



EEEN 462 – ANALOGUE COMMUNICATION

TELEVISION FROM A COMMUNICATION PERSPECTIVE– STUDY GUIDE

1. FUNDAMENTALS OF VISION & SCANNING

1. **Human Vision Properties:** Persistence of vision (16–20 fps), critical flicker frequency.

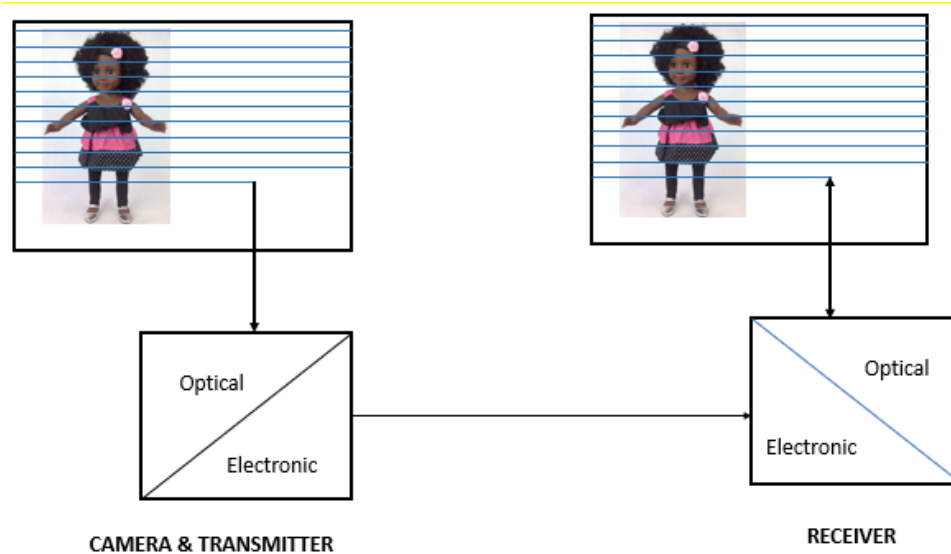


Figure 1. Principle of the television

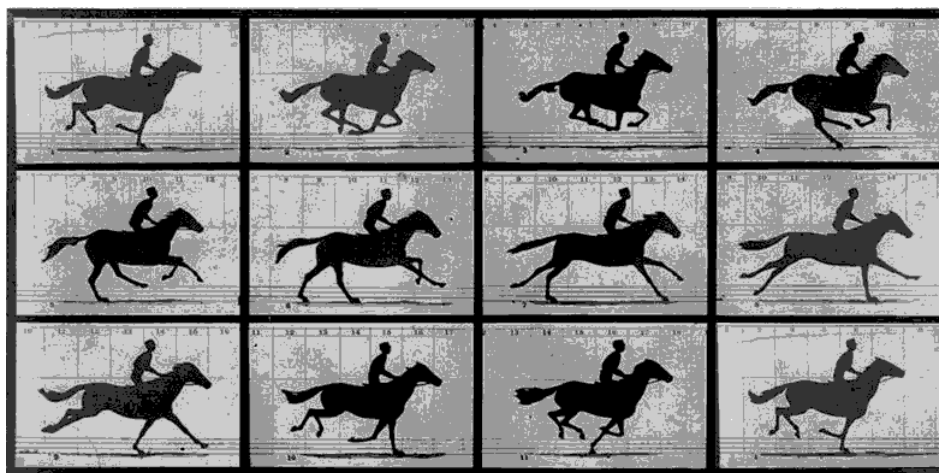
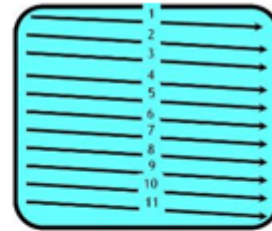


Figure 2. Principle of television - Persistence of vision.

There are two types of scanning:

1. **Progressive scanning** (also called noninterlaced scanning) is a format of displaying, storing, or transmitting moving images in which all the lines of each frame acquired and displayed in sequence.



2. **Interlaced scanning** in which one-half of the horizontal pixel rows are refreshed in one cycle and the other half in the next, meaning that two complete scans are required to display the screen image.

