Quiz Review

Quiz taken last Thursday16 November 2006.

What are the three parts of a PLL?

PLL is phase locked loop.

Parts of Phase Locked Loop

1. phase detector/comparator
2. frequency filter
3. VCO (voltage controlled oscillator)

Fourth component is a divide-by connecting the VCO output with the phase detector.

How does the PLL circuit work?

Phase Detector

Phase detector detects a difference in phase between two signals, generates/outputs some nonzero **correction voltage** when phase difference detected. Otherwise, it is a *quiescent* value of voltage; the specific voltage depends on what the designer set as the value.

Filter

Filter receives the correction voltage. What's the function of the filter? The signal is a very fast change. We don't want the VCO to immediately change on every little change detected by the phase detector. Reduces the sharp, rapid change correction voltage output by the phase detector and transforms it into a smaller, slower voltage change. Balance between making VCO responsive but not reacting to every little change.

The basic gate used for the phase comparator is the XOR. XOR goes to +5 volts when there is a difference, stays at zero volts when there is no difference. This is an extreme change, since it is a square wave (the slope of the changing voltage is steep and the voltage change is rapid). The RC filter circuit has an RC time constant. The resistor is in series and the capacitor bypasses to ground. Diagram 1. The capacitor charges, the RC filter creates a gradual increase in voltage.

Frequency Modulation

Frequency of the carrier increases and decreases according to the signal modulated onto the carrier.

For example, if a signal frequency increases from 1 kHz to 2 kHz, the carrier frequency also increases. The rate of carrier frequency change is the frequency of the modulated signal. The absolute frequency difference is the amplitude of the modulated signal.

Example

Have a VCO running at 1 MHz frequency. If try to use a PLL to lock onto FM, the VCO will try to adjust. The phase detector will increase the correction voltage to attempt to correct. Then, as frequency of signal drops, phase detector will reduce voltage. So, what's this actually doing in the PLL? Creates AC related to the modulating frequency (the signal modulated onto the carrier). The audio signal that we FM'd originally is being detected by the phase locked loop; the error voltage is the modulating voltage (the signal modulated onto the carrier).

Why do we have to have parts external to the PLL IC? The designer doesn't know what frequency the PLL will be operated at, so the designer leaves that up to the implementer.

A minimum of 5 PLLs in every cell phone.

In SMPTE Time Code, how are the digital ones and zeros defined?

If there is a change/transition of voltage within a bit's time slot, it is a one. Otherwise, it is a zero.

For a transistor to conduct, what must the potential difference be between the emitter and the base?

What is potential? Voltage. What is the voltage difference between emitter and base? Same as a diode: 0.7 volt. Could be 0.6 and 0.65. It is usually 0.7 when we are dealing with them.

Define reactance

Resistance to AC flow. Reactance can be inductive or capacitive. Reactance is a form of resistance (impedance). No reactance in a circuit containing a voltage source (battery or AC source) and a resistor. Reactance in a circuit containing an AC voltage source and an inductor. No reactance in a circuit containing a battery and an inductor. Diagram 2.

The inductor with two parallel lines running down the side is a choke. Air core has no lines. Two parallel lines is iron core. Iron core concentrates the magnetic field, increasing the inductance.

Reactance is equivalent to resistance, but in an AC circuit.

Formula for X_L = 2 pi f L. Inductive reactance depends on both frequency and inductance.

One word that means $X_L = X_C$

Resonance. We use this concept in filters and tuned circuits. This is at a particular frequency. Diagram 3 of resonant rise of voltage. Below resonant frequency, inductor shorts those frequencies to ground. Above resonant frequency, capacitor shorts those frequencies to ground. At resonant frequency, the circuit develops a very high impedance.

Is resistance the opposite of impedance? No.

Three Leads associated with an FET are called

Source, drain, gate. On transistor, are base, emitter, collector. On tube, cathode, grid, plate/anode.

Compare the three items.

