TOSHKENT DAVLAT TEXNIKA UNVERSITETI
ELIKTRONIKA VA AVTOMATIKA FAKULTETI

ELIKTRONIKA VA ASBOBSOZLIK KAFEDRASI

KURS ISHI

Mavzu; Bipolyar tranzistorlar asosidagi kuchaytrgich kaskadlarini xisoblash

Qabul qildi_____
108-11grux talabasi
Topshrdi _____

Mundarija

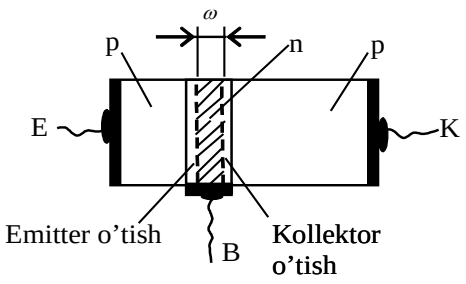
Kirish

Ishning maxsadi; radio texnik aparatlarni xisoblash natijasida amaliy malakani oshirish nazariy malakani olishdan iboratdir.zamonaviy texnikada signal kuchaytirgichlar keng qulanilmog'da televidiniyada, radioda, ovoz yozish,radiolakatsia va boshqa soxalarda kuchaytirgichlar asosan eliktr tulqinlarni uzgartmasdan kuchaytradi. Kuchaytrish manbaining eliktr enirgiyasi xisobiga sodir buladi. shuning uchun kuchaytrgichlarni boshqarish xisusiyatiga ega. Bu ishdan kurilayotgan kuchaytrgich xar xil vazipani bajarishga muljalangan. Tok kuchaytirgichlari deganda, shunday kuchaytirish kaskadlari tushuniladiki, ularda kirishdagi elektr tebranishlarning quvvat bo`yicha kuchaytirilishi tokning kuchaytirilishi hisobiga amalga oshadi. Tok kuchaytirgichlarida chiqish toki kirish tokidan ancha kattadir, chiqish kuchlanishi esa kirish kuchlanishidan kichikdir. Bu esa tok kuchaytirgich chiqishidagi qarshiligi R vix ning kirish qarshiligi Rvx dan kichikligini bildiradi.

Bu shart tok kuchaytirgichlarini past chastotali kuchaytirish qurilmalarining umumiy kompleksidagi o`rnini, nima uchun mo`ljallanganligini aniqlashda katta ahamiyat kasb etadi. Ko`p hollarda past chastotali kuchaytirish qurilmalari bir necha kaskadlardan iborat bo`ladi, Har bir oldingi kaskad keyingi kaskad uchun o`zgaruvchan elektr manbai bo`lib, keyingi kasakadning kirish zanjiri esa oldingi kaskad uchun yuklama bo`lib xizmat qiladi

Nazariy qism

TRANZISTORNING TUZILISHI VA ISHLASH PRINSIPI



1-rasm.Tranzistorning sodda tuzilishi

V.Shokli tomonidan yaratilgan 1945-1950 yillarda yaratilgan yassi tranzistor eng keng tarqalgan tranzistor turlari hisoblanadi.U ham kuchaytirish ham kalit vazifasini bajarish mumkin ya’ni elektron sxemalar uchun universal element bo‘ladi. Tranzistor ikki o‘tishli asbob bo‘lib, o‘tishlar uchta qatlam chegarasidahosil bo‘ladi (1-rasm).

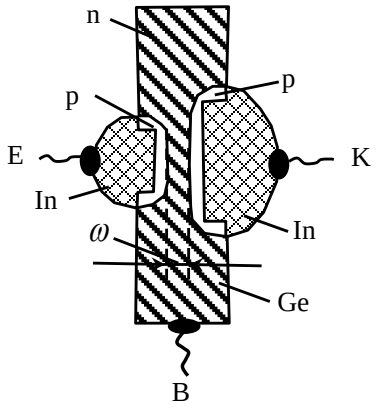
Chetki qatlamlarning o‘tkazuvchanlik turiga bog‘liq ravishda tranzistor p-n-p va n-p-n tranzistorlari ajratiladi. Tranzistor ikkala

turining shartli belgilanishi, ishchi kuchlanishning qutubi va toklarning yo‘nalishi 2-rasmda ko‘satilgan. To‘g‘ri yo‘nalishda ishlovchi o‘tishli emitter deb atasa,mos keluvchi chetki qatlamli emitter deb atashdi. Diodlar kabi bunday nomlanish o‘tish orqali noasosiy tashuvchilarning injeksiyasini yoritadi. O‘rta qatlamni baza deb atashadi.Teskari yo‘nalishda siljigan ikkinchi o‘tishni kollektor ,mos keluvchi chetki qatlamni esa kollektor qatlami deb atashadi. Bu baza orqali o‘tgan injeksiyalangan tashuvchilarni yig‘ish vazifasini yoritadi. Bunday yig‘ilishning bo‘lishi uchun baza qalinligi yetarli darajada kichik bo‘lishi kerak. Aks holda injeksiyalangan tashuvchilar baza orqali ko‘chish jarayonida rekombinasiyaga uchrashi mumkin.

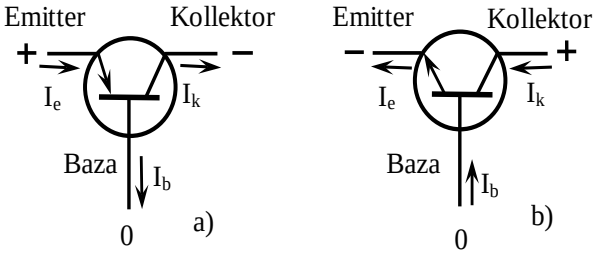
Ta’kidlash joizki, tranzistorda emitter va kollektor o‘rnini o‘zgartirgan holda ishlatish munkin. Bu holat chetki qatlamlarning bir turda ekanligidan kelib chiqadi. Biroq real strukturalarning nosimmetrikligi va emitter hamda kollektor materialining farqiga bog‘liq ravishda ko‘pgina tranzistor turlarida normal va invers ulanishlari bir hil bo‘lmaydi.

Ba’zida tranzistor ikkala o‘tishlar to‘g‘ri yo‘nalishda siljishda bo‘lgan o‘ziga xos bo‘lgan rejimda ishlaydi. Bunda noasosiy tashuvchilarning ikki tomonlama injeksiyasi va ikki tomonlama yig‘ilishi mavjud bo‘ladi. Agarda ikkala o‘tishda injeksiya vazifasi yuqoriroq, bo‘lsa tranzistor ikkita diodga aylanadi.Biroq ko‘pgina o‘tishlardan birida yig‘ilish vazifasi yuqoriroq bo‘ladi va u orqali siljish qutbiga mos

kelmaydigan yo‘nalishda oqib o‘tadi. Bunday rejimni to‘yinish rejimi deb atashadi. Tranzistor ikkita o‘zaro ta’sirlashuvi p-n o‘tishdan tashkil topgan tizim bo‘lib, bunday o‘zaro ta’sirlashuvning sharti baza qalinligining kichik bo‘lishidir (W<<L, bu yerda L-noasosiy tashuvchilarning diffuzion uzilishi)

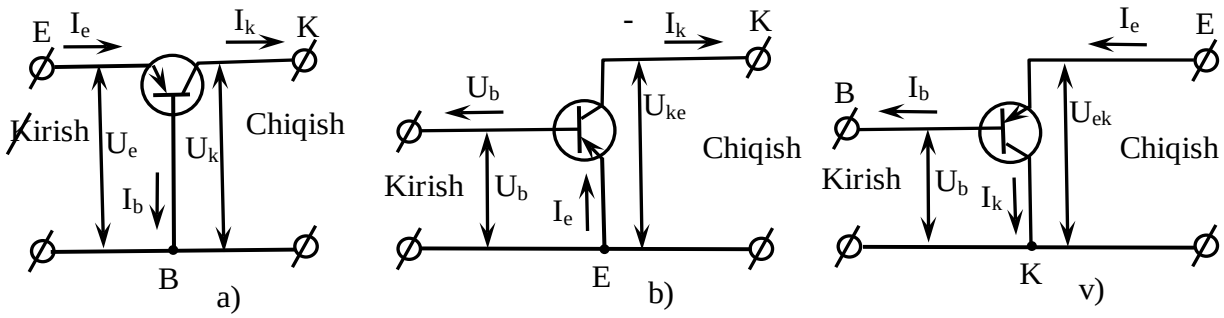


2-rasm.Qotishmali dreyefsiz(diffuzionli) tranzistorning real strukturasi



3-rasm.Tranzistorning shartli belgilanishi.
a- p-n-p tranzistor; b- n-p-n tranzistor.

Tranzistorning asosiy hususiyatlari bazadagi jarayonlar bilan aniqlanadi.Injeksiyalangan tashuvchilarning bazadagi harakatlanishi diffuziya va dreyeflardan iborat bo‘ladi. Dreyef amalga oshirilayotgan elektr maydon injeksiyaning yuqori darajasi shuningdek qatlamning bir jinsli bo‘lmaganligining natijasi bo‘lishi mumkin. Oxirgi holat katta ahamiyatga ega bo‘lib, aynan bir jinsli bo‘lmagan yarimo‘tkazgichning xusisiy maydoni injeksiya darajasiga bog‘liq bo‘lmagan holda tashuvchilarni harakatlanishining dreyef maxanizmini yuzaga keltiradi. Bazada xususiy maydoni bo‘lmagan tranzistorlarni diffuzion yoki dreyefsiz deb atalsa, hususiy maydonni –dreyefli deb atashadi. Ikkala ionlashish tashuvchilarning ko‘chishining asosiy mexanizmini yoritadi. Yuqoridagi ikkala kuchlanish (U_e va U_k) tranzistorning kirish va chiqish zanjirlari uchun umumiy, asosiy elektrod sifatida qabul qilingan bazaga nisbatan hisoblangan. Tranzistorlarning fizik hususiyatlari va parametrlarni o‘rganishga imkon beruvchi uning bunday ulanishi umumiy bazali ulanish deb ataladi. UB nafaqat yagona ulanish, balki amaliyotda keng tarqalgan sxemadir.



4-rasm- .Tranzistorning ulanish sxemalari
a-umumiy baza; b-umumiy emitter; v-umumiy kollektor.

Bu holat bir qator omillar bilan izohlanadi (tok bo‘yicha kuchaytirish mavjud bo‘lmasligi). Sxemalarda asosiy qo‘llaniladigan tranzistorning ulanishi umumiy emitterli ulanish deb ataladi. UE sxemasining asosiy afzalligi tok bo‘yicha kuchaytirishdir, chunki u uchun kirish toki bo‘lgan baza toki emitter va kollektor toklaridan ancha kichikdir. Ulanishning uchinchi turi –umumiy kollektor sxemasi deb ataladi.

Tranzistordagi asosiy jarayonlar

Diskli strukturaga ega bo`lgan qotishma o`tishli dreyefsiz tranzistorning kesimi 3-rasmda keltirilgan. Tranzistorning boshqa turlari bilan solishtirganda qotishma tranzistor tahlil uchun sodda va qulaydir. Bu tranzistorning bazasi bir jism bo`lganligi uchun tashuvchilarni harakatlanishining asosiy mexanizmi diffuziondir. Emitter va kollektor qatlamlarining solishtirma qarshiliklari bir hildir. Tranzistor asimmetriyasini asoslovchi omil S_e va S_k yuzalarining farqidir. Tranzistor asimmetriyasidan emitterdan injeksiyalangan va tranzistor o‘qiga nisbatan ma’lum burchak ostida diffuziyalangan kovaklarning kollektor tomonidan to‘liq yig‘ish imkoniyati ko‘zlangandir.

Qotishmali tranzistorning bazasi ideyallashtirilgan struktura bazasidan (2-rasm) bazada faol, oraliq va passiv uchta sohalarning mavjud bo‘lishi bilan farqlanadi. Bazaning faol sohasi balandligi w va yuzasi emitter S_e sirtiga teng bo‘lgan silindrik hajmdir. Bazaning oraliq sohasi asosning yuzasi S_k-S_e va balandligi kollektordan baza plastinkasining qarama qarshi sirtiga bo‘lgan masofaga teng bo‘lgan doiraviy

hajmiir. Tranzistor bilan dastlabki tanushuv uchun sust va oraliq sohalarni hisobga olmasa ham bo‘ladi va tranzistorni butun kesim bo‘yicha bir xil yuzaga $S=S_e$ ega bo‘lgan simmetrik desak bo‘ladi. Odatda tranzistor o‘lchamlari $w << \sqrt{S}$ nisbatda bo‘ladi.