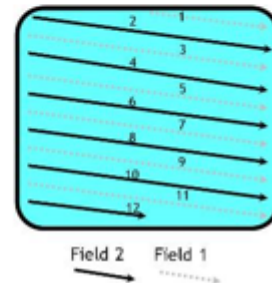


Figure 3. Progressive vs interlaced scanning.

2. Scanning Systems:

- *Progressive*: Sequential line scanning (e.g., 720p).
- *Interlaced*: Odd/even field scanning (e.g., 1080i), reduces bandwidth but causes motion artifacts.

3. **Resolution Metrics**: Pixels, lines (e.g., 480i, 1080p), aspect ratios (4:3 SD, 16:9 HDTV).

4. **Kell Factor**: Effective resolution reduction due to scanning (typically 0.7).

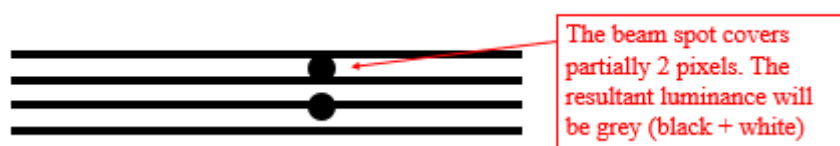


Figure 3. The Kell factor - reduction of TV lines due to merging.

2. ANALOG TV SYSTEMS (HISTORICAL & CONCEPTUAL)

1. Composite Video Signal:

- Luminance (Y) + Chrominance (C) + Sync Pulses + Blanking.
- **Sync Pulses**: Horizontal (HSYNC) & Vertical (VSYNC) synchronize scanning.

2. Modulation:

- *Luminance*: AM with **Vestigial Sideband (VSB)** modulation (save bandwidth).
- *Chrominance*: Subcarrier modulation (e.g., 3.58 MHz in NTSC).

- **Audio:** FM on separate carrier (4.5 MHz above video in NTSC).

