



Atom. 构成 : Neutrons + Protons + Electrons
 中子 质子 电子

Amphere 安培 — Amps (A)

Coulomb 库仑 \leftrightarrow Joule 焦耳 <Energy>

Voltage 电压

EMF — Electromotive Force 电动势 back EMF: opposes applied EMF (3-2A5)

Resistance 电阻 ~ Conductivity 电导率 = $\frac{1}{R}$ — Resistor 电阻.

Potentiometer 电压器

\rightarrow double resistance

Variable Resistor 可调电阻.

$$\text{Amphere} = \frac{\text{Voltage}}{\text{Resistance}} \text{ ohm'}$$

1.5 V/cell alkaline/carbon-zinc battery <non-rechargeable>

1.25V/cell Nickel-Cadmium battery (NiCd) / Lithium-Ion battery <rechargeable>
 $1.25 \times 12 = 15$

$$\text{Ohm's Law: } I = \frac{E}{R} \quad (I = \frac{E}{R}, E = IR, R = \frac{V}{I}) \quad \begin{matrix} \text{full charged lead-acid:} \\ 2.06 \text{ Volts (3-6015)} \end{matrix}$$

$$\text{Conductance } S = \frac{1}{R}$$

Common best materials: Silver 银 Copper 铜 Aluminum 铝 Iron 铁 Lead 铅

All best materials: Gold 金 Silver 银 Copper 铜

DC — Direct Current 直流电

AC — Alternating Current 交流电

power — rate of energy (Watts)

$$P = IE = I^2 R = V^2 / R$$

$$\text{Horsepower (HP)} = ?$$

Mica most useful for isol. insulation at UHF

M — Mega, 1 Million 10^6

K — kilo, 1 thousand 10^3

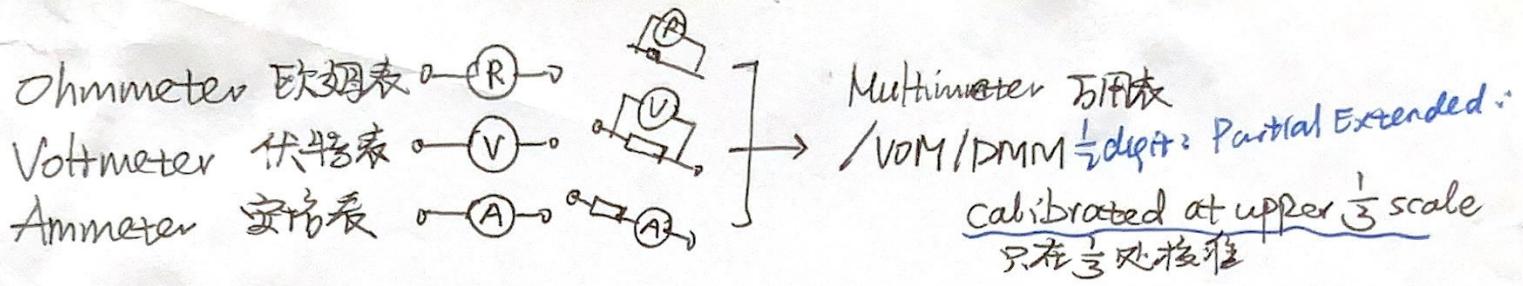
m — milli, 1 thousandth 10^{-3}

M — micro, 1 millionth 10^{-6}

n — nano, 1 billionth 10^{-9}

p — pico, 1 trillionth 10^{-12}

halved 减半



dB Tutorial:

$$\square \text{dB} = 10 \log\left(\frac{P_{out}}{P_{in}}\right) = 20 \log\left(\frac{V_{out}}{V_{in}}\right)$$

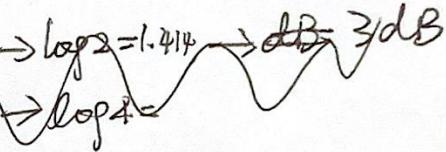
ratio

$$\begin{cases} 2 \rightarrow \lg 2 = .3 \rightarrow 3 \text{ dB} \\ 4 \rightarrow \lg 4 = .6 \rightarrow 6 \text{ dB} \\ 10 \rightarrow \lg 10 = 1 \rightarrow 10 \text{ dB} \end{cases}$$

$$\frac{P_{out}}{P_{in}} = 10^{\frac{1}{10} \square \text{dB}}$$

$$\frac{V_{out}}{V_{in}} = 10^{\frac{1}{20} \square \text{dB}}$$

dB-ratio
dBm-number



dBm	P_{out}	milliwatts	$P_{out} - 3$	W
dBW	P_{out}	Watts	$P_{out} - 1$	W
dBkW	P_{out}	Kilowatts	$P_{out} - 3$	W
dBμW	P_{out}	microwatts	$P_{out} - 6$	W

dB

Chap 31 - TTL

logic $A \rightarrow f \rightarrow A_s$ Boolean logic 布尔逻辑.

- \Rightarrow AND: both true \rightarrow true \Leftrightarrow NAND not both true \rightarrow true \Rightarrow
- \Rightarrow OR: either is true \rightarrow true \Leftrightarrow NOR all false \rightarrow true \Rightarrow
- \Rightarrow NOT: true \rightarrow false
- \Rightarrow XOR: one is true, but not both true \rightarrow true

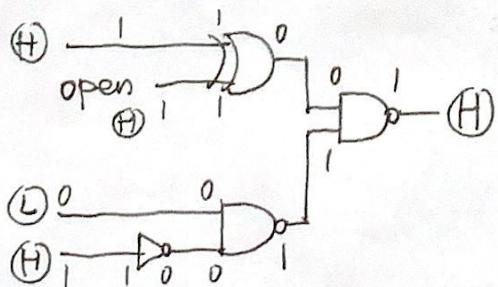
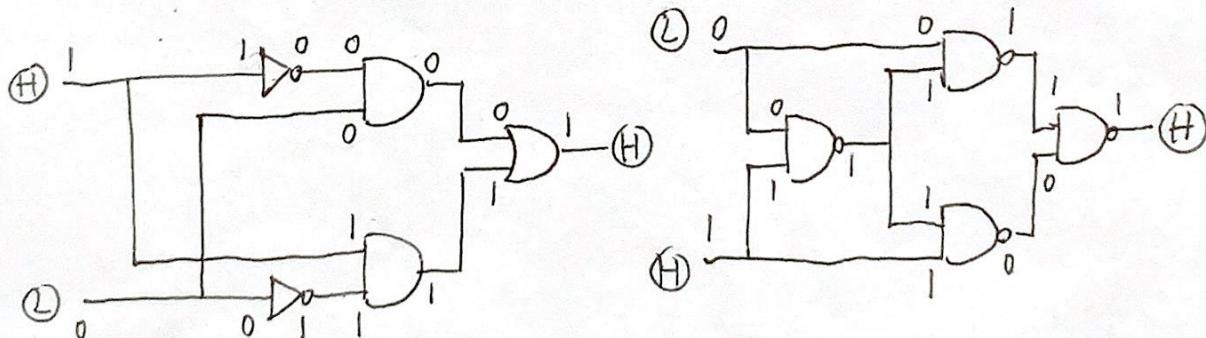
check TTL
Logic prob: indicate digital voltage states

open \rightarrow high.