Amaliy qism

Kuchaytirgich kaskadlari

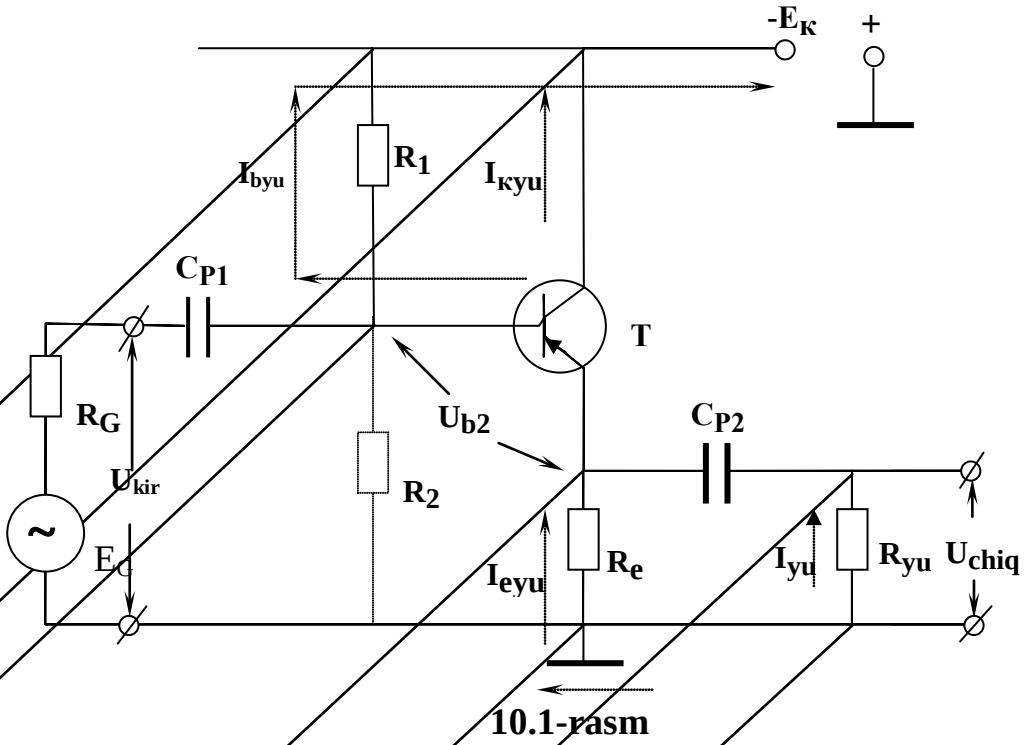
Tok kuchaytirgichlari deganda, shunday kuchaytirish kaskadlari tushuniladiki, ularda kirishdagi elektr tebranishlarning quvvat bo`yicha kuchaytirilishi tokning kuchaytirilishi hisobiga amalga oshadi. Tok kuchaytirgichlarida chiqish toki kirish tokidan ancha kattadir, chiqish kuchlanishi esa kirish kuchlanishidan kichikdir. Bu esa tok kuchaytirgich chiqishidagi qarshiligi R_{vix} ning kirish qarshiligi R_{vx} dan kichikligini bildiradi.

$$R_{chix} < R_{vx}$$

Bu shart tok kuchaytirgichlarini past chastotali kuchaytirish qurilmalarining umumiy kompleksidagi o`rnini, nima uchun mo`ljallanganligini aniqlashda katta ahamiyat kasb etadi. Ko`p hollarda past chastotali kuchaytirish qurilmalari bir necha kaskadlardan iborat bo`ladi, Har bir oldingi kaskad keyingi kaskad uchun o`zgaruvchan elektr manbai bo`lib, keyingi kasakadning kirish zanjiri esa oldingi kaskad uchun yuklama bo`lib xizmat qiladi. Ba`zida keyingi kaskadning kirish qarshiligi yoki yuklama vazifasini bajaruvchi sxemaning qandaydir qismi oldingi kaskadning chiqish(ichki) qarshiligi bilan to`g`ridan-to`g`ri moslashavermaydi. Masalan, yuklamaning kichik qarshiligi bilan kuchaytirgichning katta chiqish qarshiligini moslashtirish uchun, ularning orasiga, chiqish qarshiligi kichik, kirish qarshiligi katta bo`lgan tok kuchaytirgichlarini ulash maqsadga muvofiq. Agar signal ko`p kaskadli kuchaytirgichning birinchi kaskadiga ichki qarshiligi katta bo`lgan datchikdan berilsa, u holda ko`p kaskadli kuchaytirgichning birinchi kaskadi bo`lib, tok kuchaytirgichi ishlatiladi. Bunday kaskadlarni elektron transfomatorlar deb qarash mumkin. Mana shulardan kelib chiqib shuni

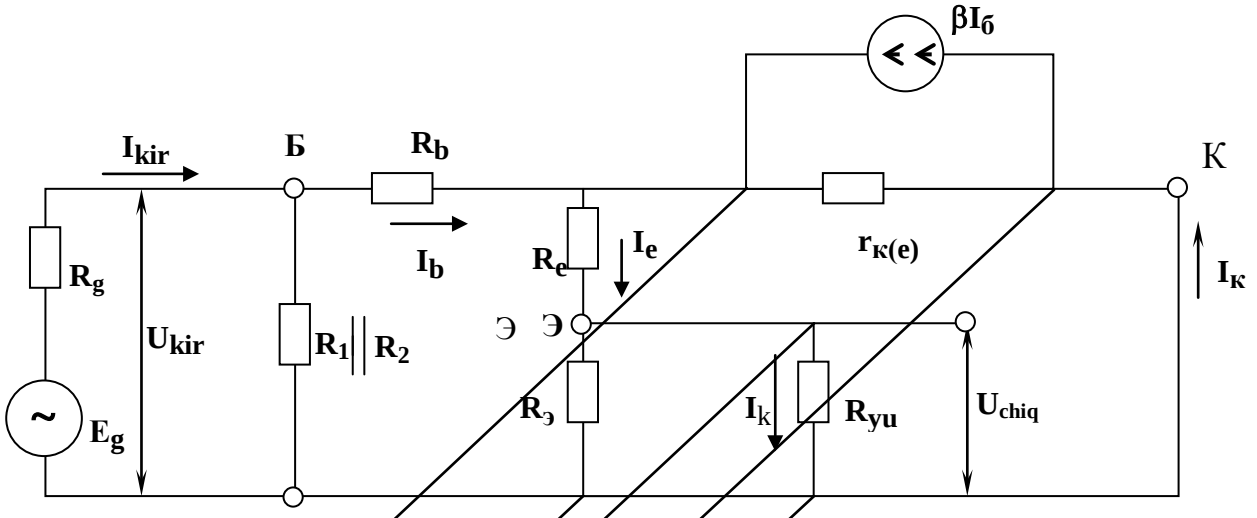
aytish kerakki, past chastotaligi kuchaytirgichlarda tok kuchaytirgichlari o`z - o`zidan ya`ni mustaqil holda ishlatilmaydi. Ular faqatgina yordamchi, bufer kaskadlari vazifasini bajaradi.

Bipolyar tranzistorlarda tok kuchaytirgichlari UK sxemasi bo`yicha yig`iladi. Shunday kaskadning sxemasi 10.1 rasmda keltirilgan. UK sxemasi deyilishiga sabab, kollektor chiqish qutbi o`zgaruvchan tok bo`yicha, ham kirish ham chiqish zanjirlari uchun umumiy qutb bo`lib xizmat qiladi. Ushbu sxemaning emitter chiqish qutbidan olinayotgan chiqish kuchlanishi qiymat jihatdan taxminan kirish kuchlanishiga teng hamda ular faza bo`yicha mos bo`lgani uchun bu sxemani emitter qaytargich sxemasi deb yuritiladi ($U_n = U_{vx} + U_{be} \approx U_{vx}$).



10.1-rasm

Ushbu sxemada R_e rezistor, UE sxemasidagi R_k rezistor vazifasini bajaradi, ya`ni baza zanjiri bilan boshqariladigan tokning oqib o`tishi natijasida, chiqish zanjirida o`zgaruvchan kuchlanish hosil qilib beradi. $S_{R2}$ kondensatorning funksiyasi esa chiqish zanjiriga signalning o`zgaruvchan tashkil etuvchisini etkazib berishdan iborat. R_1, R_2 rezistorlar esa kaskadning tinchlanish rejimini ta`minlaydi. Kaskadning kirish qarshiligini oshirish uchun ko`pincha R_2 qarshilik sxemaga ulanmaydi. Kaskadni o`zgarmas tok bo`yicha hisoblash, xuddi UE sxemasi kabi bo`ladi. Kaskadning o`zgaruvchan tok bo`yicha parametrlari uning o`rta chastotalar uchun almashtirish(ekvivalent) sxemasi yordamida aniqlaniladi (10.2 rasm).



10.2. –rasm

UK sxemasining kirish qarshiligi quyidagi ifoda orqali aniqlaniladi:

$$R_{kir} = R_1 \,||\, R_2 \,||\, r_{kir}$$

bu erda

r_{kir} - tranzistor kirish zanjirining qarshiligi va u quyidagiga teng:

$$r_{kir} = r_b + (1 + \beta)(r_e + R_e \,||\, R_n)$$

UK sxemasining R_{vx} qarshiligi UE sxemasining R_{vx} qarshiligiga nisbatan kattadir.

$r_b << (1 + \beta)(r_e + R_e \| R_n)$ ni xisobga olib,

$R_{kir} \approx R_1 \| R_2 \| [(1 + \beta)(r_e + R_e \| R_n)]$ ni hosil qilamiz.
Katta kirish qarshiligi UK kaskadining afzal tomonlaridan biridir. Chunki kuchaytirgich katta ichki qarshilikka ega bo`lgan kirish signali manbaidan ta`minlanayotganda, ushbu kaskad moslashtiruvchi zveno bo`lib xizmat qiladi. Ekvivalent sxemadan K_I qiymatini aniqlaymiz ($R_{kir} = r_{kir}$ deb olamiz).

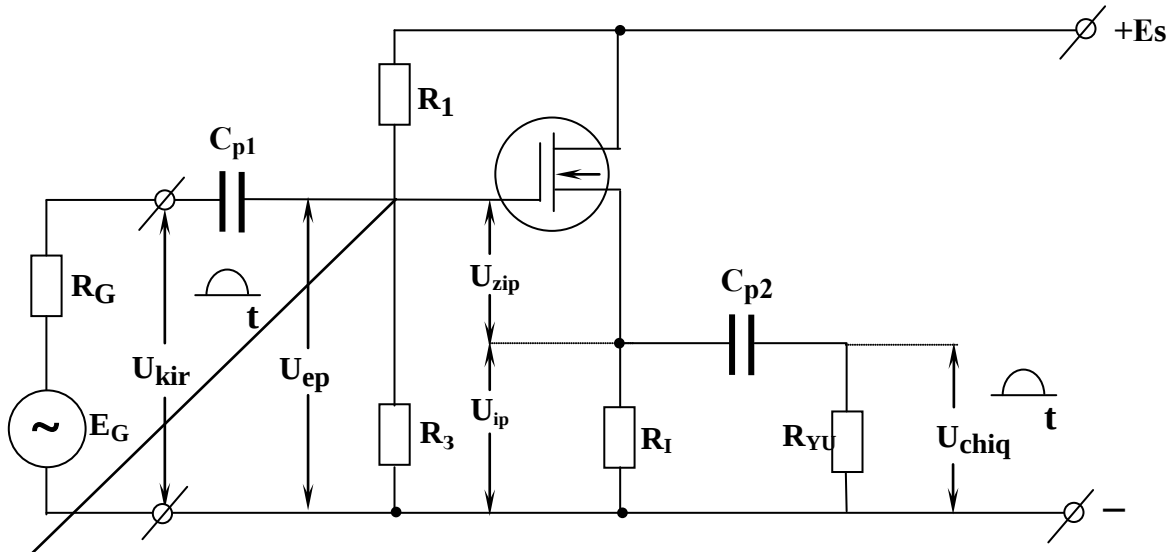
$$K_I \approx (1+\beta)\frac{R_e \| R_{yu}}{R_{yu}}$$

Kuchlanish bo`yicha kuchaytirish koeffisienti quyidagi ifoda orqali aniqlaniladi.

$$K_{YU} \approx (1+\beta)\frac{R_E \| R_{YU}}{R_G + R_{KIR}}$$

$K_U \approx 1$ bo`lgani uchun K_P qiymati K_I qiymatiga taxminan tengdir.
UK kaskadining chiqish qarshiligi quyidagiga teng (10.2 rasm).
$R_{chiq} \approx R_e \quad r_e$ ||

Kaskadning chiqish qarshiligi kichikdir (10-50 Om). Kaskadning bu xossasini kichik omli yuklamalarni chiqish zanjirining qarshiligi bilan moslashtirish uchun qo`llash mumkin va unda ushbu kaskad kuchaytirgichning chiqish kaskadi sifatida ishlatiladi.
Maydonli tranzistorlar asosida qurilgan tok kuchaytirgichlari istok qaytargich deb aytiladi.
Istok qaytargichi sxemasi tashqi ko`rinishidan UK kaskadiga o`xshab ketadi, US sxemasi o`rnatilgan kanalli maydonli tranzistorlarda quriladi, ushbu sxema 10.3 rasmda keltirilgan.



