a complex tone will have two or more simple tones known as overtones.

Interpolation using trignometric identities

TIP:



$\sin\theta = \frac{O}{H}$ $\quad \cos\theta = \frac{A}{H}$ $\quad \tan\theta = \frac{O}{A}$



$$\text{slope} = \frac{dy}{dx} = \frac{y_1 - y_0}{x_1 - x_0} = m$$

1. so: $\tan\theta = \dfrac{y - y_0}{x - x_0}$ find θ first

$$\theta = \tan^{-1}\left(\frac{y - y_0}{x - x_0}\right)$$

2. so:- $\cos\theta = \dfrac{A}{H}$

$$\cos\theta = \frac{x - x_0}{y - y_0}$$ use θ for $\frac{A}{H}$ calc.

$$(y - y_0) = \frac{x - x_0}{\cos\theta}$$

$$\boxed{y = \left(\frac{x - x_0}{\cos\theta}\right) + y_0}$$

ct8[0] = 0.985

ct8[1] = 0.990

wt1 = −49.75

wt2 = 50.75

cal-factor = 0.985 × (−49.75)
+ 0.990 × (50.75)

cal factor = 1.23875

so voltage = calculated × 1.23875

if calc = 110 = 110 × 1.2385
= 136

if calc = 98 → 98 × 1.23875
⇒ $\boxed{128}$

Glossary:

1. VSAT:- very small aperture terminal (Not virtual satellite) !

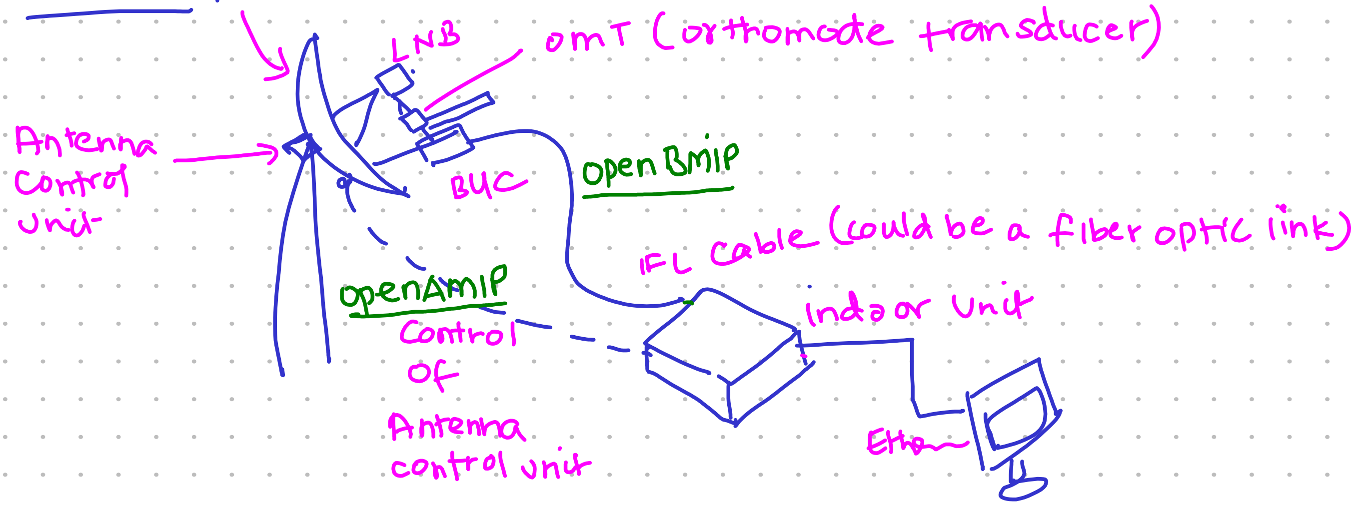
narrow band data is used in

- point of sale transactions
- polling or RFID Data
- SCADA

Broadband.