Action	*Transistor*	*Tube*	*FET*
control	base	grid	gate
collection point	collector	plate/anode	drain
supply point	emitter	cathode	source

The reactance of a carbon resistor to AC is the same as its what?

Resistance (to DC). Actually, resistors have no reactance. Its impedance is equivalent to its resistance. A carbon resistor is pure resistance and no reactance. No reactance, not zero reactance. Zero reactance would be a dead short. Question could have been "the impedance of a carbon resistor is the same as its what?".

Have to worry about reactance for wire-wound resistors. That's why the question specifies a carbon resistor, not just a resistor.

A capacitor could act as an inductor since the plates are wound into a cylinder. See *diagram* 4. The 100 picofarad capacitor handles the inductance of the 100 microfarad capacitor. You may see such a construct in a schematic.

What is the formula for capacitive reactance?

1 / (2 pi f C).

What is the formula for inductive reactance?

2 pi f L

What is the formula for two series capacitors?

C1 C2 / (C1 + C2).

Or, 1 ((1 / C1) + (1 / C2))

Draw diagram of 10V p-p 10 MHz AC wave riding on +5 VDC.

Diagram 5.

Where would we see this? Transistor input or output. Phantom power (mic-level signal riding on +48VDC). Intercom system (1 V audio signal riding on 30 VDC power).

This AC is no longer AC because it is always positive.

Using above waveform, how do I remove the DC component and retain the AC component?

Transformer.

Capacitor. Blocking or coupling capacitor.

Use a DC restorer? Wouldn't know when to apply it to clamp down to zero volts. Really just for video.

Using the above waveform, how do I remove the AC and retain the DC component?

Bypass or decoupling capacitor. Capacitor going from signal to ground.

Calculate the value of the device in # 12 for 100 ohms.

Removing the DC component and keeping AC. 100 ohms reactance. 10 MHz on a five-volt signal.

$X_C = 1 / (2 \text{ pi } f C)$, $C = 1 / (2 \text{ pi } f X_C) = 1 / (2 * \text{pi} * 10^7 * 100) = 1 / (2 * \text{pi} * 10^9) = 160$ picofarads.

What integrated circuit device would you use to recover the clock from a clock embedded data signal?

Phase locked loop.

What are the two types of bipolar transistors?

PNP and NPN.

Use NPN more than PNP. NPN has less noise. Where we use one over the other? NPN has collector voltage higher than emitter voltage; uses +VCC. PNP has collector voltage lower than emitter voltage; uses -VCC. VCC = collector voltage; Steve doesn't know why they double the C in CC.

What is a blocking capacitor used for?

To block DC. See diagram 6.

What transistor configuration has an inverted output?

Common emitter.

Which transistor configuration has both voltage and power gains?

Common emitter.

How can I get both inverted and non-inverted outputs from the same transistor?

Use a phase splitter. The amplification off the emitter is less than one; there's no voltage gain, just current. The amplification off the collector has both voltage and current gain.

SMPTE Time Code Relationships

Based on the homework assigned last week.

We will be counting clock pulses from the regenerated clock. We'll use these pulses to increment a counter, and will reset the counter when we see the synchronizing word.

Homework

OK, not really homework. Just think about this.

Think about how this relationship lets you know when exactly eight bits happens. How to know when in seconds/minutes/hours/frames, and when in units or tens. When should we reset?

If stop at bit 64 (which is numbered 63), is 2^7, just before the synchronizing word, is 0111111. Do we have any numbers in the sync pulses that are similar to those in the data section? Yes, all of them, except for that bit 6 (7^{th} bit). Would need two 8-bit counters: one for data and one for the synch word.

In our system, we have the date encoded in the user bits from the GPS. How do we put user bits into the data stream? We manually set them at the point of generation. Flip a switch called UBits. Then, can set the values.

Lab

Hook up DAs. Ensure all benches have correct video signals in the correct ports.