10.3. - rasm

Chiqish kuchlanishining amplituda qiymatini hisobga olgan holda, R_1, R_Z hamda R_i elementlar tranzistorning tinchlanish rejimini hosil qilish uchun ishlatiladi. Tinchlanish rejimini tanlash hamda uni amalga oshirish xuddi UI sxemasi kabi bo`ladi. Shuningdek kaskadning o`zgarmas va o`zgaruvchan tok bo`yicha qarshiligini tranzistorning istok zanjirida joylashganligini xisobga olish kerak. Kaskadning o`zgarmas tok bo`yicha yuklamasi bo`lib $R_i$ xizmat qilsa, o`zgaruvchan tok bo`yicha esa

$R_{n\sim} = R_i$ R_n bo`ladi. $||$

Istok qaytirgichida kirish kuchlanishi chiqish kuchlanishi bilan bitta fazada bo`ladi, qiymat jihatdan esa quyidagi ifoda orqali bog`lanadi:

$$U_n = U_{kir} - U_{zi}$$

Tranzistorning almashtirish sxemasiga muvofiq U_n kuchlanish U_{zi} kuchlanishining funksiyasi bo`ladi.

$U_n = S \cdot U_{zi}(r_i \quad R_{n\sim})$ $||$

bu erda,

$$U_{zi} = \frac{U_n}{S(r_i \quad R_{n\sim})}$$

U holda kuchlanish bo`yicha kuchaytirish koeffisienti quyidagicha aniqlaniladi:

$$K_U = \frac{U_n}{U_{vx}} = \frac{S \cdot U_{zi}(r_i \, R_{n\sim})}{1 + S \cdot U_{zi}(r_i \, R_{n\sim})}$$

$r_i >> R_{i\sim}$ bo`lgani uchun,

$$K_U = \frac{SR_{n\sim}}{1 + SR_{n\sim}}$$

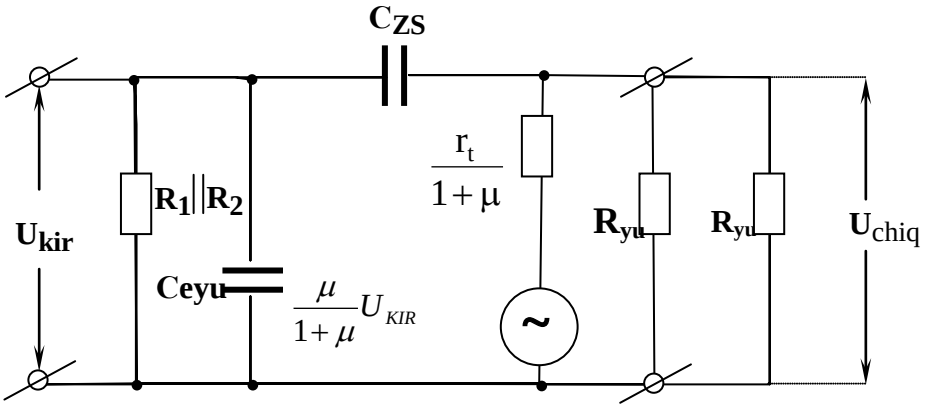
bo`ladi. S hamda $R_{n\sim}$ _ning ortishi $K_u \rightarrow 1$ bo`lishiga olib keladi. Chiqish zanjirida kuchlanish manbai tasvirlangan istok qaytargichining ekvivalent sxemasi 10.4 rasmda keltirilgan.

K_u ni tranzistorning statik kuchaytirish koeffisienti μ orqali quyidagicha yozish mumkin:

$$K_U = \frac{\mu R_{n\sim}}{r_i + (1+\mu)R_{n\sim}}$$

$K_u = \frac{U_{YU}}{U_{KIR}}$ bo`lgani uchun quyidagini hosil qilish mumkin.

$$U_n = \frac{\mu}{1+\mu} U_{vx} \frac{R_{n\sim}}{r_i + R_{n\sim}}$$



10.4 rasm

Ekvivalent sxema orqali US kaskadining chiqish qarshiligi aniqlaniladi.

$$R_{chiq} = R_u \| \frac{r_i}{1+\mu} \approx \frac{1}{S}$$

R_{kir} US kaskadida UI kaskadiga nisbatan kichikroq qiymatga ega va u quyidagiga teng: 100-3000 Om. Istok qaytargichining kirish sig`imi UI kaskadiga nisbatan kichikdir va u quyidagicha aniqlaniladi:

$$\mathbf{S_{kir} = S_{zs} + S_{zi}(1 - K_u) + S_m}$$

o‘lib, quyidagi ifoda bilan yoritiladi:

Asosiy qism

Topshriq;

Kuchaytirgich quydagi xususiyatlarga ega bulishi kerak.
1.Ishlash chastotasi 300-800 МГц
2.Fast chastotalarda 3 дБ
3.Yuqori chastotalarda 3 дБ
4.Kuchaytirish kaypisinti 20 дБ
5.CHiqish kaypisinti =1 Вт6
6.Ishlash tempraturasi +10 dan +60 gradus
7.Signal nanbaining qarshiligi Rг=Rн=50 Ом

Yeichim

3.1 Kaskad sonlarni xisoblash

Kaskad sonlari topshriqa asosan xisoblanadi .Bu aparat 20Db gacha oshirib berishi kerak. Shuning uchun 3 ta kaskad ishlatish maxsdga muopiq buladi. Xar bir 1Db tug’ri keladi.

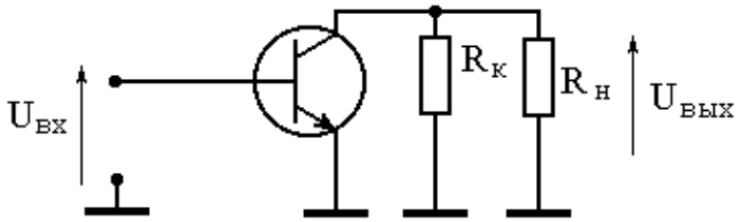
3.2 ACHX tekshrish

Topshriqdan kelib chiqan xolda aparat 3dB gacga xatolik kursatish kerak, chunki 3 kaskat ishlatliyapti. Xar bir xatolik 1dan va AChXga xar biri 1Db qushadi

3.3 Ishchi nuxtani xisoblash.

Bu sxemada rezistorli yoki drezoli kaskadlarni ishlatish mumkun.
Xisob kitoblardan sung ulardan birnitanlash mumkun.
a) kolektor zanjirda qarshilk ishlatladi.

.3.1-rasm



Kup xollarda zanjirlardagi qarshilk va nagruskaning qarshligni bir xil deb oladilar.

Kuchaytrgichdagi chiqish kuchlanishi

$$U_{вых} = \sqrt{2PR_н}\,, \qquad (3.1)$$

P- kuchaytrgichning chiqish quvati, Вт;

R- nagruska qarshligi Ом.

Shunda $U_{вых} = \sqrt{2R_н P_{вых}} = \sqrt{2 \cdot 50 \cdot 1} = \sqrt{100} = 10B.$

Nagruska qarshligning chiqsh toki

$$I_{нагр} = \frac{U_{вых}}{R_{нагр}} = \frac{10}{50} = 0.2A, \qquad (3.2)$$

Bu sxemadan ekivivalent qarshliklar faydo buladi u parallel ulangan qarshliklardan iborat. $R_н$ va $R_к$:

$$R_{нагр} = \frac{R_к R_н}{R_к + R_н} = \frac{50 \cdot 50}{50 + 50} = 25Ом$$

Shunda chiqish toki quydagiga teng buladi.

$$I_{вых} = \frac{U_{вых}}{R_{эквив}} = \frac{10}{25} = 0.4A$$

$R_{эквив}$ –Endi ishga nuxtani aniqlasak buladi, Ом.

$$\begin{cases} U_{кэ_0} = U_{вых} + U_{ост} = 12...13B, \text{ где } U_{ост} = 2...3B \\ I_{к_0} = I_{вых} + 0.1I_{вых} = 0.4 + 0.1 \cdot 0.4 = 0.44A \end{cases} \qquad (3.3)$$

Manbaning kuchlanishi quydagiga teng.

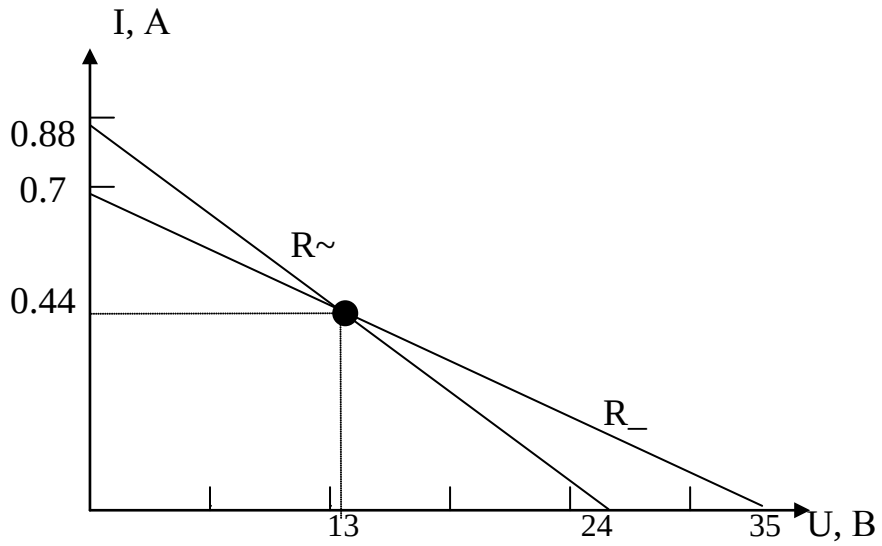
$$E_п = U_{кэ_0} + I_{к_0}(R_к + R_э) = U_{кэ_0} + I_{к_0}R_к = 13 + 0.44 \cdot 50 = 13 + 22 = 35B. \qquad (3.4)$$

Uzgarmas tok buyicha xisob kitobi quydagi formilada keltrilgan

$$E_п = U_{кэ0} + R_к \cdot I_{к0} \qquad (3.5)$$

$I_{к0}$=0: $U_{кэ0}=E_п$=35 В,

$U_{кэ0}$=0: $I_{к0}= E_п/ R_к$=35/50А=0.7А.



$$\Delta U_{вых} = I_{к0} \cdot \frac{R}{2} = 11B, \qquad U_т = 24B,$$

$$\Delta I_{к0} = \frac{\Delta U_{вых}}{R_{перем}} = 0.44B, \qquad I_т = 0.88A.$$

Transistor va istmolchilardagi qivvatni xam topamiz

$$P_{расч} = I_{к_0} \cdot U_{к_0} = 0.44 \cdot 12 = 5.72Bт \qquad (3.6)$$

$$P_{пот\ реб} = I_{к_0} \cdot E_п = 0.44 \cdot 34 = 15.4Bт \qquad (3.7)$$

B) kolektor zanjirida drossel ishlatladi.enirgetik farametirlarni xisoblaymiz.