+ Satellite internet
+ VOIP
+ video.

VSAT: Antenna



Speed seem to be from 4kbit/s to 16mb/s.

• Note: modem manufacturers now support RX range of 950-2150 MHz

$\Sigma x = 2.2$, $\Sigma y = 13.4$, $\Sigma x^2 = 20.34$, $\Sigma xy = 61.31$, $n = 5$

eq①:

$$an + b\Sigma x = \Sigma y$$
$$a\Sigma x + b\Sigma x^2 = \Sigma xy$$

$$a5 + b(2.2) = 13.4$$
$$a(2.2) + b(20.34) = 61.31$$

$$\rightarrow 5a + 2.2b = 13.4$$
$$2.2a + 20.34b = 61.31$$

10, 14 $d = 4$

14, 10 $d = -4$

Arithmatic Series

$$S_n = \frac{n}{2}(2a + (n-1)d)$$

$10 + 6 + 2 - 2 - 6 - 10 - 14 - 18 -$

$n = 20$

$a = 10$

$d = -4$

$$S_{20} = \frac{20}{2}(2 \times 10 + (20-1)(-4))$$
$$= 10(20 + (19 \times -4))$$
$$= 10(20 + -76)$$
$$= 10(-56)$$
$$= -560$$

- <u>Mathematical terms that I tend to get confused with often</u>

① <u>Binomial expression</u>

Expression = a statement

equation = one or more expression

So expression that is binomial involves "bi" two variables.

$$ax^m + bx^n$$

Note its a two term polynomial

① $4x^2 + 5y^2$

② $m + 2n$

③ $x^2 + 3$

<u>Binomial equation</u>:

contains one or more binomial expression

$x^2 + 2xy + y^2 = 0$

$V = u + \frac{1}{2} at^2$

<u>Monomial</u> is an expression of only single term

① p

② $5p^2$

There parents are <u>polynomials</u>

Poly - many
nominal - terms

$\boxed{\text{polynomial}}$

Properties

Monomial
x^2, $2x$

Binomial
$x+y^2$
$a+2b$

Trinomial
$x^2+2x+20$

degree

1 Linear Polynomial
$3x-9=0$

2 Quadratic polynomial
$3x^2-6x+x-18=0$

3 Cubic Polynomial
ax^3+bx^2+cx+d

0

Tools

factorization

GCD

Division

Integration by substitution

① $\int (5x-4)^6 \, dx$ substitute: $z = (5x-4)$

$\rightarrow \int z^6 \, dx$

$\rightarrow \int z^6 \frac{dx}{dz} \, dz$ can be removed

$$\frac{dx}{dz} = \frac{1}{\frac{dz}{dx}} = \frac{1}{\frac{d(5x-4)}{dx}} = \frac{1}{5}$$

step ①

→ So Integration becomes

$\Rightarrow \int z^6 \frac{1}{5} \, dz$

$\Rightarrow \frac{1}{5} \int z^6 \, dz$

$\Rightarrow \frac{1}{5} \frac{z^7}{7} + C$

$\Rightarrow \frac{z^7}{35} + C$

step ②

So: $\int (5x-4)^6 \, dx = \frac{(5x-4)^7}{35} + C$

z

$\int \cos(2x+5)\,dx$ $\qquad z = 2x+5$

$\Rightarrow \int \cos z \frac{dx}{dz}\, dz$

$\Rightarrow \frac{dx}{dz} = \frac{1}{\frac{dz}{dx}} = \qquad \therefore \frac{dz}{dx} = \frac{d(2x+5)}{dx} = 2$

$\Rightarrow \frac{dx}{dz} = \frac{1}{2}$

$\Rightarrow \int \cos z \frac{1}{2}\, dz$

$\Rightarrow \frac{1}{2} \int \cos z\, dz$

$\Rightarrow \frac{1}{2} \sin z + c$ — (1)