✓ True = 5V = logic 1 = HIGH

\times False = 0V = logic 0 = LOW

decade counter: 10 input pulses \rightarrow 1 output pulses



Chap 32 - Multivibrators and Flip-Flops

多谐振荡器

Multivibrator: any circuit with 2 states

monostable / bistable / unstable / astable

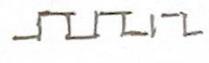
ab

单稳态 双稳态

astable multivibrator: between 2 unstable states

非稳态多谐振荡器

output: square wave 方波



monostable multivibrator: can switch to opposite binary state momentarily
单稳态多谐振荡器 and then return.

bistable multivibrator: Can store 1 bit of data
/ flip-flop 双稳态 (8 need to save 8 bits) divide AC signal
双稳态多谐振荡器
on/off 2 stable states
Can used as frequency divider: 2 flip-flops can divide frequency
by 4
No "toggle mode" 无翻转切换模式

MCU NOT contain voltage regulator

Chap 33 - Microprocessors and Memory

微处理器器

内存

RAM - random access memory Read + Write
随机存储器

DRAM - dynamic random-access memory — Must refresh periodically
(动态)

High density, cheap, complex to use

SRAM - Static r-a-m.
(静态)

ROM - read-only memory Read Only

fixed pattern of digital data stored in semiconductor's memory matrix

PROM — NOT reprogrammable

EPROM — Erasable with UV light

EEPROM — Erasable Electrically, erase in blocks

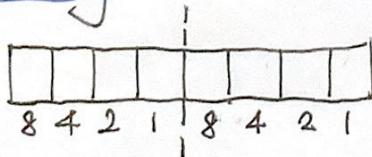


FLASH — Efficient, less expensive,

I/O — input-output

program - microprocessor's sequence of commands and instructions

BCD - binary coded decimal = 进制编码的十进制



CPU - Central Processing Unit 中央处理器

ALU - arithmetical logic unit 算术逻辑单元

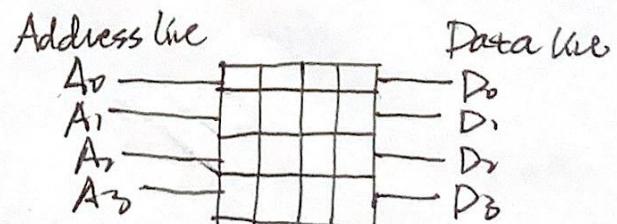
watchdog timer — verifies whether executing program.

clock — generate pulses, set speed of operations

data bus line — connect microprocessor and memory with input, output

* memory IC has 4 databus, 4 addresspins — then contains 64 memory cells

MCU NOT contain Voltage Regulator

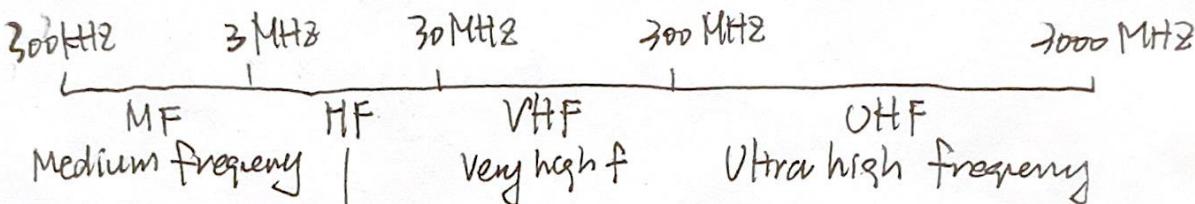


Chap 7 - radio waves

RADIO WAVES → f frequency Hertz (Hz), kHz, MHz
 无线电波 → λ wavelength meter

$$f \cdot \lambda = c \quad (300 \text{ million meters} / 186,000 \text{ miles})$$

$$\text{wavelength} (\lambda) = \frac{300 \text{ (M)}}{f \text{ (MHz)}}$$

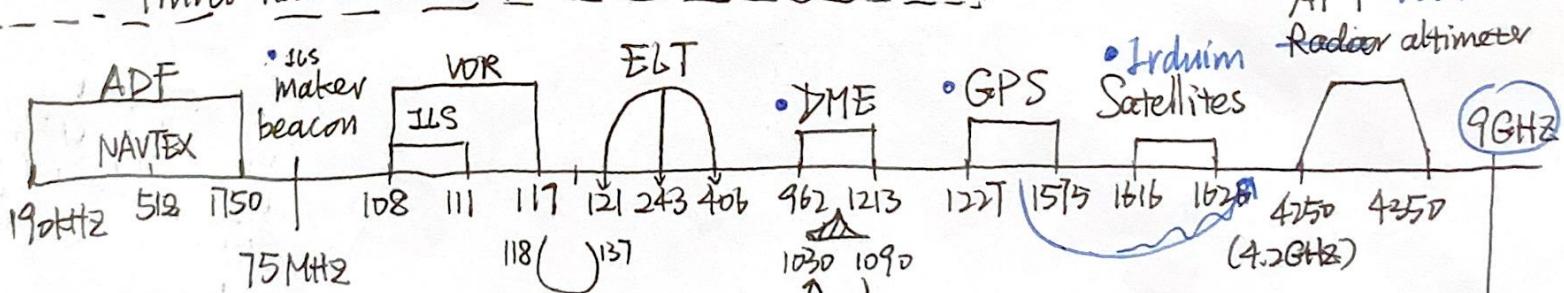


HF → high frequency
 can travel long distance around earth reflected by ionosphere
 电离层

harmonics 谐波 of frequency: $\times 2$

$$= \text{second harmonic} = f_0 \times 2 \Rightarrow \text{次谐波}$$

$$= \text{third harmonic} = f_0 \times 3 \Rightarrow \text{三次谐波}$$



ADF:
 Automatic Direction Finding
 use LF, MF beacon
 included in AM (540-1100)
 kHz

NAVTEX:
 Navigational telex

VOR:
 VHF Omni Range
 ILS:
 Instrument Landing System

ELT:
 AFT emergency locator transmitter
 121.5, 243, 406 MHz

DME:
 AFT Distance Measuring Equipment
 Aircraft radar transponders transmit
 1030 ← 1090 MHz

GPS:
 Global Positioning Service
 1227.6 - 1575.4 MHz

SART
 search and rescue transponder
 (B) 12 equally spaced dots

begin transmission:
 After being activated
 the SART responds to
 RADAR interrogation

VHF marine radio

frequency of channel spacing 25 kHz

maximum allowable frequency deviation ± 5 kHz

(channel 1b: distress and calling

(channel 70: Digital Selective Calling ↓

registered 9-digit MMSI activate DSC emergency signaling
(maritime mobile service identity)

海工移动服务标识

USA-INT control: control SOME duplex channels to simplex
双工信道 单工.

Chap 8 – Spread Spectrum 扩频

Chap 9 – Capacitors / Inductors 电容电感

Data Multiplexing Shares: separate

FDMA – Frequency Domain Access using different f

TDMA – Time Domain Access using different t

CDMA – Code Division Multiple Access different codes
same f, t

Spread spectrum: 扩频

wide bandwidth communication system, 宽带宽通信系统

RF carrier varies according pre-determined sequence
射频载波 频段顺序变化

use of multiple simultaneous carriers 多个同时载波

on pre-determined list of pseudo-random channels 假随机信道表

use frequency hopping of single carrier 单载波跳频

/ direct sequence 直接序列

② FHSS – Frequency hopping spread spectrum 跳频扩频

① DSSS – Direct Sequence Spread Spectrum 直接序列扩频

receive unique code and decode

Capacitors 电容 γF (Farad)

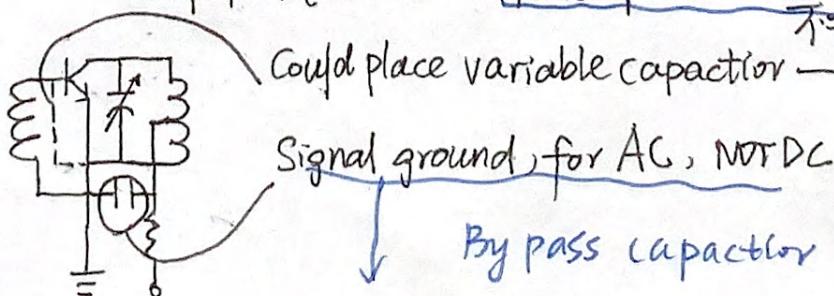
dielectric 电介质 – non-conducting material

air relative dielectric constance: 1 $\epsilon_{air} = 1$

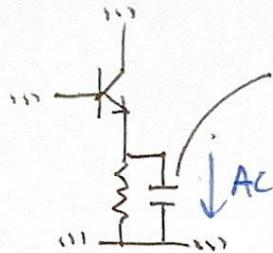
Coupling capacitor block direct current, pass AC

if fail (not short, "fails open") \rightarrow NO amplification, normal V
不会放大

Could place variable capacitor – decrease parasitic oscillations
寄生振荡

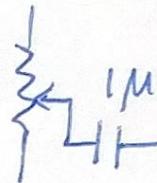


$$C = \frac{\epsilon S}{4\pi kA}$$



by pass capacitor 旁路电容

Remove AC to ground.