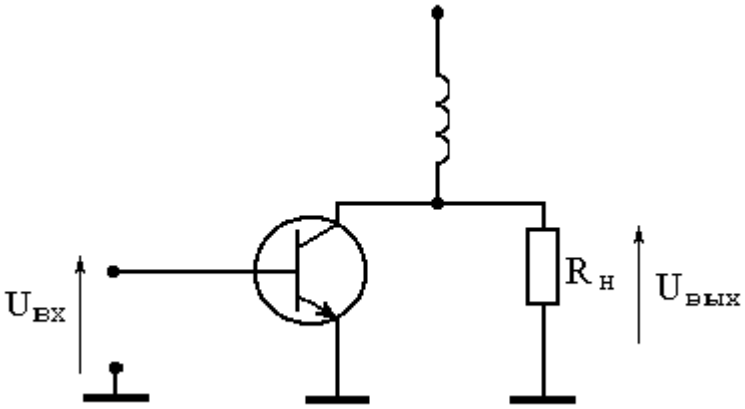
$U_{вых}, U_{кэ_0}, I_{нагр}$ uzgarmaydi.

Utgan punkitda xosil bulgan ekvivalint qarshlik nagruzka qarshiligiga teng buladi., chunki R kni drosill bilan almashtirdik shunda chiqish quydagiga teng buladi.:

$$I_{вых} = \frac{U_{вых}}{R_{эквив}} = \frac{U_{вых}}{R_{нагр}} = \frac{10}{50} = 0.2A$$

Ishch nuxta toki uzgaraditок.

$$I_{к_0} = I_{вых} + 0.1I_{вых} = 0.2 + 0.1 \cdot 0.2 = 0.22A$$



Tok va kuchlanish qiymatlarini ishchi nuxtaga yozamiz.:

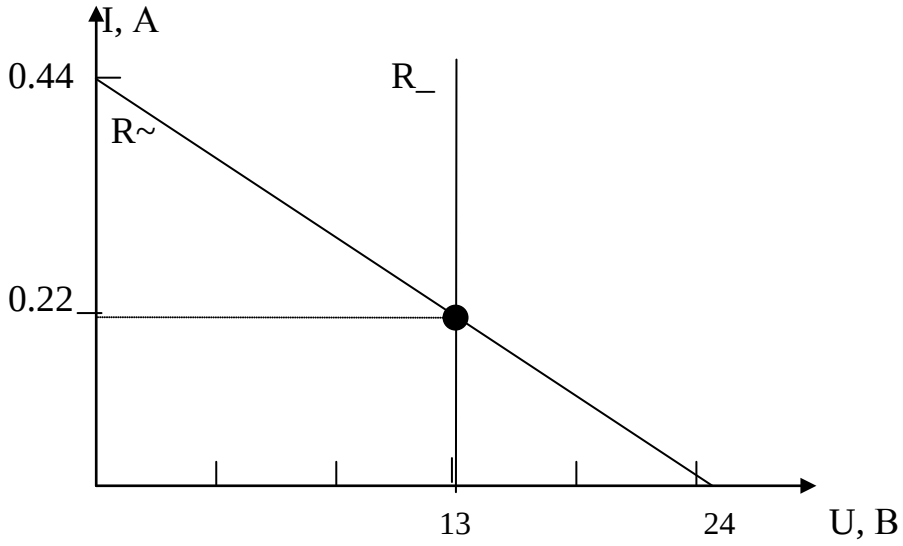
$U_{кэ0}$=13B

$I_{к0}$ =0.22A.

Manbaning kuchlanishi:

$E_п$=$U_{кэ0}$ =13v.

Kurinib turibtiki manbaning kuchlanishi ancha kamayadi 3.4 rasmda kursatilgan.tug'ri chiziq keltrlgan .



3.4 -rasm

Uzgarmas tok buyicha tug'ri chiziq xisoblash

$$E_п = U_{кэ_0} + I_{к_0}(R_к + R_э) = U_{кэ_0} + I_{к_0} \cdot (0+0) = 13B$$

Uzgaruvchan yokni xisoblash

$$\Delta U_{вых} = I_{к0} \cdot R_н = 11B, \qquad U_т = 24B,$$

$$\Delta I_{к0} = \frac{\Delta U_{вых}}{R_н} = 0.22B, \qquad I_т = 0.44A.$$

Transistor va istmolchilardagi qivvatni ham topamiz $P_{расч} = I_{к_0} \cdot U_{к_0} = 0.22 \cdot 12 = 2.64\,Вт$

$P_{пот\,реб} = I_{к_0} \cdot E_{п} = 0.22 \cdot 12 = 2.64\,Вт$

Olingan natijalarni jadivalga joylashtramiz.

3.1 - jadival

:Параметр	$E_{п}$	$P_{рас}$	$P_{пот\,р}$	$I_{к_0}$	$U_{кэ_0}$
схема с $R_{к}$	35	5.72	15.4	0.44	13
схема без $R_{к}$	13	2.86	2.86	0.22	13

Jadivaldan kurinib turibdki drizolli kaskaddagi tranzistorda ajralib chiqayotgan qivvat ancha kam,koliktorni kaskadga nisbatan topshriqa binoan transistor tanlaymiz

$$I_{к\,доп} > 1.2*I_{к0}=0.264\ А$$

$$U_{к\,доп} > 1.2*U_{кэ0}=15.6\ В \qquad (3.8)$$

$$P_{к\,доп} > 1.2*P_{расс}=3.43\ Вт$$

$$f_{т}= (3\text{-}10)*f_{в}=(3\text{-}10)*800\ МГц.$$

Bu xaraktristikaga KT 939A tug'ri keladi. Uning texnik xaraktristkasi quyda keltrilgan .

eliktr parametirlari $U_{К} = 10\,В$**:** $\tau_{ОС} = 4.6$ **пс;**

1. ОЭ $H_{21Э} = 113$;
2. $U_{КБ} = 12$ В $C_{К} = 3{,}9$ пФ;

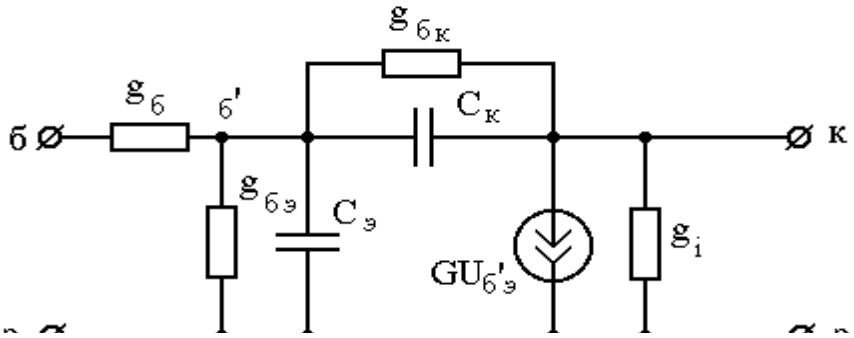
Eksplatatsion

1. $U_{КЭ\,МАХ} = 30$ В;
2. $P_{К\,МАХ} = 4$ Вт;
3. $T_{П\,МАХ} = 423$ К.

3.3.2.shu tranzistorning xisobi KT939A.

A) jikolito metodi.

. 3.5 [1].- rasm jikolito metodi



Xisob kitob uchun malulmotlar:

$\tau_{OC,10\,B} = 4.6\pi c$.

$\beta_0 = 113$,

$C_{K,12\,B} = 3.9\pi\Phi$,.

Zanjirning aloqa qaytaruvchi vaqti buyicha tranzistorning qarshligini topamiz:

$$\tau_c = C_к r_б \qquad (3.9)$$

Bizga bular malum $U_к = 10\,B$ $\tau_c = 4.6пс$, а $C_к = 3.9пФ$ на 12В. Bu shartlarni bitta setimada yozish uchun quydagi parametrlardan poydalanamiz:

$$C_к(U_{кэ2}^{т\,реб}) = C_к(U_{кэ1}^{пасп})\sqrt{\frac{U_{кэ2}^{т\,реб}}{U_{кэ1}^{пасп}}} \qquad (3.10)$$

$$C_{к10} = 3.9\cdot 10^{-12}\sqrt{\frac{10}{12}} = 3.9\cdot 10^{-12}\cdot 0.912 = 3.56\cdot 10^{-12} = 3.56пФ$$

Endi xamma parametrlarni bilgan xolda qarshlikni toppish mumkun

$r_б = \frac{\tau_c}{C_к} = \frac{4.6}{3.56} = 1.29Ом$, тогда $g_б = \frac{1}{r_б} = \frac{1}{1.29} = 0.755$

Ishchi nuxtadagi kolektorli sig'mni topamiz

Sxemada qolgan elimentlar qiymatni topamiz. $C_{к10} = 3.9\cdot 10^{-12}\sqrt{\frac{13}{12}} = 3.9\cdot 10^{-12}\cdot 1.0834 = 4.22\cdot 10^{-12} = 4.2пФ$

$$g_{бэ} = \frac{1}{r_э(1+\beta_0)}, \qquad (3.11)$$

$\beta_0 = 113$,eliktr sig'mi

$r_э = \frac{26}{I_{к_0}[мА]} + \frac{3}{I_{к_0}[мА]} = \frac{26}{220} + \frac{3}{220} = 0.118 + 0.014 = 0.132Ом -$

$g_{бэ} = \frac{1}{0.132(1+113)} = 0.066\frac{1}{Ом}$.

$C_Э = \frac{1}{2\pi f_T r_э} = \frac{1}{2\pi\cdot 3060\cdot 10^6\cdot 0.132} = 395пФ$, где $f_T = 3060МГц$ – sxemadagi qolgan parametrlarni topamiz

$$R_i = \frac{U_{кэ\,доп}}{I_{к\,доп}} = \frac{30}{400 \cdot 10^3} = \frac{30}{0.4} = 75 Ом \qquad (3.12)$$

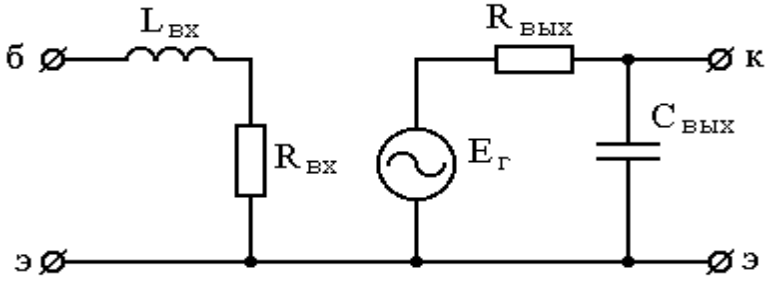
$$g_i = \frac{1}{R_i} = \frac{1}{75} = 0.0133 \frac{1}{Ом} \qquad (3.13)$$

$$G = \alpha g_э = \frac{\beta_0}{1+\beta_0} = \frac{113}{114} = 0.991 \qquad (3.14)$$

б) Bir yunalishli madel 3.6 [1].-rasmda keltrilgan .yuqori chastotsli madelning qiymatlarni aniqlashda tranzistorining passport malumotlardan foydalanamiz.

:

$$\begin{aligned} R_{вх} &= R_б = 1.29 Ом \\ C_{вых} &= C_к = 4.2 пФ \\ R_{вых} &= R_i = 75 Ом \end{aligned} \qquad (3.15)$$



3.15-rasm bir yunalishli madel.