Substitute $z = (2x+5)$ in (1)

(1) becomes $\frac{1}{2} \sin(2x+5) + C$

③ $\int \sec^2 x \, dx = \tan x + C$

so $\int \sec^2 4x \, dx$

↳ take derivative & divide

$\Rightarrow \frac{1}{4} \int \sec^2 4x + C$

$\Rightarrow \boxed{\frac{1}{4} \tan 4x + C}$

④. $\int \frac{1}{x} \, dx = \ln(x) + C$

$\therefore \int \frac{1}{2x+3} \, dx = \ln(2x+3)$ & $\frac{d}{dx}(2x+3)$ & divi

$\Rightarrow \ln(2x+3) \cdot (2)$ & divide

$\Rightarrow \frac{1}{2} \ln(2x+3) + C$

⑤ $\int \sinh x \, dx = \cosh x + C$

$\therefore \int \sinh(3-4x) = \frac{\cosh(3-4x)}{4} + C$

⑥ $\int \sin x \, dx = \cos x + C$

so $\int \sin 3x \, dx = \cos 3x \cdot \frac{1}{3} + C$

$= \frac{\cos 3x}{3} + C$

⑦ $\int e^x \, dx = e^x + C$

$\int e^{4x} \, dx = e^{4x} \cdot \frac{1}{4} + C = \frac{e^{4x}}{4} + C$

⑦ $\int (2x-7)^3 \, dx \Rightarrow$

make $z = (2x-7)$

$I = \int z^3 \frac{dx}{dz} . dz$

$\frac{dx}{dz} = \frac{1}{\frac{dz}{dx}} \rightarrow \frac{1}{\frac{d}{dx}(2x-7)} = \frac{1}{2}$

So I becomes

$\frac{1}{2} \cdot \int z^3 \, dz$

$\Rightarrow \frac{1}{2} \frac{z^4}{4} + C$

make z as $(2x-7)$ again

$\Rightarrow \frac{1}{2} \frac{(2x-7)^4}{4} + C$

$\Rightarrow \frac{(2x-7)^4}{8} + C \rightarrow \frac{(2x-7)^4}{8} + C$ ✓

(2) $\int \cos(7x+2)\,dx$

$\rightarrow \sin(7x+2)\,\frac{1}{7} + C$ ✓

(3) $\int e^{5x+4}\,dx$

$\rightarrow e^{5x+4} \cdot \frac{1}{5} + C = \frac{e^{5x+4}}{5} + C$ ✓

(4) $\int \sinh 7x\,dx$ ✓

$\rightarrow \cosh 7x \cdot \frac{1}{7} + C \Rightarrow \frac{\cosh 7x}{7} + C$

(5) $\int \frac{1}{(4x+3)}\,dx \Rightarrow$

$\rightarrow \frac{\ln(4x+3)}{4} + C$ ✓

(6) $\int \frac{1}{1+(2x)^2}\,dx = \cancel{\frac{\ln(1+(2x)^2) \cdot 8x^3}{3}}$ $\frac{\tan^{-1}(2x)}{2} + C$

(7) $\int \sec^2(3x+1)\,dx \rightarrow \frac{\tan(3x+1)}{3}$ ✓

(8) $\int \sin(2x-5)\,dx \rightarrow \frac{\cos(2x-5)}{2}$ ✓

(9) $\int \cosh(1+4x)\,dx \Rightarrow \frac{\sinh(1+4x)}{4}$ ✓

(10) $\int 3^{5x}\,dx \Rightarrow \cancel{\frac{3^{5x}}{\ln(5)}} + C \quad \frac{3^{5x}}{5\ln(3)} + C$

Summation

① $e^x = \sum_{r=0}^{\infty} \frac{x^r}{r!} = \frac{x^0}{0!} + \frac{x^1}{1!} + \frac{x^2}{2!} + \frac{x^3}{3!} + \frac{x^4}{4!} + \dots$

$= \frac{1}{1} + \frac{x}{1} + \frac{x^2}{2!} + \frac{x^3}{3!} + \frac{x^4}{4!} +$

$= 1 + x + \frac{x^2}{2!} + \frac{x^3}{3!} + \frac{x^4}{4!} + \dots$

② $\sum_{r=1}^{n} f(r) = f(1) + f(2) + f(3) + f(4) + \dots f(n)$

③ $\sum_{r=1}^{n} r = \frac{n(n+1)}{2}$ Remember this proof.