1MF - adjust tone

Capacitor pass RF signals NOT DC current

↳ solve radio frequency interference 射频干扰

0.1 μF capacitor 容量 0.1 μF 电容

Inductor 电感 (Henry, H) 磁场能量

Store energy in magnetic field \leftrightarrow Capacitor store in electrostatic field

larger coil \rightarrow larger inductance
大线圈 大电感

reduce inductance: reduce number of turns

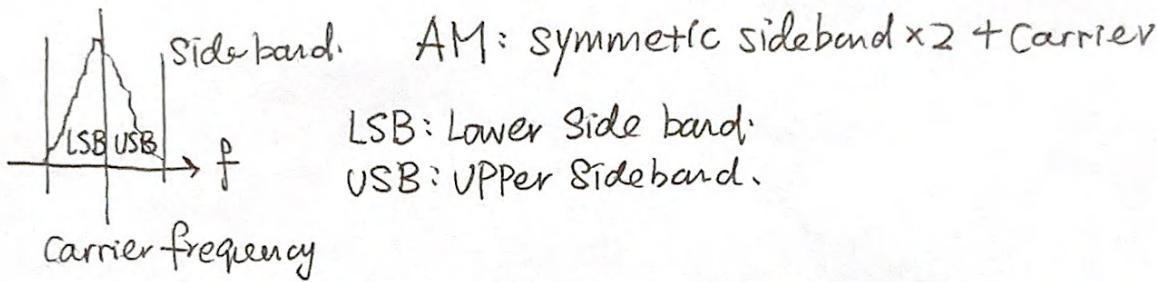
$$m \Rightarrow m \\ L \downarrow$$

$$L = L_1 + L_2$$

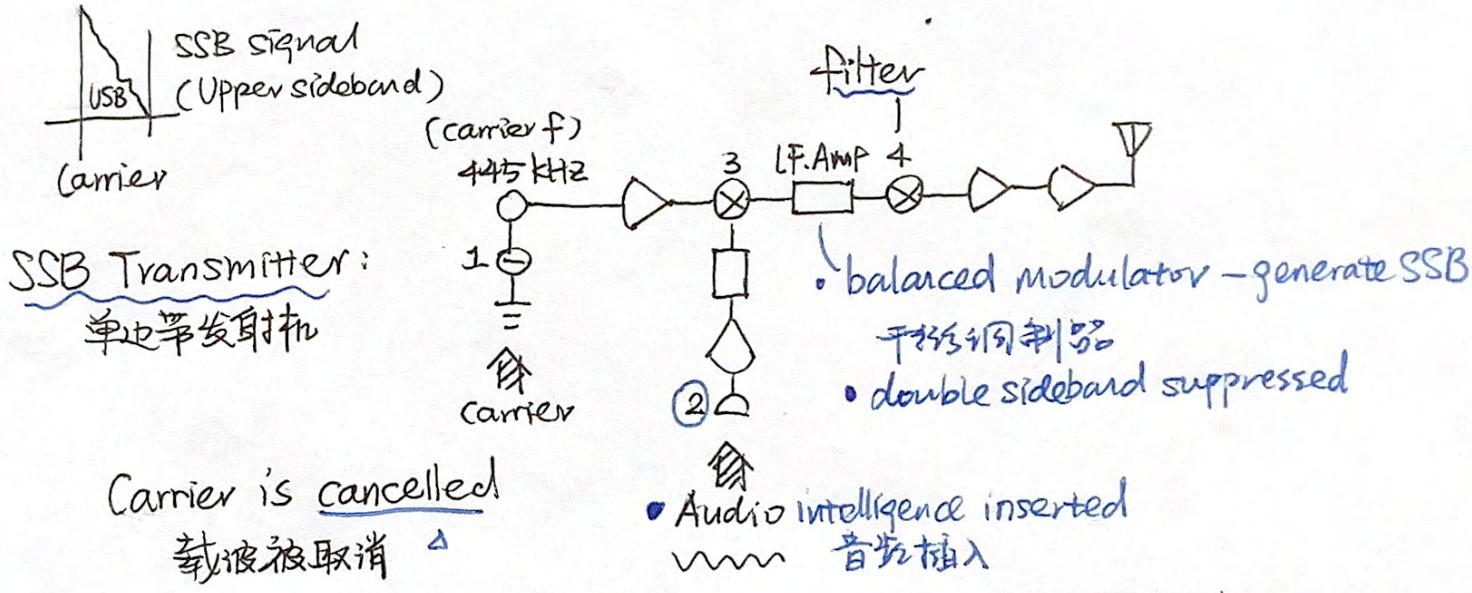
Chap 22 - Single Sideband & AM.

单边带.

调幅 Amplitude modulation



SSB: Single sideband 单边带, HF marine and AFT communication.



SSB modulation: $P_{\text{output}} \propto \text{Amount of modulation}$ 输出功率 \propto 调制量 正比

| 调制

J3E emission J3E 型发射

Peak voltage Amp A

PEP - peak power 峰值功率

speaker silent $\rightarrow P_{\text{output}} = 0$

$\frac{\text{PEP}}{\text{average power}}$ RATIO depends on speech characteristics

- voltage indicator may glow if Speech = 0, still have P_{output} \rightarrow transmitter wrong

phone 2.5 m! causing carrier transmitted

TEST SSB linearity: two-tone test 双音测试

• oscilloscope 示波器

two tone must not be harmonically related. 双音节不能相关

Amplify SSB signal: linear amplifier (same shape waveform) \rightarrow nonlinear distortion 失真

evaluate linearity: peak voltage of input signal

AM modulation: can use class C (nonlinear) final amplifier (Produce double-side band)

Chap 23 - FM

FM: Frequency Modulation 调频

phone ↓ land mobile service and VHF marine radio
• produced by oscillator / phase modulation
 • directly 振荡器 ↓ 相位调制
phase modulation: carrier f change \Rightarrow modulation index NOT change
载波频率变化不影响调制指数

Deviation: modulation caused Maximum Difference in Carrier frequency 偏差

Normal in VHF and FM: $\pm 5.0 \text{ kHz}$ • Maximum deviation

$$\text{Deviation ratio} = \frac{\text{Max Deviation (carrier } f)}{\text{Max audio modulating } f}$$

$$\text{Modulation ratio} = \frac{\text{Max Deviation of}}{\text{modulating } f}$$

Squelching systems: no desired signal \Rightarrow turn off speaker
静噪系统 无音频信号 关闭扬声器

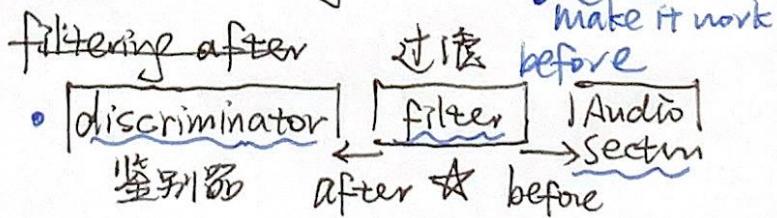
most FM have squelch control:

Squelch: noise \Rightarrow speaker off \Rightarrow no signal received

other squelch: Digital Coded Squelch: Digital Codes

CTCSS continuous tone-coded squelch system "PL"
连续音编码静噪

continuously transmitted tones with audio



TEST FM transceiver: Service monitor 服务监视器

Programmable: use laptop computer
monitor frequency and check receiver sensitivity

Chap 24 — Bandwidth 带宽

signal bandwidth < receiver's IF filter bandwidth.

Single sideband phone $2\text{ kHz} < 2.1\text{ kHz} / 2.4\text{ kHz}$

Weather fax reception $< 1\text{ kHz}$ filter

Double-Sideband AM $10\text{ kHz} <$

FM voice signal $15\text{ kHz} < 16\text{ kHz}$

To determine effective bandwidth: modulation-acceptance bandwidth test
调制接收带宽测试

Chap 17 - Oscillators 振荡器

(Chap 18 - Receivers 接收器)

Oscillators: produce AC, including AF (audio Frequency) and RF (radio f.)