Passport malumotlarida indiktuvlikning qiymati berilmagan. Tranzistorning analik parametrlaridan foydalanamiz. KT913,3:

$$\begin{aligned} L_{вх} &= L_э + L_б \\ L_э &= 0.55/3 = 0.183 нГн \\ L_б &= 3/3 = 1 нГн \end{aligned}$$

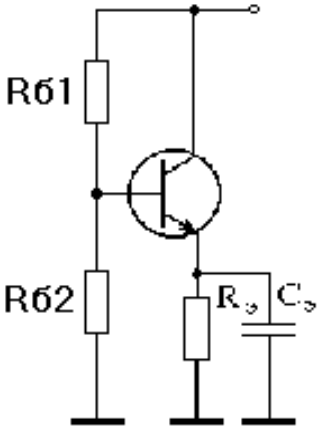
$L_э, L_б$ –

Natijada quydagi formula xosil buladi:

$L_{вх} = 0.183 + 1 = 1.183 нГн$

$f_{\max} = f_T = 3.06 ГГц$

3.3.3. tranzistorlarning ishchi nuxtasidagi termostabilzatsiya chizma si xisobi.



3.7 –Emittrli termostabiilzatsiya .

Elimintlarning yaxlitlangan xisobi ishchi nuxtadan kelib chiqan xolda amalga oshiradi .rezistorni Re kuchlanish kamida 3.5 v bulishi kerak .

Ishchi nuxta :

$U_{кэ0}$= 13В,

$I_{к0}$=0.22А.:

$R_э = \frac{U_э}{I_{к_0}}$, где $U_э = 3B,\ -\ 0.22\,A$:

$$R_э = \frac{3}{0.22} = 13.6 Ом \text{ и } P_{R_э} = U_э I_{к_0} = 0.66 \text{ Вт} \quad (3.16)$$

Bazadagi tok β_0 koliktordan kotta:

$$I_б = \frac{I_к}{\beta_0} = \frac{0.22}{113} = 0.0019\,A, \quad (3.17)$$

Bulivchi bazadagi tok esa un marta kotta buladi :

$$I_{делит} = 10 I_б = 0.019\,A \quad (3.18)$$

Manbaning kuchlanishi quydagiga teng:

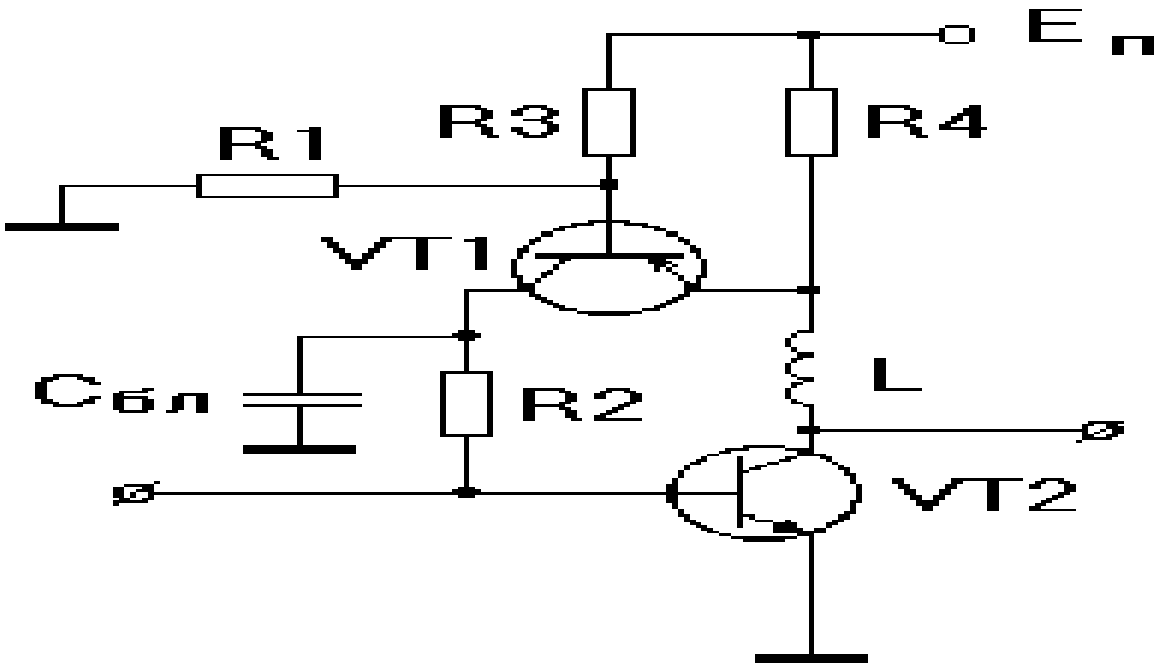
$$E_п = U_{K_э} + U_{кэ_0} = 3 + 13 = 16B, \quad (3.19)$$

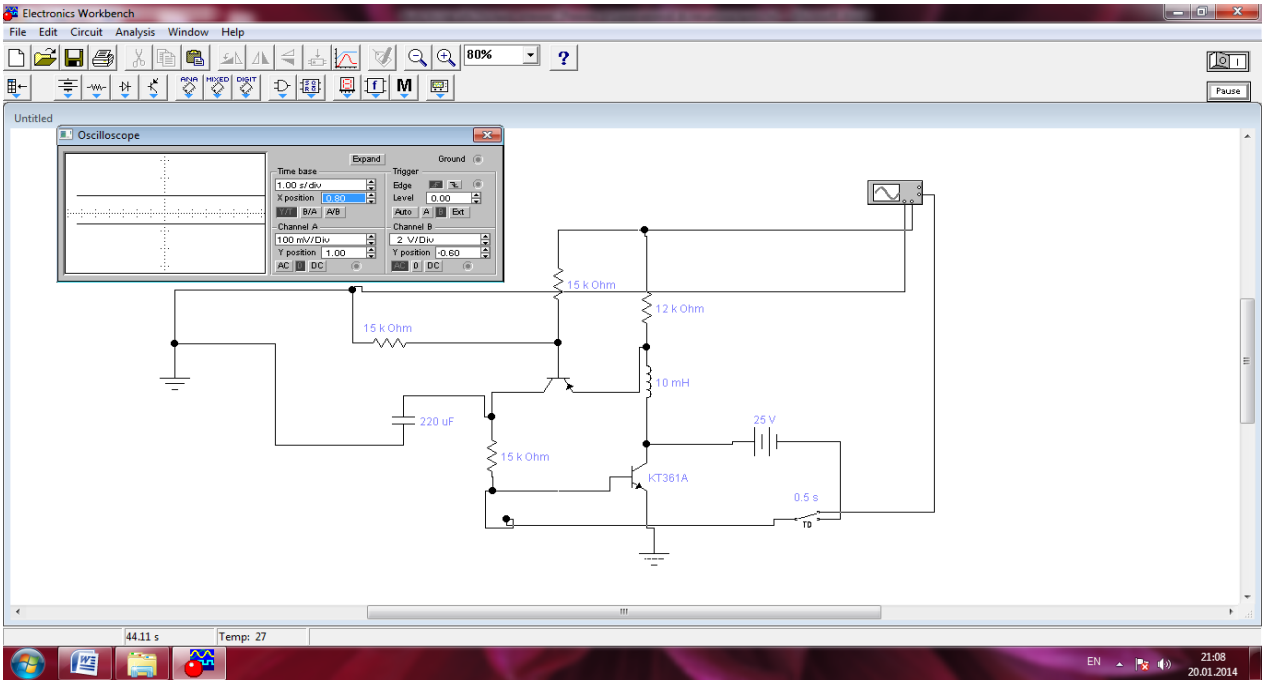
Bulivchi bazaning qarshilgini xisoblaymiz:

$$R_{б1} = \frac{E_п - (U_{R_э} + 0.7)}{I_{делит}} = \frac{16 - (3 + 0.7)}{0.019} = \frac{12.3}{0.019} = 647.3 Ом \quad (3.20)$$

$$R_{б2} = \frac{U_{R_э} + 0.7}{I_{делит}} = \frac{3 + 0.7}{0.019} = 194.7 Ом \quad (3.21)$$

Aktiv koliktor termostabilzator chizmasi 3.8chi rasmda





Boshqariladigan aktiv qarshilik sifatida kam qivvatli Kt361 A transistor tanlangan koliktorzanjirdagi qarshilikning kuchlanishi uzgarmas tok buyicha 1v dan kup bulishi kerak. Sxema xisob kitobi:

$$I_{K0,VT1} = I_{б,VT2} = \frac{I_{K0,VT2}}{\beta_{0,VT2}} = \frac{0.22}{113} A = 1.9 мА$$

$$I_{делит еля} = 10 \cdot I_{б,VT1} = 10 \frac{I_{K0,VT1}}{\beta_{0,VT1}} = \frac{0.0019}{50} мА = 0.38 мА.$$

$$E_п = U_{R4} + U_{КЭ0} = 1В + 13В = 14В$$

$$U_{КЭ0,VT1} = \frac{U_{КЭ0,VT2}}{2} = 6.5В.$$

(3.22):

$$P = U_{R4} \cdot I_{K0} = 1 \cdot 0.22 = 0.22 Вт \ . \qquad (3.23)$$

Kurinib turibdiki yuqoridagi quvvat 3marta amaygan oldingi sxemanlarga sxemaning yahlit xisob kitobi [1]:

$$R_1 = \frac{E_п - (U_{Rэ} + 0.7)}{I_{делит еля}} = \frac{14 - 1 - 0.7}{0.38 \cdot 10^{-3}} Ом = 31590 Ом$$

$$R_2 = \frac{U_{КЭ,VT1} - 0.7}{I_{б,VT2}} = \frac{6.5 - 0.7}{1.9 \cdot 10^{-3}} Ом = 2979 Ом$$

$$R_3 = \frac{U_{R4} + 0.7}{I_{делит еля}} = \frac{1 + 1.7}{0.38 \cdot 10^{-3}} = 4366 Ом \qquad (3.24)$$

$$R_4 = \frac{U_{R4}}{I_{K0}} = \frac{1}{0.22} = 4.5 Ом.$$

Radiaktiv elimentlarning nomuluktrasida kelib chiqan xolda tanlanadi:

$$L\omega_н >> R_н$$

$$\frac{1}{\omega C_{бл}} << R_2 . \qquad (3.25)$$

Bu talablarga quydgi nomunalar javob beradi:

L=100 мкГн ($R_н$=50 Ом) и $C_{бл}$=1 мкФ ($f_н$=300 МГц).
Fassiv kpliktor stabilzatsiyasi 3.9 rasmda kursatilgan. bu sxemada kuchlanish 5-10 vbulishi kerak urtacha 7v .

Sxema xisob kitobni boshlaymiz :

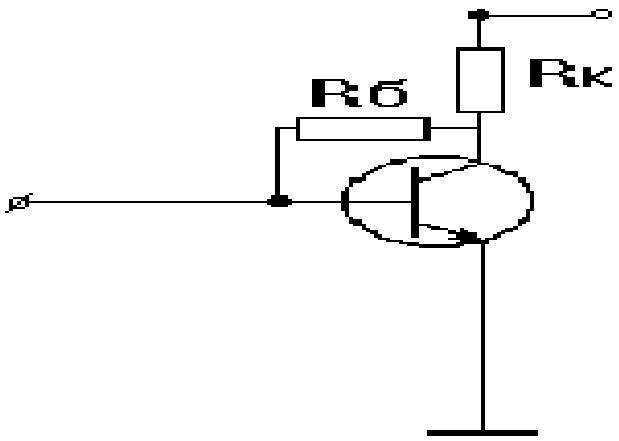
$$I_б = \frac{I_{к0}}{\beta_0} = \frac{0.22}{113} = 0.0019 A = 1.9 мА \ . \qquad (3.26)$$

$$E_п = U_{R_К} + U_{КЭ_0} = 7 + 13 = 20 В$$

Kaliktor qarshilikdagi quvat:

$$P = U_{R4} \cdot I_{K0} = 0.22 \cdot 7 = 1.54 Вт \ . \qquad (3.27)$$

Kurinib turibdiki bu sxemada qivvat endi katta buladi.



3.9 – sxema kurinishi .