Integration I : 811pg. #15

1). $\int \frac{\sec^2 x}{\tan x} dx = \ln(\tan x) + c$ ✓

2). $\int \frac{2x+4}{x^2+4x-1} dx = \ln(x^2+4x-1) + c$ ✓

3) $\int \frac{\sinh x}{\cosh x} dx = \ln(\cosh x) + c$ ✓

4). $\int \frac{x-3}{x^2-6x+2} dx =$ 1st $\frac{1}{2}(2x-6) = x - 3$

so $\frac{1}{2} \int \frac{(2x-6)}{x^2-6x+2} dx$

$= \frac{1}{2} \ln(x^2-6x+2) + c$ ✓

page 813 when one product is derivate of another.

$$\int \sinh x \cosh x \, dx = \int \sinh x \, d(\sinh x)$$
$$= \boxed{\frac{\sinh^2 x}{2} + c}$$

19

1. $\int \frac{(2x+3)\,dx}{x^2+3x-7} \rightarrow \boxed{\ln(x^2+3x-7)+c}$ ✓

2. $\int \frac{\cos x}{1+\sin x} \, dx \rightarrow \boxed{\ln(1+\sin x)+c}$ ✓

3. $\int (x^2+7x-4)(2x+7)\,dx \rightarrow \int (x^2+7x-4)\,d(x^2+7x-4)$

$\rightarrow \boxed{\frac{(x^2+7x-4)^2}{2} + c}$ ✓

4. $\int \frac{4x^2}{x^3-7} \, dx \rightarrow$ Num $\Rightarrow 4x^2 \Rightarrow$

$\frac{d}{dx} x^3 \Rightarrow 3x^2 \Rightarrow \frac{4}{3} \cdot 3(x^2)$

eq. can be written as $\frac{4}{3} \int \frac{3x^2}{x^3-7} \, dx$

$\Rightarrow \boxed{\frac{4}{3} \ln(x^3-7) + c}$ ✓

Rules for partial fractions

(1) Numerator must be lower degree than denominator

(2). Factorize the denominator. It shows how the function shapes out

(3). linear factor $(ax+b) \to \dfrac{A}{ax+b}$

(d). Factors $(ax+b)^2 \to \dfrac{A}{ax+b} + \dfrac{B}{(ax+b)^2}$

(e) Factors $(ax+b)^3 \to \dfrac{A}{(ax+b)} + \dfrac{B}{(ax+b)^2} + \dfrac{C}{(ax+b)^3}$

(f) Quadratic factor $(ax^2+bx+c) \to \dfrac{Ax+B}{ax^2+bx+c}$

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(1).

$$x^2+1 = A(x+2)^2 + B(x+2) + C \qquad C=5$$

The coefficient of $(x+2)^2$ is A & is '1' so $A=1$

$$\therefore 1 = 4A + 2B + C$$

$$\boxed{C=5,\ A=1}$$

$$1 = 4 + 2B + 5$$

$$1 = 2B + 9$$

$$2B = 1 - 9 = -8 \quad \to \quad 2B = -8$$

$$\boxed{B=-4}$$

$$\int \frac{x^2+1}{(x+2)^3}\,dx = \int \frac{1}{x+2} - \int \frac{4}{(x+2)^2} + \int \frac{5}{(x+2)^3}$$