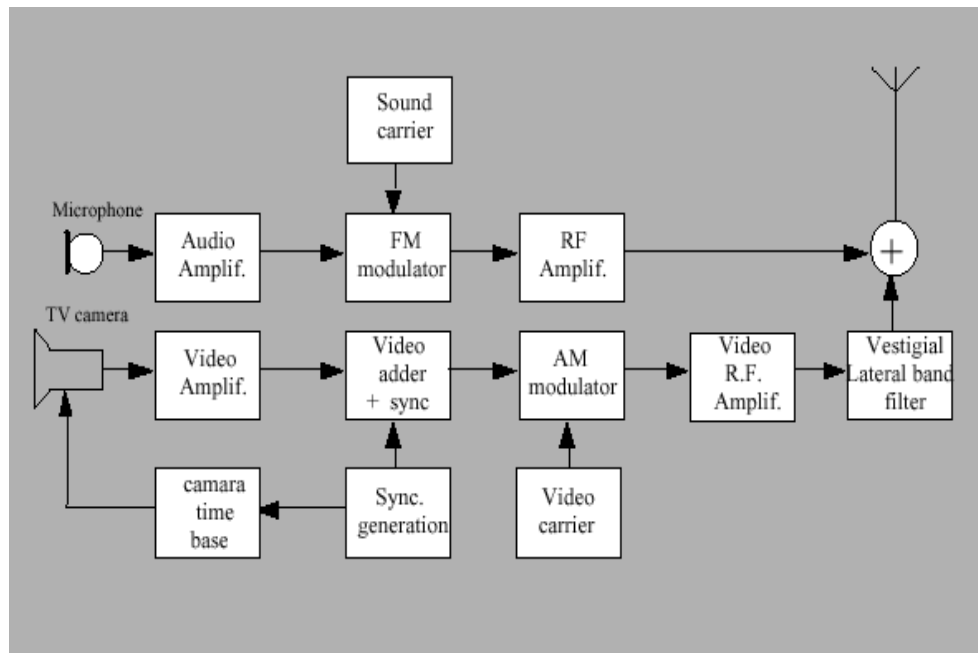


Figure 4. Block diagram of black and white TV transmitter

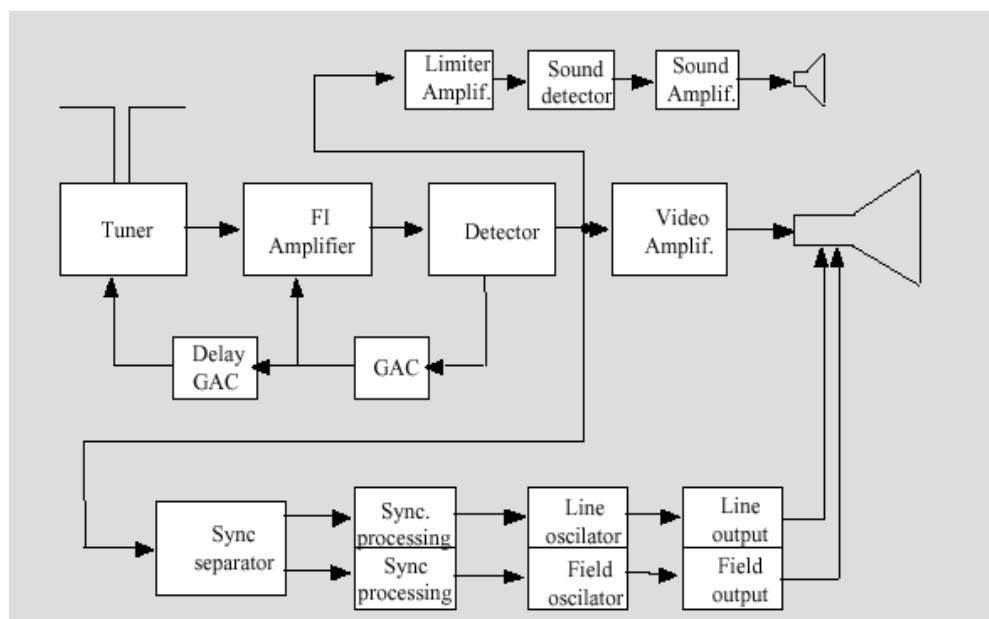


Figure 4. Block diagram of black and white TV receiver

3. Colour Encoding:

- **NTSC** (North America): I/Q modulation, phase-sensitive color ("Never Twice Same Colour").
- **PAL** (Europe): Alternating V-phase to cancel hue errors.

- **SECAM** (France): Frequency-modulated color lines.
4. **Bandwidth:** 6 MHz/channel (NTSC), 8 MHz (PAL).