Sxema nomunalini xisoblashni boshlaymiz :

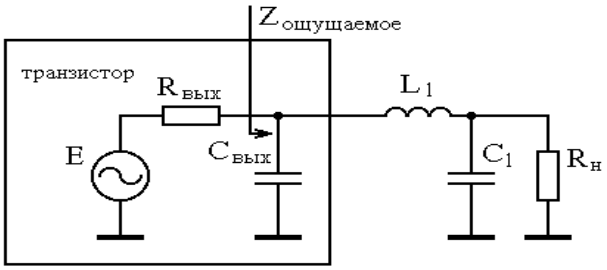
$$R_б = \frac{U_{КЭ_0} - 0.7}{I_б} = \frac{13 - 0.7}{1.9 \cdot 10^{-3}} Ом = 6473 Ом$$

$$R_к = \frac{U_{Rк}}{I_{К0}} = \frac{7}{0.22} = 31.8 Ом.$$

(3.28)

Sxemalarni solishtrishdan urinib turibdiki enirgitik va amaliy tarafdan akktiv koliktorli termostabilzatsiyadan foydalanish urinliroq.

3.3.4. tug'ri zanjizning chiqishni xisoblaymiz .



3.10 –rasim

Kuchaytirgich chiquvchi kaskadidan maksimal chiqvchi quvvat xosil qilish talab qiladi.bu qarshilik sezgirligidan amalga oshriladi .tranzistorning ichki genratori uchun bulardan biri transistor chiquvchi sig'mining pas chastotali filtirga ulash КЦ. КЦ xisobi fFana metodi buyicha xisoblanadi .kaskadning chiquvchi sig'mi buyich b-3 parametrlarni topamiz buning uchun tablitsadan foydalanamiz:

$$b_3 = C_{ВЫХн} = C_{ВЫХ} \cdot R_Н \cdot \omega_В = 4.2 \cdot 10^{-12} \cdot 50 \cdot 2 \cdot \pi \cdot 8 \cdot 10^8 = 1.05. \qquad (3.29)$$

Jadivaldan quydagi natijalarni olamiz:

$C_{1н}$=b1=1.9, $L_{1н}$=b2=0.783, $C_{1н}$=b3=1.292, S=0.292, $\nu = 1.605$.

Sxema dagi eliment nominallaridan foydalanamiz:

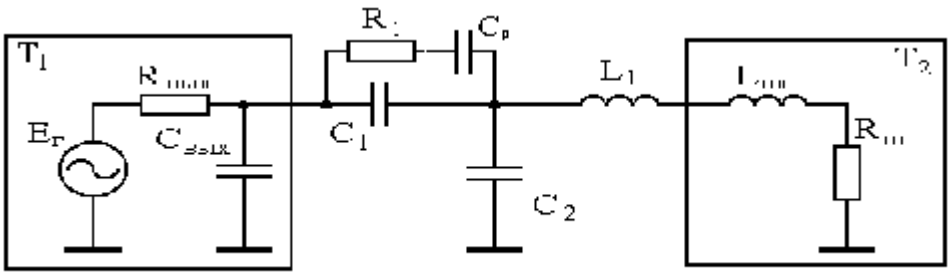
$$L_1 = \frac{L_{1Н} \cdot R_Н}{\omega_В} = \frac{0.783 \cdot 50}{2\pi \cdot 8 \cdot 10^8} Гн = 48.9 нГн$$

$$C_1 = \frac{C_{1Н}}{R_Н \cdot \omega_В} = \frac{1..9}{2\pi \cdot 8 \cdot 10^8 \cdot 50} Ф = 47.5 пФ. \qquad (3.30)$$

$$R_{ОЩ} = \frac{R_Н}{\nu} = 31.5 Ом.$$

3.3.5 Tug'ri zanjir urta kaskadini xisoblaymiz .

. 3.11 [1]-rasmda tug'ri zanjir kaskadi kursatilgan .



3.11 –bu sxemada zanjirning tug'ri bulmagan ACHX bilan taminlaydi, yuborish kaypisinti quydagiga teng:

$$\frac{1}{1+a_1 p+a_2 p^2+a_3 p^3} \qquad (3.31)$$

Koliktorning yuborish funkisiyasi ham xuddi shunday , bundan malumki bu zanjirni koliktor tenglamasidan kelib chiqan xolda xisoblash metodlarni 1 meto-dida kursatilgan filtrlar teorimasidan ACHX mos keladigan A1,A2,A3 kaypisindlari berilgan. Tug'ri bulmagan ACHX xisobiga amal xolida bizning xolatdagi kaypisind qiymatlarnini topamiz:

$a_1 = 2.65, \quad a_2 = 2.012, \quad a_3 = 2.035$

Kirivchi kaskad ancha kuchliroq KT 996 A Tranzistor ancha kuchli chiquvchi sig'mi va yuborish va uzatish kaypisinti kamiriq bu esa bizga maqulKT 996A transistor parametrlari [5]:

$f_T = 5 ГГц = f_{\max}$

$C_{вых} = C_к = 1.8 пФ$ при $U = 13 В$

$\tau = 4.6 пс$

$\beta_0 = 55$

$R_{вх} = r_б = 2.9 Ом$

$L_{вх} = 1.18 нГн$

$R_{вых} = 100 Ом$

$P_{К\ рассеив} = 2.5 Вт$

C1, L2, R3, faralil qiymqtlarni topamiz .

$$C_{ВЫХН} = C_{ВЫХ} \cdot \omega_В \cdot R_{ВЫХ},$$

$$L_{ВХН} = L_{ВХ} \cdot \omega_В / R_{ВЫХ}, \qquad (3.32)$$

$$R_{ВХН} = R_{ВХ} / R_{ВЫХ}$$

$C_{вых} = C_к = 1.8 пФ$ и $R_{вых} = 100 Ом$

$C_{выхн} = 1.8 \cdot 10^{-12} \cdot 2\pi \cdot 8 \cdot 10^8 \cdot 100 = 0.904$

$L_{вхн} = 1.18 \cdot 10^{-9} \cdot 2\pi \cdot 8 \cdot 10^8 / 100 = 0.059$

$R_{вхн} = 1.29 / 100 = 0.013$

Natijada quydagilarni olamiz :

$$A = D \cdot a_1 \cdot a_3 \cdot R_{BXH} \cdot (a_1 - C_{BЫXH})^2 / a_1^2;$$
$$B = D \cdot (a_3 \cdot D - a_1 \cdot a_2); \qquad (3.33)$$
$$D = 1 + 2R_{BXH} \cdot (a_1 - C_{BЫXH})^2 / a_1^2;$$

qushimcha parametirlarni xisoblaymiz C_1, C_2, va L_1:

$$\left.\begin{aligned} C_{1H} &= C_{1H}' / K; C_{2H} = \left[C_{2H}' - C_{1H}' \cdot (K-1)\right] / K^2; \\ L_{1H} &= L_{1H}' / K^2 - L_{BXH}, \end{aligned}\right\}$$

где $K = C_{1H}' / (C_{1H}' - C_{BЫXH});$ (3.34)

$$C_{1H}' = a_3 / L_{1H}' \cdot C_{2H}';$$

$$C_{2H}' = a_3 \cdot D / a_1 \cdot L_{1H}';$$

$$L_{1H}' = (\sqrt{B^2 - 4a_1^2 \cdot A} - B) / 2a_1^2.:$$

Qushimcha paramtrlarni xisoblaymiz .

$$L_{1H}' = \left(\sqrt{9.24 - 4 \cdot 6.35 \cdot 0.027} + 3.04\right) / 2 \cdot 6.35 = 0.47$$
$$C_{2H}' = 2.035 \cdot 1.01 / (2.52 \cdot 0.47) = 1.73$$
$$C_{1H}' = 2.035 / (0.47 \cdot 1.73) = 2.5$$
$$K = 2.5 / (2.5 - 0.904) = 1.56$$
$$L_{1H} = L_{1H}' / K^2 - L_{BXH} = 0.47 / 2.43 - 0.059 = 0.134$$
$$C_{2H} = \frac{C_{2H}' - C_{1H}'(K-1)}{K^2} = \frac{1.73 - 2.5(1.56-1)}{2.43} = 0.135$$
$$C_{1H} = \frac{C_{1H}'}{K} = \frac{2.5}{1.56} = 1.6$$

Qushimcha faramtrlarning xisobi.

$$G_{ном1,2}(1) = \left(\frac{\omega_{\max}}{\omega_в}\right)^2 = \left(\frac{f_{\max}}{f_в}\right)^2 = \left(\frac{5 \cdot 10^9}{8 \cdot 10^8}\right)^2 = 39 \qquad (3.35)$$

$$S_{210} = 2 \cdot C_{1H} \cdot \sqrt{R_{вхн} \cdot G_{ном12}(1)} = 2 \cdot 1.6 \cdot \sqrt{0.013 \cdot 39} = 2.27 \qquad (3.36)$$

ACHX tug’rlash maxsadida R1 rezistor ishlatiladi va u 3.37 ga teng buladi .

$$R_1 = \frac{2\beta_0 \cdot R_н}{S_{21O}} = \frac{2 \cdot 113 \cdot 50}{2.27} = 4977\,Ом \qquad (3.37)$$

C_{1H}, C_{2H}, L_{1H},

$$C_1 = \frac{C_{1H}}{R_{ВЫХ} \cdot \omega_B}, \quad C_2 = \frac{C_{2H}}{R_{ВЫХ} \cdot \omega_B}, \; L_1 = \frac{L_{1H} \cdot R_{ВЫХ}}{\omega_B}, \tag{3.38}$$

$$C_1 = \frac{1.6}{100 \cdot 2\pi \cdot 8 \cdot 10^8} = 3.184 \cdot 10^{-12} = 3.184 пФ$$

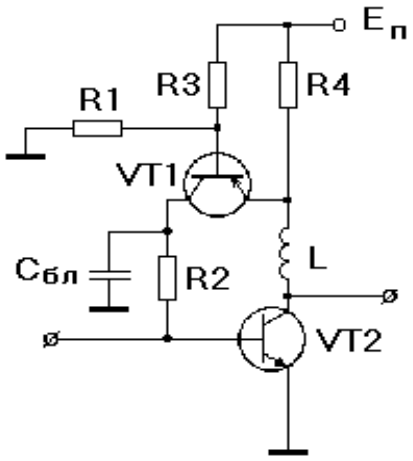
$$C_2 = \frac{0.135}{100 \cdot 2\pi \cdot 8 \cdot 10^8} = 2.687 \cdot 10^{-13} = 0.269 пФ$$

$$L_1 = \frac{0.134 \cdot 100}{2\pi \cdot 8 \cdot 10^8} = 2.667 \cdot 10^{-9} = 2.7 нГн$$

3.4 Kaskad xisobi .

KT 939 A Tranzistor urniga KT 996 Atranzistor ishlatamiz.

3.4.1 Aktiv koliktorni termostabilzatsiyasi.



3.12 – rasn trmostablizatsiyasi sxema aktiv koliktor trmostablizatsiyasi.

