Signals and Noise

- Sampled signals

Continuous voltage function of time: $V(t)$

Sampling signal : $P(t)$

Frequency of sampling signal : F_s

Period of sampling signal : $T = \frac{1}{F_s}$

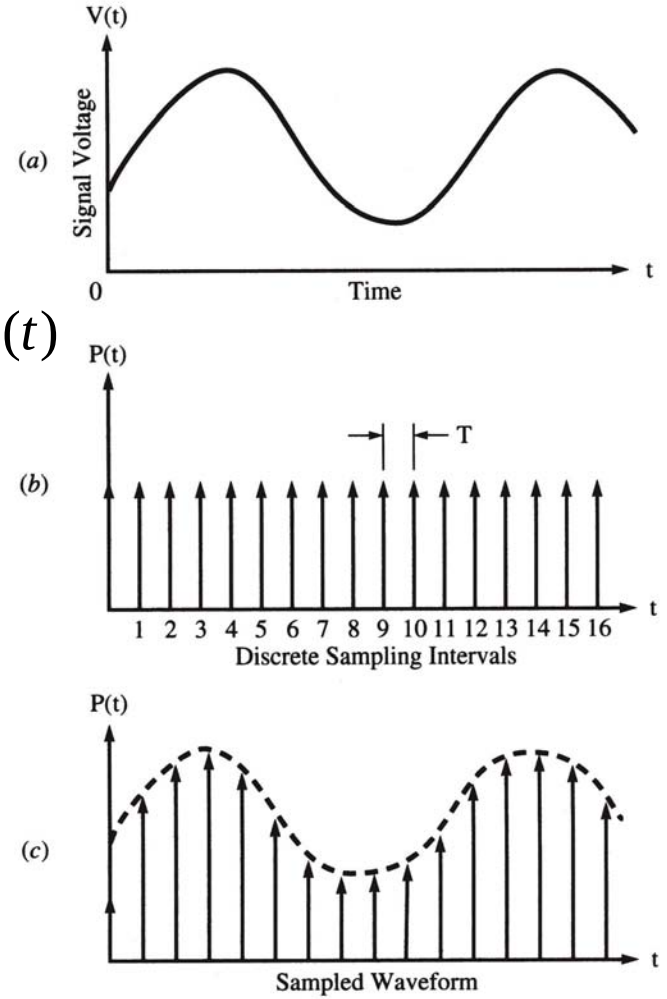

Figure 5-10
Sampled signal. (*a*) Sine wave. (*b*) Sampling of sine wave. (*c*) Sampled sine wave.

Signals and Noise

- Nyquist's theorem
  - The sapling rate, F_s, must be twice the maximum frequency F_m

$$F_s \geq 2F_m$$

  - The reconstruct the original signal, it is necessary to pass the sample waveform through a low-pass filter, Fc, that limits the band pass to F_s

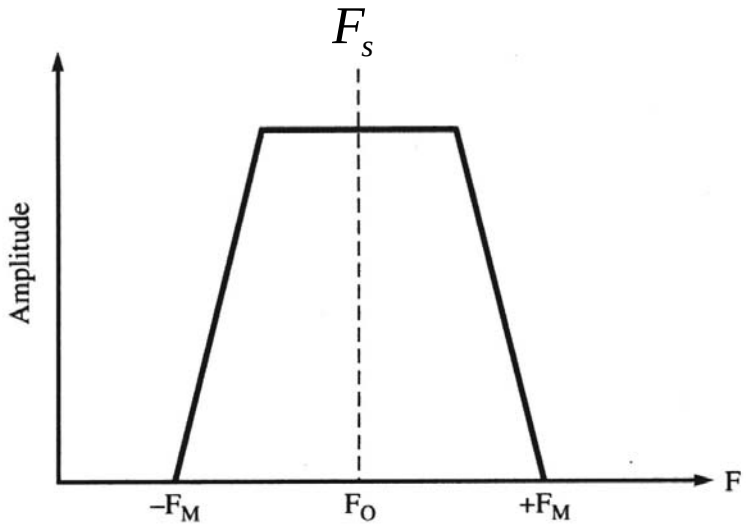

Figure 5-11
Spectrum of sampled signal.