Require sufficient ^{positive} feedback to change input from output.
需要足够的反馈 音频 耦合
signal overcome noise

3 types: Colpitts: use as VFO (variable f oscillator 变频振荡器)
stable

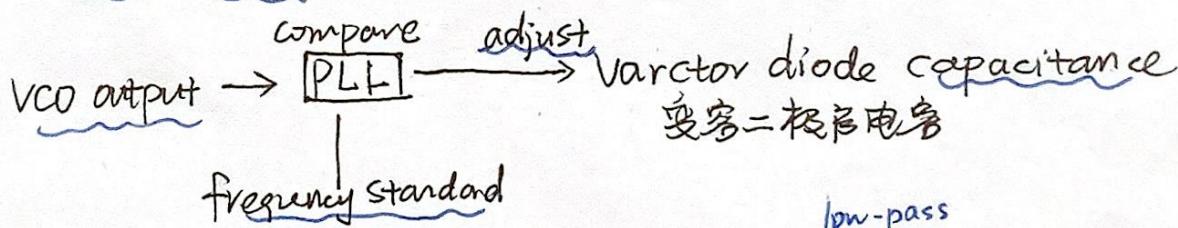
Hartley

Pierce: use piezoelectric effect, voltage cause crystal mechanical vibration
压电效应 英文

VCO - Voltage Controlled Oscillator 压控振荡器

used in Frequency synthesizers 频率合成

PLL - Phase Lock Loops 锁相环



PLL is serv loop contain: phase detector, LP filter, VCO
伺服电路 监相器 滤波器 压控振荡器

disadvantage: broadband Noise 宽带噪声

DDS - Direct Digital Synthesizer 直接数字合成器

use phase comparator, look-up table, DAC, LP anti-aliasing filter
• 相位比较器 查找表 LP混叠滤波器

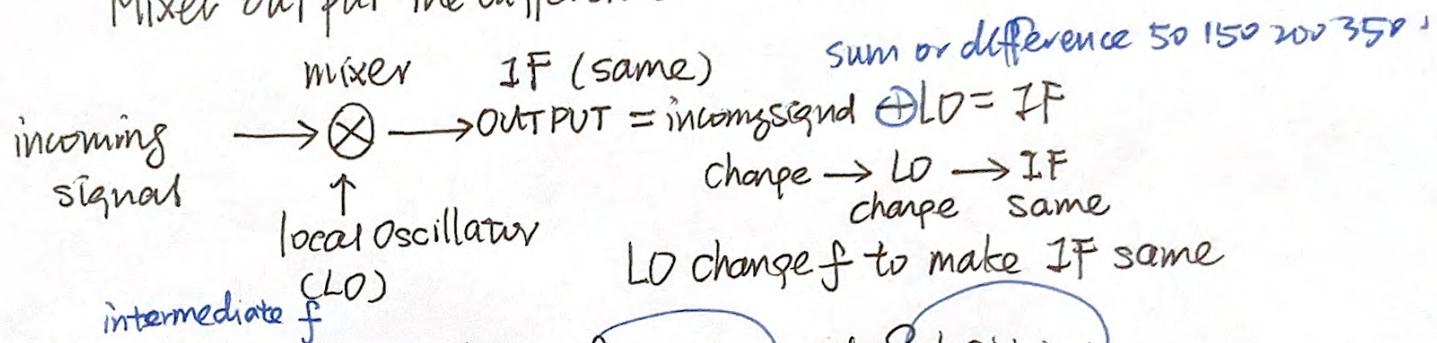
disadvantage: Spurs at discrete frequencies
高放频率

• Digital to Analog Converter
数模转换器

Chap 18 — Receivers

Mixing 2 signals: incoming signal (Desired Tuned Frequency) +
Combination with Local Oscillator (LO) with Mixer

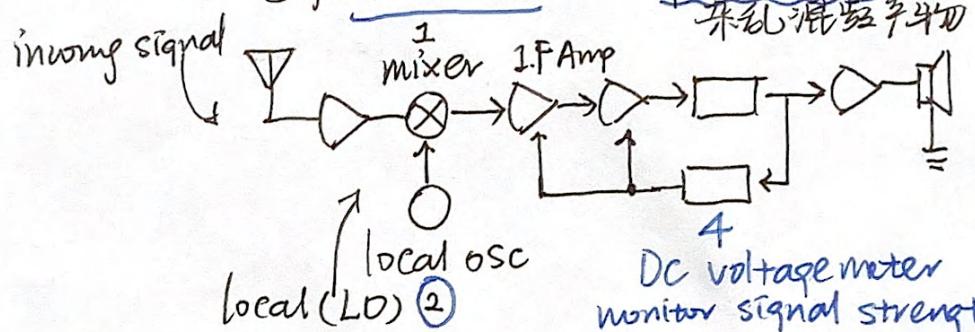
Mixer output the difference



IF depends on Image Rejection and Selectivity

Signal excessive → spurious mixer products

杂乱混频产物



Measure signal strength: DC voltmeter at 4 → AVG (AGC - Auto gain control)
自动增益控制

- In micro-miniature electronics: use SAW filter in IF stage
微型电子设备

Image Response Interference: mixer "sees" input f × 2 higher/lower as turned f
镜像响应干扰

→ Remove RF stage REJECT RF stage

In SSB: Product detector of mixer combines IF + Beat Frequency Oscillator
混频器的乘积检测器 中频 振荡器
using mixing process

Notch filter: use "notching out" reduce carrier interference
陷波滤波器 阻带

Discriminator: FM receiver
鉴频器

I.F. amp → to audio

Sensitivity: can receive how weak signal
Desensitizing: sensing reduction because nearby strong signal
Noise Floor (level of background noise or circuit)

unwanted high-end

RF amp improve noise figure RF stage primarily establish noise figure

Noise figure: how much frequency increase

随着射频 compared with noise, cause interference
level of noise in front and succeeding stages of receiver
SNR (Signal to noise ratio) similar to $\frac{P_{\text{signal}}}{P_{\text{noise}}}$ VHF receiver

Cross-Modulation interference: unwanted modulation on desired f
交叉干扰调制 VHF by strong signal nearby transmitters

GaAs FET — preamp in VHF receiver — high gain, low noise floor
前放放大器

• Front end RF stage

Dynamic range = $\frac{\text{Strongest tolerable signal}}{\text{Minimum discernable}}$ 最强可容忍信号 / 最小可辨别信号
动态范围

Selectivity: separate between 2 close frequency

选择性 Receivers ability

improve by preselector 精选器 — selectivity in front-end circuitry

Super-Het advantage:

circuitry only need amplify IF filter

• Final IF amp increase receiver's gain

First — increase selectivity

receiver's detector: recover intelligence from modulated signal

detection in SSB: product detector • use mixing process with locally generated carrier.

• in FM: frequency discriminator 频率鉴相器 circuit detects FM signals

DSP: digital signal processor 数字信号处理器

remove noise from receive signal • Adaptive filtering and autocorrelation

advantage: wide filter bandwidth range, shapes

signal (analog) \rightarrow (digital) \rightarrow digital processing
模拟信号 数字信号 数字处理

analog to digital converter

digital to analog converter

digital processor chip

• DSP NOT CONTROL SWR

SDR - software-defined radio 软件定义无线电

software process signal

have built-in self-test feature: quick overall evaluation

内置自检功能

low-pass filter: in Powersupply, AVC/AGC, NOT in oscillator

低通滤波器

不在振荡器里。

deemphasis: if had re-emphasis + noise reduction

去加重

Chap 19 - Amplifiers 放大器

Class A: entire signal cycle, highest linearity, least distortion
(360°) 转一周 线性 最小失真
least efficient

Class AB: $180^\circ < AB < 360^\circ$, eliminate cross-over distortion, 50% efficiency
(half wave cycle)

Class B: 180° , push-pull, causes distortion when crossing over
(half) 推拉式

Class C: $C < 180^\circ$, bias 偏差 beyond cutoff, great efficiency
(less than half)