Sxemaning xisob kitobi

$$\begin{cases} U_{кэ0} = 13В \\ I_{к0} = I_{к0оконечного}/S_{210Vtоконечного} = 0.09А. \end{cases}$$

Koliktor qarshlikdagi qivvat formilasi, sxema nominallari (3.22):

$$I_{K0,VT1} = I_{б,VT2} = \frac{I_{K0,VT2}}{\beta_{0,VT2}} = \frac{0.09}{55} A = 1.6\,мА,$$

$$I_{делит еля} = 10 \cdot I_{б,VT1} = 10\frac{I_{K0,VT1}}{\beta_{0,VT1}} = \frac{16}{50}\,мА = 0.32\,мА,$$

$$E_п = U_{R4} + U_{КЭ0} = 1В + 13В = 14В,$$

$$U_{КЭ0,VT1} = \frac{U_{КЭ0,VT2}}{2} = 6.5В.$$

Koliktor qarshilik formilasi :

$$P = U_{R4} \cdot I_{K0} = 1 \cdot 0.09 = 0.09\,Вт \ .$$

Formula buyicha xisoblaymiz . (3.24):

$$R_1 = \frac{E_п - (U_{R4} + 0.7)}{I_{делит еля}} = \frac{14 - 1.7}{0.32 \cdot 10^{-3}} = 38437\,Ом,$$

$$R_2 = \frac{U_{КЭ,VT1} - 0.7}{I_{б,VT2}} = \frac{6.5 - 0.7}{1.6 \cdot 10^{-3}} = 3625\,Ом,$$

$$R_3 = \frac{U_{R4} + 0.7}{I_{делит еля}} = \frac{1 + 0.7}{0.32 \cdot 10^{-3}} = 5312\,Ом,$$

$$R_4 = \frac{U_{R4}}{I_{K0}} = 11Ом.$$

Reaktiv eliment nominallari tengsizlikdan kelib chiqan xolda taminlanadi. bu talabga quydagilar javob buladi :

$$L\omega_н >> R_{экв} = R_{т\,р\,вых} \parallel R_{1МКЦ}$$

$$\frac{1}{\omega C_{бл}} << R_2 \qquad .$$

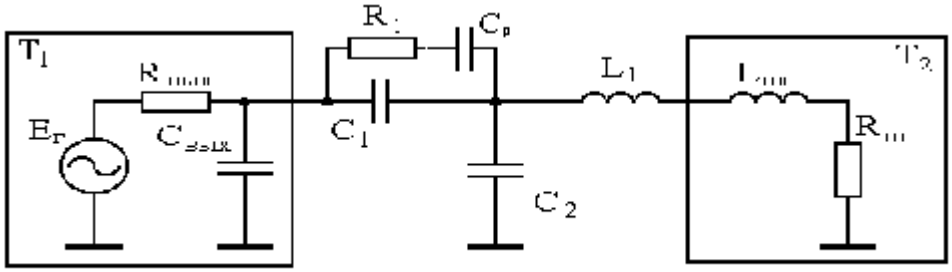
L=100 мкГн ($R_{экв}$=98 Ом), и $C_{бл}$=1 мкФ ($f_н$=300 МГц, R_2=3625 Ом).
Bu erda $R_{экв}$ kaskadning ekvivalint qarshligi .

$$R_н = \frac{4977 \cdot 100}{4977 + 100} = 98Ом$$

3.4.1 Urta kaskadli zanjir .

:

$$C_{ВЫХН} = C_{ВЫХ} \cdot \omega_В \cdot R_{ВЫХ},\ L_{ВХН} = L_{ВХ} \cdot \omega_В \,/\, R_{ВЫХ},\ R_{ВХН} = R_{ВХ} \,/\, R_{ВЫХ}$$



3.13 - rasm Межкаскадная корректирующая цепь третьего порядка.

Xisob kitob avvalgiday faqat C, L, R, lar qiymatlari uzgaradi.

$$C_{ВЫХН} = 1.8 \cdot 10^{-12} \cdot 2\pi \cdot 8 \cdot 10^{8} \cdot 100 = 0.904$$
$$L_{ВХН} = 1.18 \cdot 10^{-9} \cdot 2\pi \cdot 8 \cdot 10^{8} / 100 = 0.059$$
$$R_{ВХН} = 2.9 / 100 = 0.029$$

KT 996 A tranzistorning bilgan xolda quydagilarni topamiz :

$$A = D \cdot a_1 \cdot a_3 \cdot R_{ВХН} \cdot (a_1 - C_{ВЫХН})^2 / a_1^2;$$
$$B = D \cdot (a_3 \cdot D - a_1 \cdot a_2);$$
$$D = 1 + 2R_{ВХН} \cdot (a_1 - C_{ВЫХН})^2 / a_1^2;$$

bu yerda narmal qiymatlarni topamiz C_1, C_2, и L_1:

$$\left.\begin{aligned} C_{1H} &= C_{1H}' / K; C_{2H} = \left[C_{2H}' - C_{1H}' \cdot (K-1) \right] / K^2; \\ L_{1H} &= L_{1H}' / K^2 - L_{ВХН}, \end{aligned}\right\}$$

где $K = C_{1H}' / (C_{1H}' - C_{ВЫХН});$

$$C_{1H}' = a_3 / L_{1H}' \cdot C_{2H}';$$

$$C_{2H}' = a_3 \cdot D / a_1 \cdot L_{1H}';$$

$$L_{1H}' = (\sqrt{B^2 - 4a_1^2 \cdot A} - B) / 2a_1^2.$$

Qushimcha faramtrlarni xisoblaymiz:

$$L_{1H}' = \left(\sqrt{9.3 - 4 \cdot 6.35 \cdot 0.062} + 3.05\right) / 2 \cdot 6.35 = 0.459$$
$$C_{2H}' = 2.035 \cdot 1.023 / (2.52 \cdot 0.459) = 1.8$$
$$C_{1H}' = 2.035 / (0.459 \cdot 1.8) = 2.463$$
$$K = 2.463 / (2.463 - 0.904) = 1.58$$
$$L_{1H} = L_{1H}' / K^2 - L_{ВХН} = 0.459 / 2.5 - 0.059 = 0.125$$
$$C_{2H} = \frac{C_{2H}' - C_{1H}'(K-1)}{K^2} = \frac{1.8 - 2.463(1.58-1)}{2.5} = 0.148$$
$$C_{1H} = \frac{C_{1H}'}{K} = \frac{2.463}{1.58} = 1.59$$

Qushimcha faramtrlarni xisoblaymiz:

$$G_{ном1,2}(1) = \left(\frac{\omega_{\max}}{\omega_в}\right)^2 = \left(\frac{f_{\max}}{f_в}\right)^2 = \left(\frac{5\cdot 10^9}{8\cdot 10^8}\right)^2 = 39$$

$$S_{210} = 2\cdot C_{1н}\cdot\sqrt{R_{вхн}\cdot G_{ном12}(1)} = 2\cdot 1.59\cdot\sqrt{0.029\cdot 39} = 3.3$$

Elimentlarning xaqiqy qiymatlarni topamiz.

$R_1 = \frac{2\beta_0 \cdot R_н}{S_{21O}}$, здесь $R_н$

$R_н = \frac{4977\cdot 100}{4977+100} = 98 Ом$, учтя это:

$R_1 = \frac{2\cdot 55\cdot 98}{3.3} = 3267 Ом$

$$C_1 = \frac{C_{1H}}{R_{ВЫХ}\cdot\omega_В}, \quad C_2 = \frac{C_{2H}}{R_{ВЫХ}\cdot\omega_В}, \quad L_1 = \frac{L_{1H}\cdot R_{ВЫХ}}{\omega_В},$$

$C_1 = \frac{1.59}{100\cdot 2\pi\cdot 8\cdot 10^8} = 3.164\cdot 10^{-12} = 3.164 пФ$

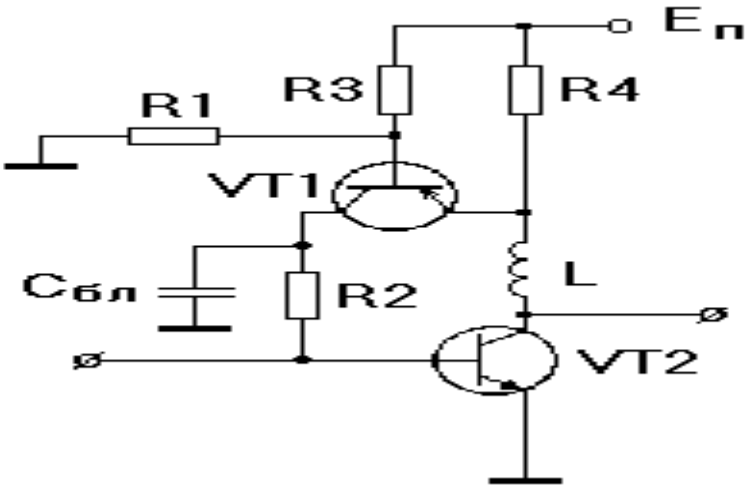
$C_2 = \frac{0.148}{100\cdot 2\pi\cdot 8\cdot 10^8} = 2.945\cdot 10^{-13} = 0.294 пФ$

$L_1 = \frac{0.125\cdot 100}{2\pi\cdot 8\cdot 10^8} = 2.488\cdot 10^{-9} = 2.488 нГн$

3.5Krivchi kaskadni xisoblah .

Kirvchi kaskad tranzistori uzgarmaydi faqat kaskad boshida 50 om qarshlik genrator turbid.

3.5.1 Aktiv koliktorli sitabilzatsia.



3.14 –rasm sxemaning aktiv koliktor termstabilzatsiyasi.

Kirvchi kaskad uchun xamma farametrlar oldigiday qoladi,faqat ishchi nuxta uzgaradi:

$$\begin{cases} U_{кэ0}= 13В, \\ I_{к0}= I_{к0предоконечного}/S_{210Vt\ предоконечного}=0.09/2.45=37мА. \end{cases}$$

Enirgitik xisoblash:

$$I_{K0,VT1} = I_{б,VT2} = \frac{I_{K0,VT2}}{\beta_{0,VT2}} = \frac{33}{55}\,мА = 0.6\,мА,$$

$$I_{делит\ еля} = 10 \cdot I_{б,VT1} = 10\frac{I_{K0,VT1}}{\beta_{0,VT1}} = \frac{6}{50}\,мА = 0.12\,мА,$$

$$E_{п} = U_{R4} + U_{КЭ0} = 1В + 13В = 14В,$$

$$U_{КЭ0,VT1} = \frac{U_{КЭ0,VT2}}{2} = 6.5В.$$

Koliktordagi qarshilk formilasi

:

$$P = U_{R4} \cdot I_{K0} = 1 \cdot 0.037\,Вт = 37\,мВт\ .$$

Sxemaning nominal xisobi:

$$R_1 = \frac{E_{п} - (U_{R4} + 0.7)}{I_{делит\ еля}} = \frac{14 - 1.7}{0.12 \cdot 10^{-3}}\,Ом = 102500\,Ом,$$

$$R_2 = \frac{U_{КЭ,VT1} - 0.7}{I_{б,VT2}} = \frac{6.5 - 0.7}{0.6 \cdot 10^{-3}}\,Ом = 9667\,Ом,$$

$$R_3 = \frac{U_{R4} + 0.7}{I_{делит\ еля}} = \frac{1 + 0.7}{0.12 \cdot 10^{-3}} = 14167\,Ом,$$

$$R_4 = \frac{U_{R4}}{I_{K0}} = 27\,Ом.$$

Reaktiv elimentlarning nominal tensizligidan kelib chiqan xolda topiladi.

$$L\omega_{н} >> R_{экв} = R_{т р вых} \parallel R_{2МКЦ}$$

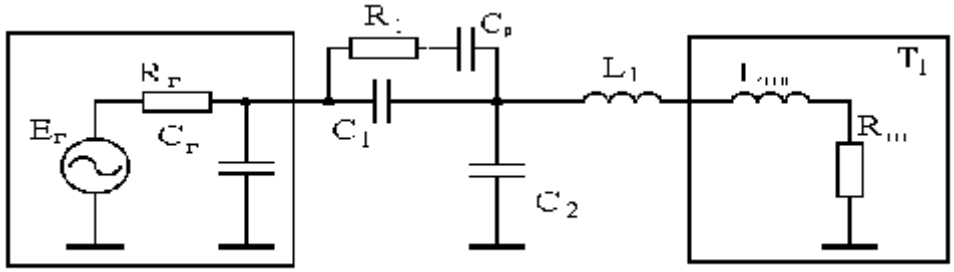
$$\frac{1}{\omega C_{бл}} << R_2 \qquad .$$

Bunga quydagi nominal javob beradi.

L=100 мкГн ($R_{экв}$=49.2 Ом) и $C_{бл}$=1 мкФ ($f_{н}$=300 МГц, R_2=9667 Ом), где

$$R_{экв} = \frac{3267 \cdot 50}{3267 + 50} = 49.2\,Ом$$

3.5.2 Kirvchi koliktor nominallar zanjirlar ni xisoblash.



3.15 – rasm .

FXisoblash metodikasi va transistor uzgarmagan kaskadning qismida generator turbidi quyda,uning farametrlari keltrilgan.