$$= \ln(x+2) - \frac{4}{-1(x+2)} + \frac{5}{-2(x+2)^2} + C$$

$$= \ln(x+2) + \frac{4}{(x+2)} - \frac{5}{2(x+2)^2} + C$$

$$x^2 = A(x^2+1) + (x-2)(Bx+c)$$

Put $x=2$ for calculating A

$$4 = A(4+1) + 0$$

$$4 = A(5)$$

$$\boxed{A = \frac{4}{5}}$$

Now:

$$x^2 = A(x^2-2x+1) + B(x^2-1) + c(x+1)$$

$$= Ax^2 - 2Ax + A + Bx^2 - B + Cx + C$$

So coefficient of "x^2"

are $1(x^2) = A(x^2) + B(x^2)$

$$B = 1 - A = 1 - \frac{4}{5} = \boxed{\frac{1}{5}}$$

$$(x^2+1) = A(x+2)^2 + B(x+2) + c$$

$$x^2+1 = A(x^2+2x+4) + Bx + 2B + C$$

$$x^2 = Ax^2 + 2Ax + 4A + Bx + 2B + C$$

$\boxed{1 = A}$ equate coefficient of "x^2"

To find out "c"

$$x^2 + 1 = Ax^2 + 2Ax + 4A + Bx + 2B + C$$

coeffient of constants only :

$$1 = 4A + 2B + C$$

$$1 = 4 + 2B + 5$$

$$2B = 1 - 9$$

$$2B = -8$$

$$\boxed{B = -4}$$

(5) pg 824.

$$\int \frac{4x^2+1}{x(2x-1)^2}\,dx$$

$$= \frac{A}{x} + \frac{B}{(2x-1)} + \frac{C}{(2x-1)^2}$$

$(4x^2+1) = A(2x-1)^2 + Bx(2x-1) + Cx$

put $\boxed{(2x-1)=0}$ to get c

$\boxed{x = \frac{1}{2}}$ &

$4\left(\frac{1}{2}\right)^2 + 1 = A(0) + B(0) + C\left(\frac{1}{2}\right)$

$\frac{4}{4} + 1 = 4\left(\frac{1}{2}\right)$

$1 + 1 = C\left(\frac{1}{2}\right)$

$2 = \frac{C}{2}$

$\boxed{C=4}$

Equate power of x^2

$4\cancel{x^2} = 4A\cancel{x^2}$

$4 = 4A + 2B$ Highest coefficient.

So:

$\boxed{1 = A}$ lowest coefficient

$4 = 4 + 2B$

$2B = 0$ $B = 0$

$A = 1, \; C = 4, \; B = 0$

$$I = \int \frac{1}{x} + \int 0 + \int 4(2x-1)^{-2}\,dx$$

$$= \ln(x) + \frac{4(2x-1)^{-1}}{-1 \times (2)} + C$$

$$= \ln(x) - 2(2x-1)^{-1} + C$$

$$= \boxed{\ln(x) - \frac{2}{2x-1} + C}$$

I. AC ckts

1. combine AC ckts
   - diff V
   - diff f

2. Calculate AC: V, I, P
   - (a) V_{Rms}
   - (b) I_{Rms}
   - (c) P_{Rms}

   because Rms power is actually used and meaningful.

II. Capacitance

1. Capacitance
2. Current in Capacitor
3. voltage in Capacitor
4. Energy in Capacitor
5. RC time constant
6. Cap in Parallel
7. Cap in Series

   DC

8. AC current in Capacitor
   - (a) Capacitive Reactance
   - (b). Capacitive Divider
   - (c). Quality factor $Q = \frac{X}{R}$ $\frac{\text{(Reactance)}}{\text{Resistance}}$

III Inductors

1. Electromagnetism
2. Self Inductance
3. Inductors
   - (a) Equations
   - (b) Energizing Inductors
   - (c) RL ckts
     - (i) V_L
   - (d) Deenergizing Inductors
   - (e) Inductors in
     - (i) Series
     - (ii) Parallel
4. AC current in Inductors
   - (i) Inductive Reactance
   - (ii) Quality factor
   - (iii) Inductive Divider