Signals and Noise

- Nyquist's theorem
  - Spectral density of original signal: $V_p(f)$
  - Spectral density of sampling signal: $P(f)$
  - Original signal frequency : F_m
  - Sampling frequency: $F_s \geq 2F_m$
  - Cutoff frequency of a low-pass filter : F_c

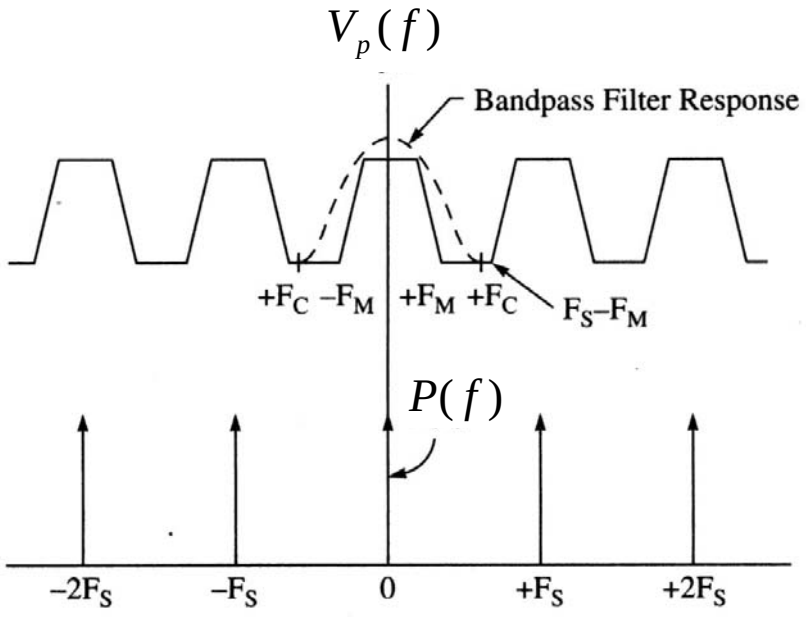

Figure 5-12
Wider view of sampled signal spectrum.

Signals and Noise

- Nyquist's theorem
  - Sampling frequency: $F_s < 2F_m$

$$F_s - F_m < F_m$$

- Each harmonic overlap
- The phenomenon called aliasing（混疊）

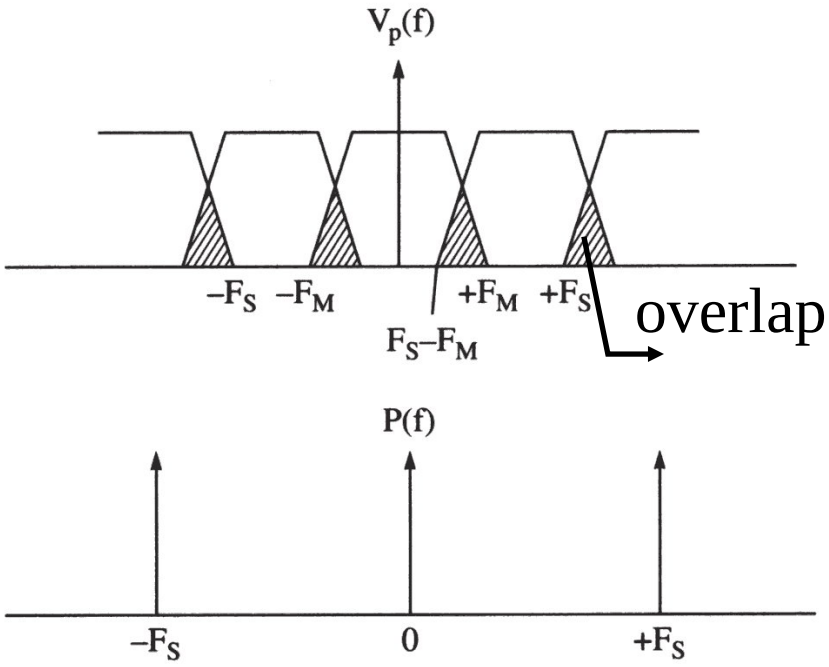

Figure 5-13
Aliasing occurs when $F_s < 2F_M$.

Signals and Noise

❑ Noise

- An ideal electronic circuit produces no noise

❖ Thermal noise: Thermal agitation(振動) noise, Johnson noise, White noise(nearly Gaussian)

❖ Random noise in semiconductor

✓ Popcon noise

✓ Schottky noise

✓ Flicker noise

☛Thermal noise

-At any temperature above absolute zero(0°K,-273°C), electrons in any material are in constant random motion.

- Electron motions are therefore statistically decorrelated

- A continuous series of random current pulses generated in the material

- The noise spectrum is dominated by mid-frequencies, 10^4~10^5 Hz