$R_{вых} = R_{Г} = 50$ и $C_{вых} = 0$

Qushmcha parametrlarni topamiz :

$$C_{ВЫХН} = C_{ВЫХ} \cdot \omega_{В} \cdot R_{ВЫХ},$$

$$L_{ВХН} = L_{ВХ} \cdot \omega_{В} / R_{ВЫХ},$$

$$R_{ВХН} = R_{ВХ} / R_{ВЫХ}$$

$$C_{ВЫХН} = 0 \cdot 2\pi \cdot 8 \cdot 10^{8} \cdot 100 = 0$$

$$L_{ВХН} = 1.18 \cdot 10^{-9} \cdot 2\pi \cdot 8 \cdot 10^{8} / 100 = 0.059$$

$$R_{ВХН} = 2.9 / 50 = 0.058$$

Bularni bilgan xolda quydagi kaypisintlarni xisoblaymiz.

$$A = D \cdot a_1 \cdot a_3 \cdot R_{ВХН} \cdot (a_1 - C_{ВЫХН})^2 / a_1^2;$$

$$B = D \cdot (a_3 \cdot D - a_1 \cdot a_2);$$

$$D = 1 + 2R_{ВХН} \cdot (a_1 - C_{ВЫХН})^2 / a_1^2;$$

$$D = 1 + 2 \cdot 0.058 \cdot (2.52 - 0)^2 / 6.35 = 1.116$$

$$B = 1.116 \cdot (2.035 \cdot 1.116 - 2.52 \cdot 2.012) = -3.12$$

$$A = 1.116 \cdot 2.52 \cdot 2.035 \cdot 0.058 \cdot (2.52 - 0)^2 / 6.35 = 0.332$$

Qushimcha faramtrlarni xisoblaymiz C_1, C_2, и L_1:

$$\left.\begin{array}{l} C_{1H} = C_{1H}' / K; C_{2H} = \left[C_{2H}' - C_{1H}' \cdot (K-1) \right] / K^2; \\ L_{1H} = L_{1H}' / K^2 - L_{ВХН}, \end{array}\right\}$$

где $K = C_{1H}' / (C_{1H}' - C_{ВЫХН});$

$$C_{1H}' = a_3 / L_{1H}' \cdot C_{2H}';$$

$$C_{2H}{}' = a_3 \cdot D / a_1 \cdot L_{1H}{}';$$

$$L_{1H}{}' = (\sqrt{B^2 - 4a_1{}^2 \cdot A} - B) / 2a_1{}^2.$$

При расчете получим:

$L'_{1н} = \left(\sqrt{9.73 - 4 \cdot 6.35 \cdot 0.332} + 3.12\right) / 2 \cdot 6.35 = 0.335$

$C'_{2н} = 2.035 \cdot 1.116 / (2.52 \cdot 0.335) = 2.69$

$C'_{1н} = 2.035 / (0.335 \cdot 2.69) = 2.258$

$K = 2.258 / (2.258 - 0) = 1$

и в результате:

$L_{1н} = L'_{1н} / K^2 - L_{вхн} = 0.335 / 1 - 0.059 = 0.276$

$$C_{2н} = \frac{C'_{2н} - C'_{1н}(K-1)}{K^2} = \frac{2.69 - 2.258(1-1)}{1} = 2.69$$

$$C_{1н} = \frac{C'_{1н}}{K} = \frac{2.258}{1.} = 2.258$$

:

$$G_{ном1,2}(1) = \left(\frac{\omega_{\max}}{\omega_в}\right)^2 = \left(\frac{f_{\max}}{f_в}\right)^2 = \left(\frac{5 \cdot 10^9}{8 \cdot 10^8}\right)^2 = 39$$

$S_{210} = 2 \cdot C_{1н} \cdot \sqrt{R_{вхн} \cdot G_{ном12}(1)} = 2 \cdot 2.258 \cdot \sqrt{0.058 \cdot 39} = 6.79$

где S_{210}-

$R_1 = \frac{2\beta_0 \cdot R_н}{S_{21O}}$ - .

$R_н = \frac{3967 \cdot 50}{3967 + 50} = 49.2 Ом$, учтя это:

$R_1 = \frac{2 \cdot 55 \cdot 49.2}{6.79} = 797 Ом$

$$C_1 = \frac{C_{1H}}{R_{ВЫХ} \cdot \omega_В}, \quad C_2 = \frac{C_{2H}}{R_{ВЫХ} \cdot \omega_В}, \; L_1 = \frac{L_{1H} \cdot R_{ВЫХ}}{\omega_В},$$

$C_1 = \frac{2.258}{100 \cdot 2\pi \cdot 8 \cdot 10^8} = 4.494 \cdot 10^{-12} = 4.494 пФ$

$C_2 = \frac{2.69}{100 \cdot 2\pi \cdot 8 \cdot 10^8} = 5.354 \cdot 10^{-13} = 5.354 пФ$

$L_1 = \frac{0.276 \cdot 100}{2\pi \cdot 8 \cdot 10^8} = 5.494 \cdot 10^{-9} = 5.494 нГн$

Kirvchi kaskad xisobi tugatildi.

3.6 bulivchi sig'mlarni xisoblaymiz.

Aparat 4ta reaktiv elimentdan iborat. Bu elimentlar bulvchi sig'mlardir bularning xar biri texnik topshriqa kura kupi bilan 0,75dB chastotali xatolik berishi kerak xar qay-si sig'mning nominali fprmiladan topiladi.

$$C_P = \frac{Y_H}{(R_1 + R_2) \cdot \omega_H \cdot \sqrt{1 - Y_H}}, \qquad (3.39)$$

$Y_н$ – berilgan xatolik ;
R_1 va R_2 – qarshilk Ом;
$w_н$ –fast chastota , Гц.

$$Y = \frac{1}{10^{\frac{M}{20}}}, \qquad (3.40)$$

$0.75_{дБ} = 20\lg K_{РАЗЫ}$,

$K = 10^{\frac{0.75}{20}} = 1.09,$

$Y = \frac{1}{K} = 0.917.$

Tugatilgan kaskadning buluvchi sig'mi nominali :

$$C_P = \frac{Y}{(R_{выхVT} + R_н) \cdot \omega_н \cdot \sqrt{1 - Y^2}} = \frac{0.917}{(50 + 797) \cdot 6.28 \cdot 3 \cdot 10^8 \cdot \sqrt{1 - 0.84}} = 1.437 нФ.$$

$$C_P = \frac{Y}{(R_{выхVT} + R_н) \cdot \omega_н \cdot \sqrt{1 - Y^2}} = \frac{0.917}{(100 + 3267) \cdot 6.28 \cdot 3 \cdot 10^8 \cdot \sqrt{1 - 0.84}} = 0.3614 нФ.$$

Urta kaskadning bulivchi sig'mi nominali :

$$C_P = \frac{Y}{(R_{выхVT} + R_н) \cdot \omega_н \cdot \sqrt{1 - Y^2}} = \frac{0.917}{(100 + 4977) \cdot 6.28 \cdot 3 \cdot 10^8 \cdot \sqrt{1 - 0.84}} = 0.2397 нФ.$$

Kirvchi kaskadning bulivchinominali:

$$C_P = \frac{Y}{(R_{выхVT} + R_н) \cdot \omega_н \cdot \sqrt{1 - Y^2}} = \frac{0.917}{(100 + 50) \cdot 6.28 \cdot 3 \cdot 10^8 \cdot \sqrt{1 - 0.84}} = 8.112 нФ.$$

3.7 Natijaviy kuchaytirgich kaypisintni xisoblash .

$S_{21O\Sigma} = S_{21O\ оконечн.} \cdot S_{21O\ предоконечн..} \cdot S_{21O\ входн.} = 2.27 \cdot 3.3 \cdot 6.79 = 50.8\ раз$,

$S_{21O\Sigma} = 20 \cdot \log S_{21O\Sigma} = 20 \cdot \log(50.8) = 34 дБ$

Xulosa

Bu kurs ishini tayorlash natijasida AM .CHM signallarning funksianal keng palasali Kuchaytrgich eliktrik sxemalarni xosil qildik .Elimentlarning nominalari topildi .
Usiltelnng minimal chiqish qivvqti 1vt,
kuchaytrsh koyfsinti 40 Db.
Achx xatoligi ,±1dB,
manbaning kuchlanishi 13v,
Usiltel kuchaytrgich 300-800 Мгц.

Поз. обознач.	Наименование		Примечание
	Резисторы ГОСТ 7113-77		
R_1	**МЛТ 0,125-820 Ом ± 10%.**	1	
R_2	**МЛТ 0,125-120 кОм ± 10%.**	1	
R_3	**МЛТ 0,125-10 кОм ± 10%.**	1	
R_4	**МЛТ 0,125-15 кОм ± 10%.**	1	
R_5	**МЛТ 0,125-27 Ом ± 10%.**	1	
R_6, R_{13}	**МЛТ 0,125-3,3 кОм ± 10%.**	2	
R_7	**МЛТ 0,125-39 кОм ± 10%.**	1	
R_8	**МЛТ 0,125-3,9 кОм ± 10%.**	1	
R_9	**МЛТ 0,125-5,6 кОм ± 10%.**	1	
R_{10}	**МЛТ 0,125-12 Ом ± 10%.**	1	
R_{11}	**МЛТ 0,125-5,6 кОм ± 10%.**	1	
R_{12}	**МЛТ 0,125-33 Ом ± 10%.**	1	
R_{14}	**МЛТ 0,125-4,7 кОм ± 10%.**	1	
R_{15}	**МЛТ 0,125-4,7 Ом ± 10%.**	1	
	Конденсаторы ОЖ0.464.107 ТУ		
C_1	**К10-17-1,5 пФ ± 5%.**	1	
C_2	**К10-17-4,7 пФ ± 5%.**	1	
C_3	**К10-17-5,6 пФ ± 5%.**	1	
C_4, C_9, C_{14}	**К10-17-1 мкФ ± 10%.**	3	
C_5, C_{10}, C_{15}	**К10-17-1 мкФ ± 10%.**	3	
C_6	**К10-17-0,39 пФ ± 5%.**	1	
C_7, C_{12}	**К10-17-3,3 пФ ± 5%**	2	
C_8	**К10-17-0,3 пФ ± 5%**	1	
C_{11}, C_{13}	**К10-17-0,27 пФ ± 5%**	2	
C_{16}	**К10-17-0,39 пФ ± 5%**	1	
C_{17}	**К10-17-51 пФ ± 5%**	1	

Поз. обознач.	Наименование		Примечание
	Катушки индуктивности		
L_1	**Индуктивность 5,6 нГн ± 10%.**	**1**	
L_2, L_4, L_6	**Индуктивность 100 мкГн ± 10%.**	**3**	
L_3, L_5	**Индуктивность 2,7 нГн ± 10%.**	**2**	
L_7	**Индуктивность 56 нГн ± 10%**	**1**	
	Транзисторы		
VT1,VT3,VT6	**КТ361 ФЫ 0.336.012 ТУ**	**3**	
VT2,VT4	**КТ996 аА 0.336.676 ТУ**	**2**	
VT5	**КТ939 аА 0.339.150 ТУ**	**1**	

Изм.	Лист	№ Докум.	Подпись	Дата	РТФ КП 431137.001 ПЭ		
Выполнил		Свалов С.С			Широкополосный усилитель мощности	Лит	Лист 2 / Листов 2
Проверил		Титов А.А.					
Принял		Титов А.А.			Перечень элементов	ТУСУР, РТФ, Кафедра РЗИ	

Foydalanilgan adabiyotlar ;

1 Титов А.А. Расчет корректирующих цепей широкополосных усилительных каскадов на биполярных транзисторах – http://referat.ru/download/ref-2764.zip
2 Титов А.А. Расчет корректирующих цепей широкополосных усилительных каскадов на полевых транзисторах – http://referat.ru/download/ref-2770.zip
3 Титов А.А. Расчет диссипативной межкаскадной корректирующей цепи широкополосного усилителя мощности. //Радиотехника. 1989. № 2.
4 Мамонкин И.Г. Усилительные устройства: Учебное пособие для вузов. – М.: Связь, 1977.
5 Полупроводниковые приборы: Транзисторы. П53 Справочник. В.Л. Аронов, А.В. Баюков, А.А. Зайцев и др. Под общей редакцией Н.Н. Горюнова. – 2-е изд, перераб. – М.: Энергоатомиздат, 1985 – 904с, ил.