IV AC and complex numbers

V ckts

Series Impedence

- RL
- $\boxed{RC}$?
  Not covered
- LC
- RLC

Parallel Impedence

- $\boxed{RL}$?
  Not covered
- $\boxed{RC?}$
  Not covered
- LC
- RLC

Each find
- I
- V
- X

VI Impedences

- Input
- Output

VII

Filters

(a). High pass filter : RL

(b). Band pass filter : RLC

(c). Notch filter

(d) Attenuators

$$\int \frac{1}{x^2 + 10x + 18}$$

$$\text{Den} = x^2 - 2\cdot 5 \cdot x + 5^2 - 5^2 + 18$$

$$= x^2 - 10x + 5^2 - 7$$

$$= (x-5)^2 - (\sqrt{7})^2$$

$$= \int \frac{1}{(x-5)^2 - (\sqrt{7})^2}$$

$$\boxed{= \frac{1}{2\sqrt{7}} \ln \left\{ \frac{x - 5 - \sqrt{7}}{x - 5 + \sqrt{7}} \right\} + C}$$

(1) $\int_1^2 (2x-3)^4 \, dx$

$\Rightarrow \left[\frac{2x^2}{2} - 3x \right]_1^2$

$\Rightarrow \left[x^2 - 3x \right]_1^2$

$\Rightarrow \left[2^2 - 3 \cdot 2 \right] - \left[1^2 - 3 \cdot 1 \right]$

$\Rightarrow \left[4 - 6 \right] - \left[1 - 3 \right]$

$\Rightarrow \left[-2 \right] - \left[-2 \right]$

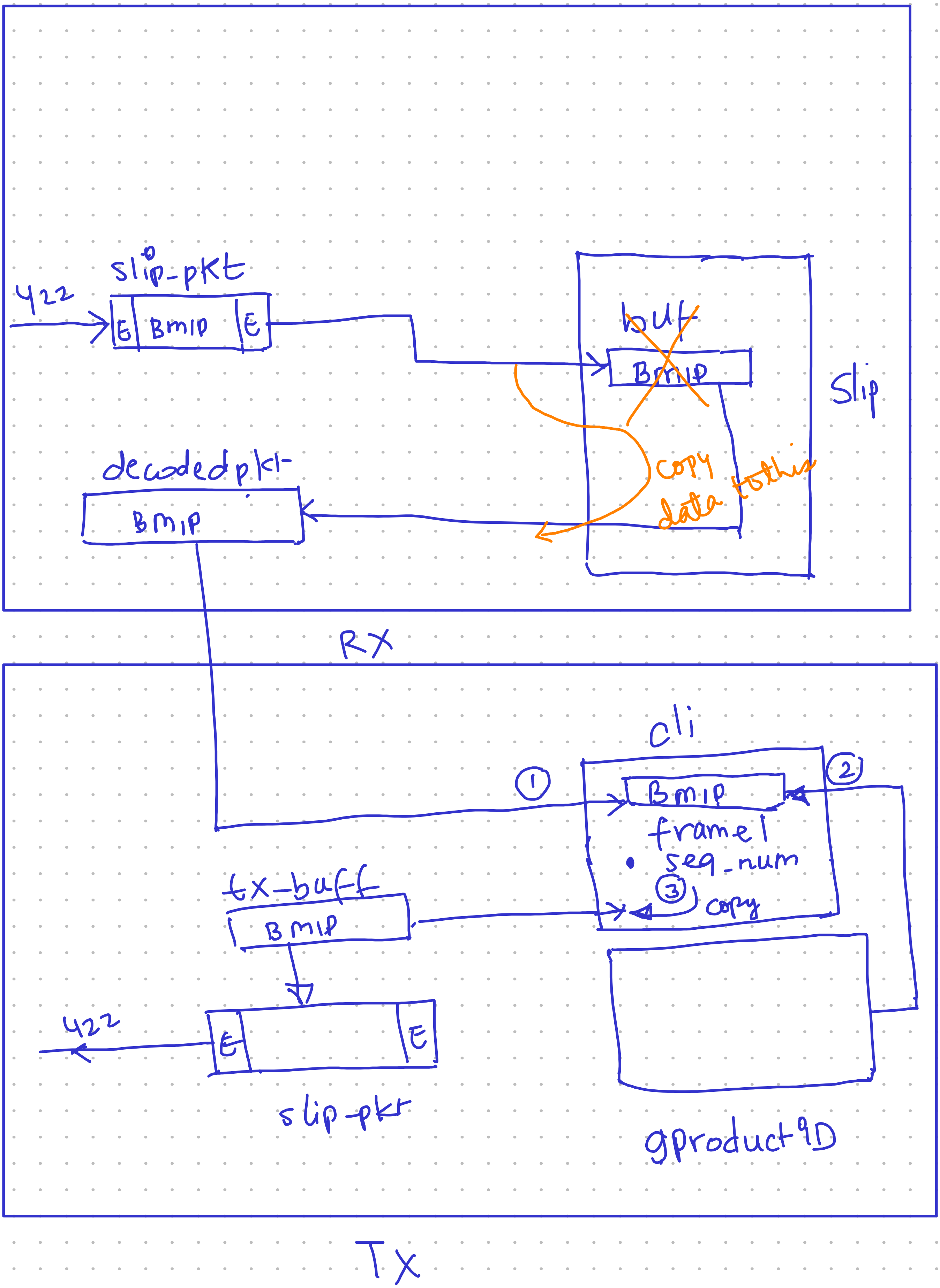