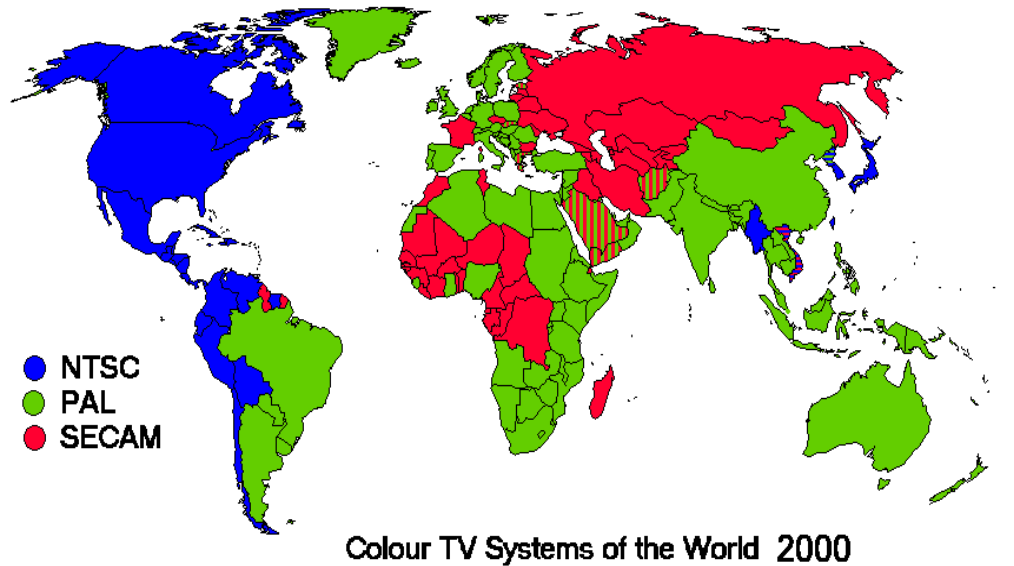


Figure 5. World analogue television systems

3. DIGITAL TELEVISION (DTV)

1. **Advantages:** Noise immunity, compression, HD/4K support, data services.
2. **Compression Standards:**
 - **MPEG-2:** SD/HD broadcasting (e.g., ATSC 1.0, DVB).
 - **H.264/AVC & H.265/HEVC:** 4K/8K, efficient compression (ATSC 3.0, DVB-T2).
3. **Digital Modulation:**
 - **ATSC 1.0:** 8-VSB (8-level Vestigial Sideband).
 - **DVB-T:** COFDM (Coded Orthogonal FDM) with QPSK/16-QAM/64-QAM.
 - **ATSC 3.0:** OFDM + LDM (Layered Division Multiplexing).

4. SIGNAL TRANSMISSION & RECEPTION

- **Channel Coding:**
 - *Forward Error Correction (FEC):* Reed-Solomon + Trellis coding (ATSC 1.0), LDPC (ATSC 3.0).
 - *Interleaving:* Mitigates burst errors.
- **RF Propagation:** VHF (54–216 MHz) & UHF (470–890 MHz) bands.

- **Receiver Components:**

- Tuner → Demodulator → Decoder → Display Processor.
- **Equalization:** Compensates for multipath distortion.

5. MODERN STANDARDS & TECHNOLOGIES

1. **ATSC 3.0** (Next-Gen TV):
 - IP-based, 4K HDR, immersive audio, emergency alerts.
 - **Modulation:** OFDM with QAM (64–4096).
2. **DVB Family:** DVB-S (satellite), DVB-T (terrestrial), DVB-C (cable).
3. **Streaming & IPTV:** HLS/DASH protocols, multicast delivery.

6. KEY FORMULAS & CALCULATIONS

- **Bandwidth:**
 - Analog: $B \approx f_m + f_v$ (VSB reduces to $\sim 1.25\times$ baseband).
 - Digital: $B = \frac{\text{Symbol Rate}}{\log_2 M}$ (for M-QAM).
- **Color Space Conversion:**
 - YUV/YIQ:
$$Y = 0.299R + 0.587G + 0.114B$$
$$U = 0.492(B - Y), V = 0.877(R - Y)$$
- **Horizontal Scan Rate (Analog):**
 - NTSC: $525 \text{ lines} \times 30 \text{ fps} = 15.75 \text{ kHz}$.

7. CHALLENGES & SOLUTIONS

1. **Interference:** Co-channel/adjacent channel interference, mitigated by guard bands.
2. **Multipath Fading:** OFDM resilience (DVB/ATSC 3.0).
3. **Compression Artifacts:** Blocking, ringing (solved by better codecs like HEVC).

8. REVIEW QUESTIONS

1. Why does analogue TV use VSB instead of DSB?
2. Explain how interlaced scanning reduces bandwidth at the cost of motion artifacts.
3. Calculate bandwidth for 720p60 video (1280×720) uncompressed → then with MPEG-2 (50:1 compression).

4. Contrast NTSC and PAL colour encoding. Why was SECAM less prone to phase errors?
5. How does OFDM in ATSC 3.0 improve robustness in urban environments?
6. Draw a block diagram of a digital TV transmitter (MPEG encoder → modulator → RF stage).

KEY TAKEAWAYS FOR EXAMS

- **Analog TV:** Master VSB modulation, sync pulses, colour subcarriers.
- **Digital TV:** Understand MPEG/H.26x compression, modulation schemes (VSB/OFDM), error correction.
- **Evolution:** Contrast analogue vs. digital, legacy vs. ATSC 3.0/DVB-T2.
- **Math:** Bandwidth calculations, colour space transforms, Kell factor impact.

Last updated: Friday, 27 June 2025