~~neutral~~

neutralization: adjust Capacitor near output to neutralize amp
中和 prevent oscillating tube/transistor
eliminated in power amp ↓
parasitic signal 寄生信号

push-pull amplifier reduce even-order harmonics

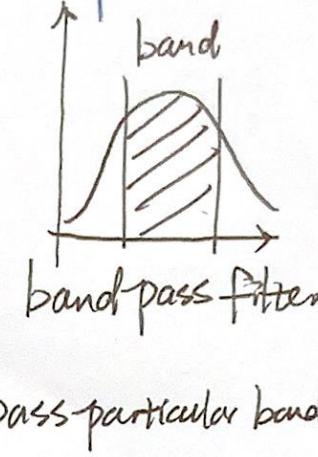
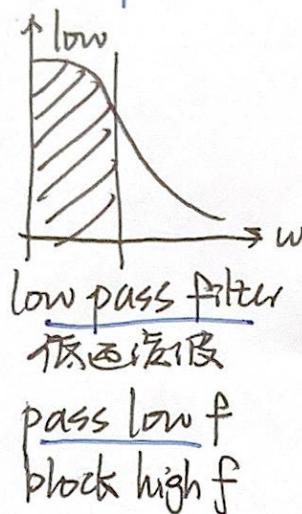
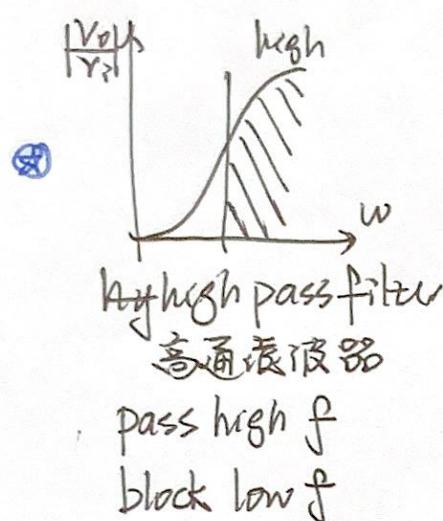
推拉式放大器

减少偶次谐波

(class B)

Chap 20. Filters

three general group



Chebyshev filter — allow ripple in the passband
纹波

- m-derived filter — f close to constant-k filter's cutoff f .
when using constant-k filter:

Butterworth filter — maximally flat response
最大平坦响应

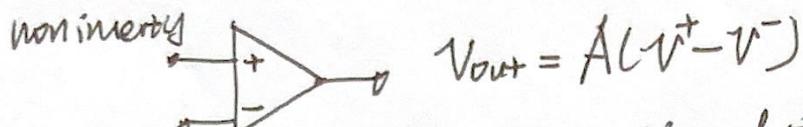
high attenuation of signals \sim far removed from the passband

If receiver IF section filter bandwidth too wide — Then undesired signals will reach the audio stage

Operational amplifiers — exhibits gain rather than loss
运算放大器 表现出增益

Op-amp: bandpass characteristics — Most important parameter
带通特性 (when designing)

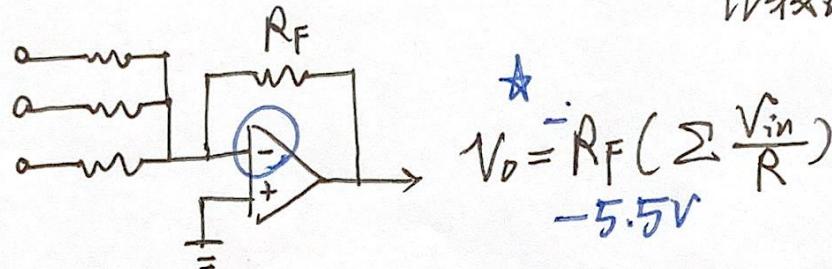
Chap 21 Op-Amps 运算放大器



output proportional to input difference

feedback — output \rightarrow input

without feedback — Open-loop — Comparator
比较器

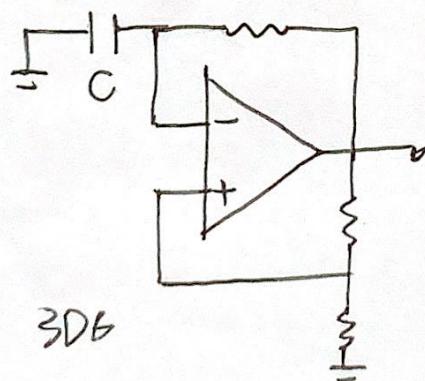
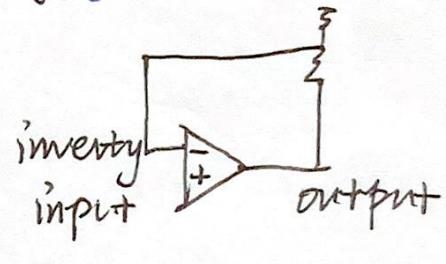


inverting op-amp: Input and output 180 degree out of phase

Gain of

Closed-loop op-amp: external feedback

from output \rightarrow inverting input



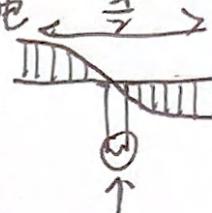
C doubled \rightarrow Frequency lower

Chap 25 Antenna and Feedlines

天线

馈线

half-wave dipole long: half-wavelength, feed in center
 半波偶极子 半波长 中心馈电



end of antenna: Maximum Voltage
 minimum current

quarter-wave vertical $\frac{1}{4}$ wavelength
 四分之一波垂直天线
 transmit signals equally from all horizontal directions.

lengthen antenna: add inductance in series
 加长天线 电感 lower frequency ↓

Shorter antenna: add capacitor in series
 缩短天线 电容 higher frequency ↑
 Shorten band width — decrease loady coils

antenna band width: frequency range

Multiband antennas: Traps prevent signals of f to part of antenna.
 多频带天线
 Multiband operation traps $\frac{1}{4}$ wavelength antenna

excited antenna (hooked up) \rightarrow electromagnetic and electrostatic fields
 激发天线 电磁场 静电场
 excited in $\frac{1}{4}$ length of antenna

antenna radiation resistance — Match transmitter's impedance
 天线辐射电阻 与发射器阻抗匹配

"equivalent resistance that would dissipate the same amount of power as that radiated from antenna"

Receiving: Voltage is proportional to field strength
 \propto 场强

SWR—Stand wave ratio

驻波比

perfect SWR: 1:1

30W \Rightarrow 25W actually radiated
 5W back $\xrightarrow{5 \text{ watts}}$ $\xleftarrow{7 \text{ dB}}$ 1Watts!

high SWR: detuned antenna coupler
失谐天线耦合器

SWR meter: Verify antenna function

Skin effect — RF current flows in a thin layer close to surface

集肤效应

射频电流

靠近表面的薄层

Thinner as frequency increase

Velocity factor = $\frac{\text{velocity through feedline}}{\text{speed of light}}$
 速度因子 $\xrightarrow{\text{determine}}$ 影响
 affected by dielectrics 电介质

Nitrogen used in feedlines — prevent moisture

氮气

水分

TDR—Time domain reflectometer = Oscilloscope + pulse generator

时域反射仪

示波器

脉冲发生器

frequency domain reflectometer — used for checking antennas

频域反射仪

most accurate

and transmission lines at the particular operating f of antenna

在天线特性工作频率下检查天线、传输线

Isolator — allow RF energy pass in ONE direction

隔离器



Chap 26 Interference 干扰

Phase-type interference — reduce: Resistance in series with spark plug wires
脉冲型干扰 在火花塞导线串联电阻

Ferrite beads — primary and secondary ignition leads
铁氧体磁珠 初级和二级点火引线

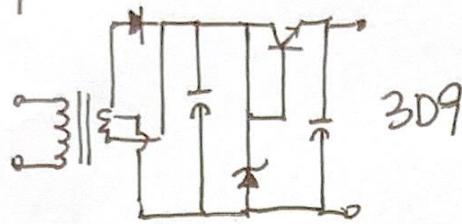
EMI—Electromagnetic interference — use portable AM radio
电磁干扰 使用便携式 AM 收音机

Intermodulation interference — two transmitters close
互调干扰 signal mix

eliminate by installing a terminated circulator or ferrite insulator in the feed line
通过在馈线中安装端接环行器或铁氧体绝缘部件

Shorted Stub line — $\frac{1}{4}$ wavelength
短截线

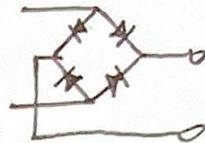
Chap 27 Batteries and Power Supply



No problem!