$\Rightarrow -2 + 2 \Rightarrow 0.$

0x 11ff

0001 0001 1111 1111

$\rightarrow$ 1110 1110 0000 0000

e e 00



422
slip_pkt
E
Bmip
E
buf
Bmip
slip
copy data to this
decodedpkt
Bmip
RX
cli
1
2
Bmip
frame
• seq_num
3
copy
tx_buff
Bmip
422
E
E
slip_pkt
gproductID
Tx

$$\left[\left(\frac{(x_1 - x_0)}{2}\right) + x_0\right]$$

$x_0 = 5850$

$x_1 = 6725$

$$= \left(\frac{6725 - 5850}{2}\right) + 5850$$

$$= \boxed{6287.5}$$

(1) Factory info.

(2) : Calibrate

(3) Run the unit | Status | (a)

based on pages

(1) info page
(2) sensor status
(3) alarm status
(4) Event log

} status.

Configuration (b)

(1). TX config
(2) : Alarm config
(3). : Sys config
(4) Interface config
(5) : Redundancy config
(6) : User config

SNMP (c).

(1) version
(2) : SNMP users
(3) : Notifications
(4) : Traps
(5) . Groups
(6) . ?

Definition of log

since
$y = P_{dB}$
$x = P_w$
$a = 10$

(1) $y = \log_a x$

$x = a^y$

(2) $P_{dB} = \log_{10}(P_w)$

$10^{P_{db}} = P_w$

$y = \log_{10} x$ } y shrank by 10 power

so:

$10^y = x$ } x increased by 10 ^ power

(3) for $P_{dBm} = 10 \cdot \log_{10}(P_{mw})$

$\therefore \frac{P_{dBm}}{10} = \log_{10}(P_{mw})$

$\therefore 10^{\left(\frac{P_{dBm}}{10}\right)} = P_{mw}$

x	y
1	10
2	100
3	1000
4	10000
5	100000
⋮	⋮

Normal scale

normal log scale

x	y
10	1
100	2
1000	3
10000	4

now $\frac{100}{10} = 10$ $\frac{1000}{10} = 100$

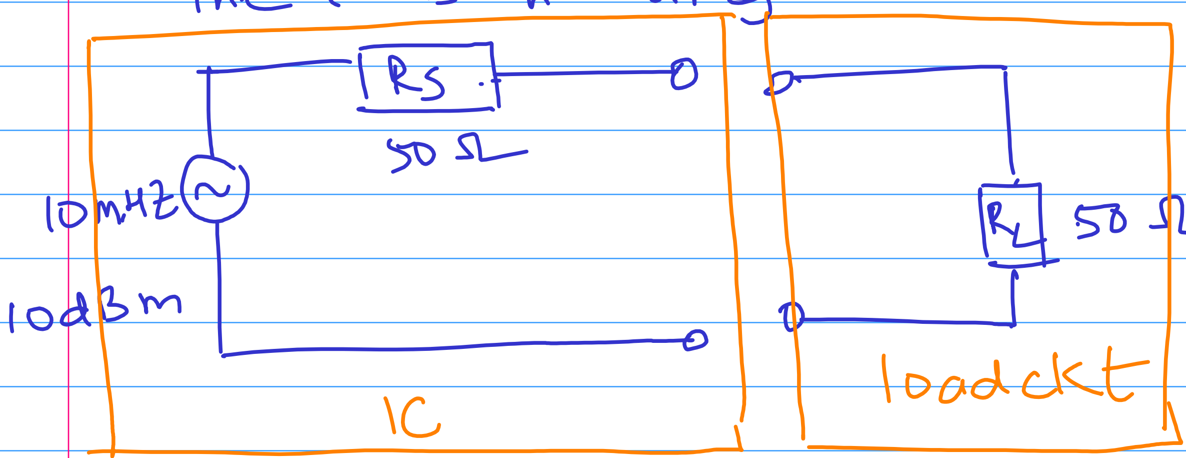
becomes $2 - 1 = 1$

$3 - 1 = 2$

(*) I got a spec of a 10 MHz device that outputs a power of 10 dBm. I was like why not 10 mV or 10 V? why 10 dBm?

A: So the answer is very interesting. 10 dBm is specified to indicate the power that the device can transfer. What I did not pay attention was the 50 Hz resistance that it has. So at 50 Hz internal resistance the device can transfer 10 dBm of power. So what about the sinusoid signal. What is the characteristic of that? First of all this IC is having a resistive source impedence, so the phase diff is '0'. One can put a diff ckt to it and have a diff load impedence and the power reduces. But in ideal condition, this is what it looks like:

The IC is nothing but



So for maximum power transfer, the Z_S should be same as Z_L. In this case, there is no reactance component like 'C' or 'L' and so $Z_S = Z_L = R$

NOW : $10\,dB_m = ?\ mW$

$$P_{mW} = 10^{\frac{10\,dBm}{10}}$$

$$= 10^1$$

$$\boxed{P_{mW} = 10\ mW}$$

So far we got to "mW" from dBm

Now :

$$P_{mW} = \frac{V_{L_{Rms}}^2}{R_L} \qquad \text{since } P = \frac{V^2}{R}$$

$$10 = \frac{V_{L_{Rms}}^2}{50}$$

$P_{mW} = 10\ mW$

$P_W = \frac{10}{1000}$

$= 0.01W$

$$0.01 \times 50 = V_{L_{Rms}}^2$$

$$\sqrt{0.5} = V_{L_{Rms}}$$

$$0.707 = V_{L_{Rms}}$$

$$V_{pp} = 2\sqrt{2} \cdot V_{Rms}$$

$$V_{pp} = 2 \times 1.414 \times 0.707$$

$$\boxed{V_{pp} = 2V}$$

That is how got from "10dBm" to "Vpp".

10dBm ideally is $2V_{pp}$ under a 50HZ load resistance ~~for~~ for max power transfer.