full-wave rectifier
全波整流器

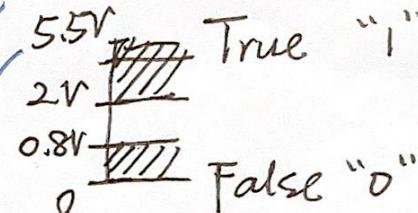
$$\frac{\text{Output } f}{\text{Input } f} = 2:1$$



$$\text{regulation percentage} = \frac{\text{No load - load}}{\text{load}}$$

TTL—Transistor-transistor logic

Voltage supply: 5 V



$$12.5V \text{ DC } 0.5A - 110V \text{ DC } R = \frac{110}{0.5} = 220 \Omega$$

$$R_D = 220 - 12.5 = 0.5$$

$$R = \frac{E - V_o}{I} = \frac{110 - 12.5}{0.5} = 195 \text{ ohms}$$

50W, 6h, 70% load 40A, 1.5A load

$$A \cdot H = (40 \times 0.7 + 1.5) \times 6 = 177 \text{ A} \cdot \text{H}$$

325W + 55W, 12.6V, 55A

$$t = \frac{12.6 \times 55}{325 + 55} \approx 1.8 \text{ h}$$

315W + 50W, 50A · H 12.6V

$$t = \frac{50 \times 12.6}{315 + 50} = 1 \text{ h } 43 \text{ min}$$

75W + 325W, 50A · H, 12V

$$t = \frac{50 \times 12}{325 + 75} = 1 \frac{1}{2} \text{ hours}$$

50W + 300W, 12.6V, 8A · H

$$t = \frac{12.6 \times 8}{50 + 300} = 17 \text{ min } / 0.3 \text{ h}$$

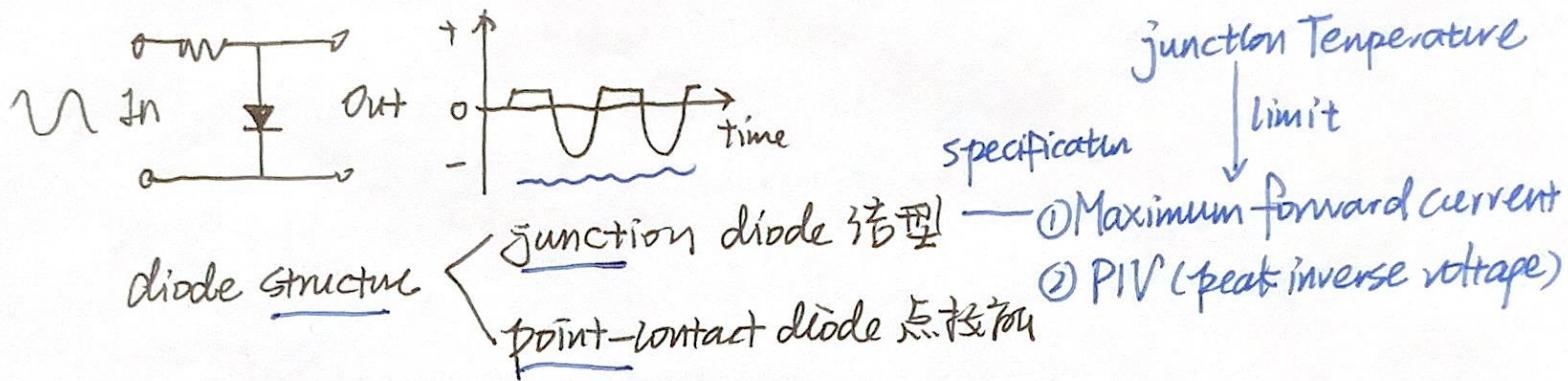
6V $R_{in} = 0.01 \text{ ohm}$, 3W 6V

$$I = \frac{6}{0.01 + \frac{36}{3}} = 0.4995 \text{ amps}$$

$$I = \frac{6}{1.2 + 6} = 0.83 \text{ amps}$$

Chap 10 Diodes 二极管

→ Forward biased - low impedance
正向偏置



Zener diode — use establish reference voltages in regulators

齐纳二极管

2.4V - 200V and above



20V, 8Ω, 5-95mA, middle of range - 200Ω

Light emitting diode - LED max 20mA Forward bias
发光二极管 material → color luminescence

opto-isolator use LED and photo-diode
/ optocoupler (photosensitive device)

PIN diode - RF switch protect LED - series resistor

Hot carrier diode - VHF and UHF detector

Tunnel diode - application: oscillation
principle characteristic 放大 反馈
negative resistance region

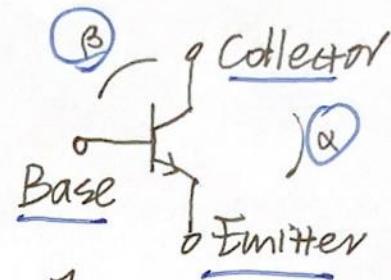
Varactor diode - varies internal capacitance as applied Voltage

detection in radio diode detector: Reflection and filtering of RF

Chap 11 Semiconductors

半导体

BJT — bipolar junction transistor
双极性晶体管



$$\alpha = \frac{I_C}{I_E} \quad \beta = \frac{I_C}{I_B}$$

Beta cutoff frequency: $f_E = f_{max} - 0.7D_f$

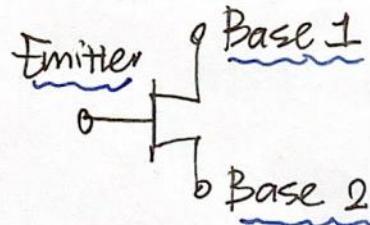
Saturation: Collector current maximum
Base > both forward bias
饱和

Cutoff: collector current minimum
截止 N ~ Emitter and collector

NPN — at least 0.7 positive

VJT — Unijunction Transistor

单结晶体管



JFET < N-channel P-channel > Junction field-effect transistor

FET — Very HIGH input impedance

FET HIGH input impedance
bipolar transistor

MOSFET — built-in Zener

LOW input impedance

CMOS — Complementary metal-oxide semiconductor
互补 金属 奉作物 半导体

Static electricity → damage $R < 100,000 \Omega$
静电

Photocductive device
光电导元件

light → $R \downarrow$ → Conductance ↑

photoconductive effect

in crystalline solid: The Resistance of Solid

Voltage regulator 稳压器

Conduction proportion to line V/I

Switch regulator 开关稳压器

adjustable PWM by switch output ON/OFF

SCR - Silicon-controlled rectifier 可控硅整流器

Parallel to increase power

SCR terminal: Anode, Cathode, Gate

TRIAC 双向可控硅 - 2SCR back-to-back

Anode 1 (MT1), Anode 2 (MT2), Gate

$\text{V}_{\text{common-base AMP}}$ $>$ $\text{V}_{\text{common-emitter AMP}}$ $>$ $\text{V}_{\text{common-collector AMP}}$

$I_{\text{emitter-follower}}$ $>$ $I_{\text{common...}}$

Chap 12 Waveforms

Sinewave: projection of a point on wheel ④

Square wave 方波 abruptly change



complete Sinewave circle: 360°

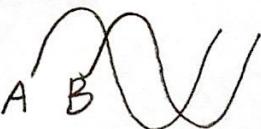
$= \sum$ odd-harmonics of fundamental f
奇次谐波

Sawtooth wave 锯齿波 Rise slow, fall fast

$= \sum$ harmonics

$$e = E(\sin\theta)$$

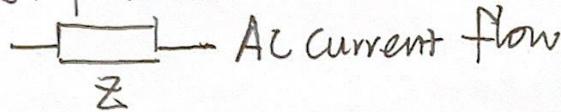
Polar Coordinates 极坐标 angle, magnitude as phasor/vector
相量 夹量

phase shift A  B lagging A 90°

Chap 13 AC Electricity, Reactance, Impedance and Resonance

交流电、电阻、阻抗和谐振

Impedance



$$\sqrt{R^2 + X_L^2} = Z$$

$$\tan \theta = \frac{X_L}{R}$$

$$jX_L - X_L = 2\pi f L$$

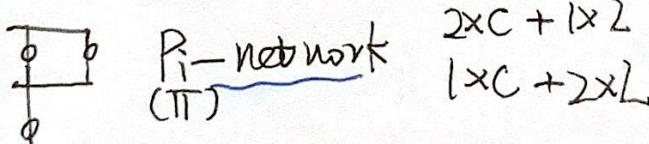
$$-jX_C - X_C = \frac{1}{2\pi f C}$$

Maximum power:

Load impedance = internal



L-network $jX_C + jX_L$



L-Pi(π)-network $2jX_C + 2jX_L$

Resonance X_C and X_L equal and cancel out

$$f - X_L = X_C$$

Voltage greater Current Maximum, in phase with Voltage

$$\text{parallel: } 159 - j150$$

$$4000n \quad 2490 \angle -51.5^\circ$$

$$400n \quad 240 \angle 36.9^\circ$$

product of AC voltmeter and AC ammeter

$$I \cdot V$$

S, Apparent Power

视在功率

$$j\theta$$

P, real power

有功功率

Q, Reactive Power

无功功率

out of phase

alternates

$$\text{power factor } \text{pf} = \cos \theta$$

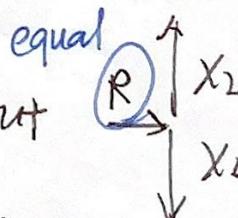
between magnetic and electric

Real power = pf · apparent power

$$P = WS \cdot S$$

Capacitor - Improve power factor

Greatest harmonic suppression



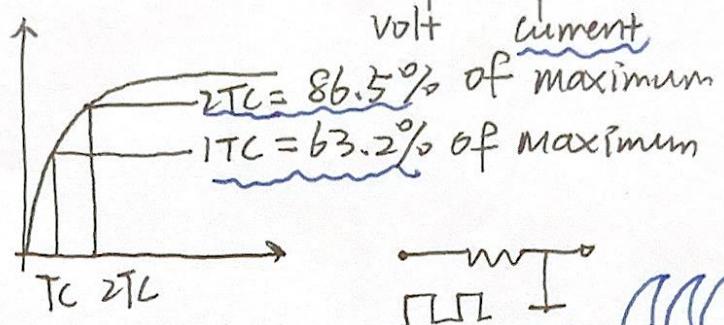
Chap 14, 15, 16 Time constants, Transformers, Decibels

时间常数

变压器

dB 分贝

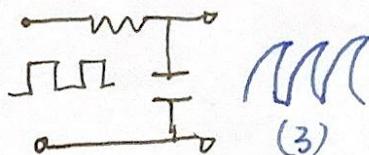
$$\text{Time constant} - T_C = R_C = \frac{R}{L}$$



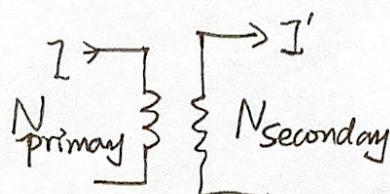
micro 10^{-6}

mega 10^6

22a 47



Transformers



Mutual Inductance
互感

$$\frac{V_{\text{secondary}}}{V_{\text{primary}}} = \frac{N_{\text{secondary}}}{N_{\text{primary}}} = \sqrt{\frac{\text{Impedance}}{\text{Impedance}}}$$

$\sum \frac{1}{\sum} \frac{1}{150}$ — highest resistance

Airline equipment: 400 Hz — Smaller and Lighter

dB - $\times 2 \rightarrow 3 \text{ dB}$

分贝 $\div 2 \rightarrow -3 \text{ dB}$

$\times 10 \rightarrow 10 \text{ dB}$

ratio = $\sum \text{dB}$

transmitter $\times \text{dB(gain-loss)}$
power output

double frequency
 \hookrightarrow gain — increase (6dB)

Chap 28 Motors and Generators

电机

发电机

One horsepower = 746 watts

remove load from DC series motor → Speed up til falls apart

shunt field open from Shunt motor → Speed up
并联电机

Shunt motor "Voltage regulation" — Voltage fluctuation load → no load

Output of AC generator — adjust by Varying amount of field current
constant speed 改变励磁电流大小

$$I = \frac{P}{V} = \frac{P_{in}}{\text{pf}} = \frac{P_{out}}{\text{pf} \cdot \text{eff.} \cdot V} = \frac{746 \times n}{\text{pf} \cdot \text{eff.} \cdot V}$$

$$\frac{7 \times 746}{0.8 \times 0.95 \times 120} = 57.2 \text{ amps}$$

$$\frac{3 \times 746}{100 \times 0.85} = 26.3 \text{ amps}$$

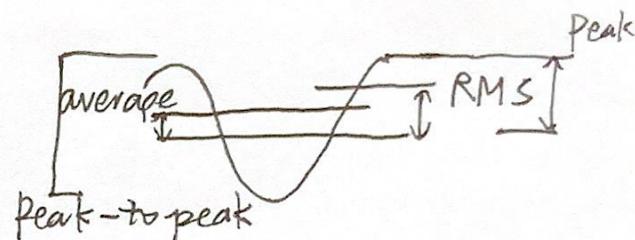
Chap 29 RMS and PEP

RMS - root mean square - Same power dissipation as a DC
均方根 Voltage of the same value
 $\text{RMS} = 0.7 \times \text{Peak}$ $1.414 \rightarrow \text{Peak voltage}$

AC meter - indicate RMS values

household voltage - 117V (RMS)

peak household voltage - 165.5V



Peak-to-Peak voltage - easiest V to measure oscilloscope

$$\text{average} = 0.9 \times \text{RMS} = 0.637 \times \text{Peak-to-Peak}$$

PEP - Peak envelope power

峰值包络功率

$$200\text{V peak-to-peak}, 50\Omega \rightarrow 100\text{W}$$

$$P_{\text{out}} = \frac{\left(\frac{200}{2} \times 0.7\right)^2}{50} = 98$$

$$50\Omega, 100\text{W} \rightarrow 245\text{V}$$

Chap 30 Safety

Lead-acid battery dangerous — emission of Hydrogen gas

Wear safety glass! — repairing circuit board

Cables — don't interfere with the normal operation of vehicle

RF heating → cataracts 白内障

Power drill — No without protection

U.S. Health Department limit — 5.0 mW/centimeter

"controlled" environment → 6 min

"uncontrolled" environment → 30 min

MPE — average 1000Watts ~~RP~~ ERP

certified yearly

before ground test by RADAR.
Ensure infant clear!

multiple antennas: 5% of the maximum power density exposure

NEVER look into fiber optic cable — burn retina

infra-red signal — unable to see

Impossible to against direct lighting hit — No device

Sharp bend — lighting can jump off the ground lead

FEZD — electrical fires

GFI prevent electric shock — ground path current and Shutoff
down the circuit

Shorted-stub protector — No, only work tuned frequency band

Cheat 34 - Air NAV/COM

VOR - VHF omnidirectional range
超高频全向范围

① all directions → ② directional antenna 30 times/second
measure phase difference, "azimuth"
方位
"radial" 纬向

in phase → when antenna pointy magnetic north, 360 degrees

VOR - magnetic north!

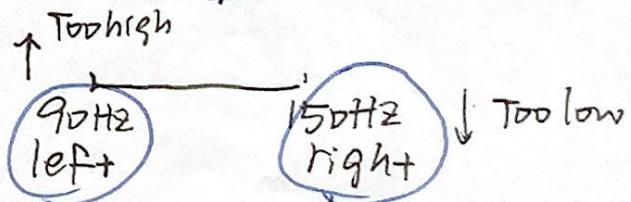
VOR antenna: horizontally polarized omnidirectional antenna
and LOC 水平极化全向天线

DME - distance measuring equipment 测距仪
measures time, "slant range"

Most DME automatically
turn transmitter/receiver
to paired VOR/LOC chan-

has delay - allow operation at close range

ILS - instrument landing system
仪表着陆系统



ILS
Localizer - horizontal position, right/left
glide slope - ~~folded dipole antenna~~ balanced loop-marker beacon
折叠偶极子 折叠偶极子

ADF - signals ^{max} can follow curvature of earth, hundreds miles away

"night effect" - NDB received any direction
bounce off the ionosphere

ground station \rightarrow 1030 MHz, directional pattern

Model C: Pulse position modulation

Transponder is omnidirectional L-band monopole

Model S: has mid-air collision avoidance capabilities

空中防撞

HF transmitter: 100 watts

VHF transmitter: 20 watts

Aviation communications: dynamic microphones

SELCAL (selective calling): call selected aircraft

without crew monitoring frequency

Chap 35 Air Navigation 空中导航

GMDSS - Global Maritime Distress Safety System

海上遇险安全系统

EPRIB, NAVTEX, INMARSAT, HF radio, Search and rescue.

GMDSS primary source

EPRIB - emergency position-indication radio beacons

406 MHz

unique hexadecimal identification 十六进制

determine location position

NAVTEX - navigation text

begin with subject indicator

receiver can program to reject messages

★ SITOR-B or FEC mode

SITOR - simplex teletype over radio 单工无线电传

NOT necessary to two-way communication

ARQ - data groups consisting of three-character blocks

ARQ - two-way communication

FEC - one-way communication, to all stations

SFEC - one-way communication, to single station

SITOR 7 bits = 4 × 0 + 3 × 1

0000111 = 1

SART - Search and rescue transmitter

Show in RADAR Screen: 12 equally spaced dots

begin transmission — after activated SART

response to RADAR interrogator

DSC - digital selective calling

GMDSS - DSC

10 bit error correctly code, followed 3 bits error correctly

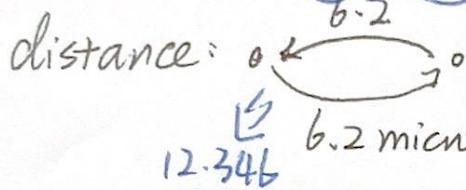
HF weather facsimile transmission: 120 lines per min

facsimile: print picture on paper

Chap 3b RADAR

direction: synchro transmitter and receiver

↳ transmit the antenna's angular position

distance:  nautical mile - 1.15 statute mile
6.2 microseconds / nautical mile

Shipboard radar - SHF portion

舰载雷达

magnetron tube — power output of RADAR

pulse repetition rates normal range: 500 ~ 2000 pulse/second

pulse width: 0.05 ms to 1.0 ms

Long range: wide pulse, slow repetition

Short range: narrow pulse, fast repetition

Close target: 1.5 miles

pulse width 0.05 ms repetition rate: 2000

Mid target: 6 miles

0.25 ms

1000

Away target 48 miles / 25 miles

1.0 ms

500

Keep TR properly tuned — Nothing to do with protect magnetron

circulator duplexer — electronic switch

ATR box — prevent signal enter transmitter

Echo box — determine RADAR performance

Conductance through waveguide takes place through electromagnetic and electrostatic fields in the walls of waveguide.

Energy is coupled into and out of the waveguide with thin piece of wire as an antenna.

J-hook pick up device — extract RADAR signal from waveguide

Slotted array — common type of shipboard RADAR antenna

Exhibit gain → bandwidth ↓, gain ↑
decrease

traveling wave tube surrounded by a magnetic field
— prevent electron beam from spreading

Anemometer — NOT in input
风速计

ARPA — Automatic RADAR Plotting Aid

自动雷达绘图辅助

Chap 3T Pulse Modulation

脉冲调制

pulse modulation: Peak power much greater than average power

- ① Pulse width modulation

transmit voice, vary duration of pulse

- ② Pulse position modulation

Varies the time at which each pulse occurs

Pulse-code modulation using time division multiplex:

Important to synchronize the transmit and receive
clock pulse rates.

Chap 4.5, b Magnetism, Galvanic Corrosion, Parts Per Millions

- amount of current — determine strength of field

Lenz's law. induced currents produce expanding magnetic fields around conductors in a direction that opposes the original magnetic field.

- Reluctance — opposition to the creation of magnetic lines of the force

Permeability — ratio = $\frac{\text{magnetic flux density}}{\text{magnetizing force}}$

relay — remotely controlled switching device

Galvanic corrosion — result from electric current flow between dissimilar metals
电偶腐蚀

Stainless steel — least affected by galvanic corrosion.

Sacrificial anode — Zinc
牺牲阳极

Parts per million — ppm

百万分之几 PPM

$$\frac{462,100,000 \times 0.1 \text{ ppm}}{1,000,000}$$

million

Chapter 38 Satellites

Iridium satellite — altitude 485 miles

铱星

provide digital voice and data, 2.4 kbps

48 spot beams, footprint 30 miles diameter
波束

Main function

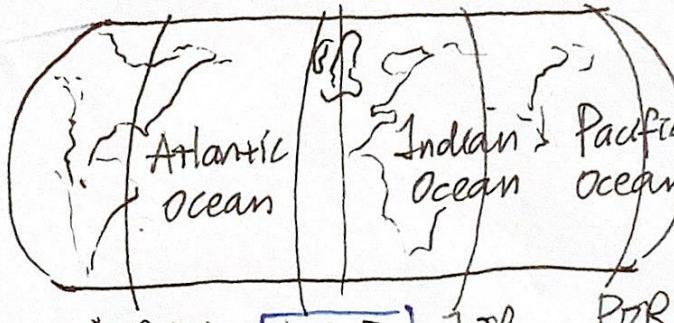
COSPAS-SARSAT — monitoring EPIRB, 406 MHz

determines location by Doppler shift

多普勒效应

INMARSART altitude 22,177 miles

coverage nearly all of the world's navigable waterways



INMARSART

altitude 22,177 miles

AOR-E
15.5°W

IOR

POR

45°E 178°E

INMARSART-B voice 16 kbps, fax 14.4 kbps

high-speed data 64/54

Impossible
all of the above

INMARSART-B use CODECS

INMARSART-M voice 6.2 kbps, data/fax 2.4 kbps

and email

INMARSART mini-M — spot beams for small craft communication

INMARSART

-B:

larger

antenna

INMARSART-C store-and-forward system. omni-directional
route and distress communications

INMARSART High speed data: B, M4 Fleet — 64/54

GPS - Global Positioning Service 12,544 miles

24 Satellites

equally spaced in SIX orbital planes, inclined 55 degrees

4 Satellites — complete position, time data

DGPS - Differential GPS

provide additional correction factors to improve position accuracy

verify correct GPS sentence in DSC VHF:

look for latitude and longitude on display

Chap 39 Repair Maintenance Test Equipment

Stripping wire:  thermal stripper
ideal 热剥设备

remove solder from printed circuit board — Vacuum device
焊料 印刷电路板

Flush-cut diagonal pliers: cut plastic wire ties flush
平口 钳 剪平

White or translucent tie wraps

— NOT used because UV station radiation
from sun deteriorates the plastic

hot gas bonder — non-contact melting of solder
热气焊接机 焊化

tolerance — just inside the bubble ~~(0.05mm)~~

low voltage on marine SSB transmitter

— negative fuse (Blown black)

oscilloscope 示波器

can't use to measure speed of light

maximum frequency response — determine by vertical amplitude

sweep oscillator and deflection amplifier bandwidth

— determine accuracy, frequency response, and stability

decrease circuit loading — 10:1 divider probe

Spectrum analyzer

amplitude

useful for displaying spurious signals in

a transmitter's output

frequency

frequency counter measures frequency

the time between events

prescaler: divides the frequency of high ^{HF} frequency signal
預分頻器 so can be measured on lower frequency counter

frequency standard: device used to produce highly accurate reference frequency

Rubidium standard: used as the base standard

Chap 4b Standards

NMEA 0183 — Should be terminated to ground at the talker and unterminated at the listener

NMEA 2000 — bi-directional, multi-transmitter, multi-receiver

One device fail, NOT interruption to others

LEN (load equivalence number) = 50 mA

end-powered network — power single location device

end of last segment — voltage drop 1.5 Volts

P25 radio system — can be monitored with a scanner P25 decoder

AMBE — CODEC in phase 2 P25

color coding — 100-pair cable 51-75 green
 — 25-pair sixth pair red/blue, blue/red

GTO-15 high-voltage cable — connect SSB automatic tuner to an insulated backstage

ASCII — computer exchanging data

→ physical layer — actual transmission of data

→ link layer — arranges bits into frames
control data flow

Chap 41 Miscellaneous

PCS - personal communication System

using CDMA, GSM

RF power reading on a CDMA radio is not very accurate
if using running analog power meter

TDMA - time division multiple access

时分多址

uses separate time slots for each user

CODEC - coder/decoder 编码器/解码器

Coder/decoder IC or circuit converts voice signal to digit

* GSM uses RPE type CODEC

share GSM channel - Time Division Multiplex

Infrared communications — program radios

红外线通信

SINAD meter — determining exact sensitivity of receiver

12dB

consists of an AF voltmeter calibrated in dB,
and sharp 1000 Hz filter