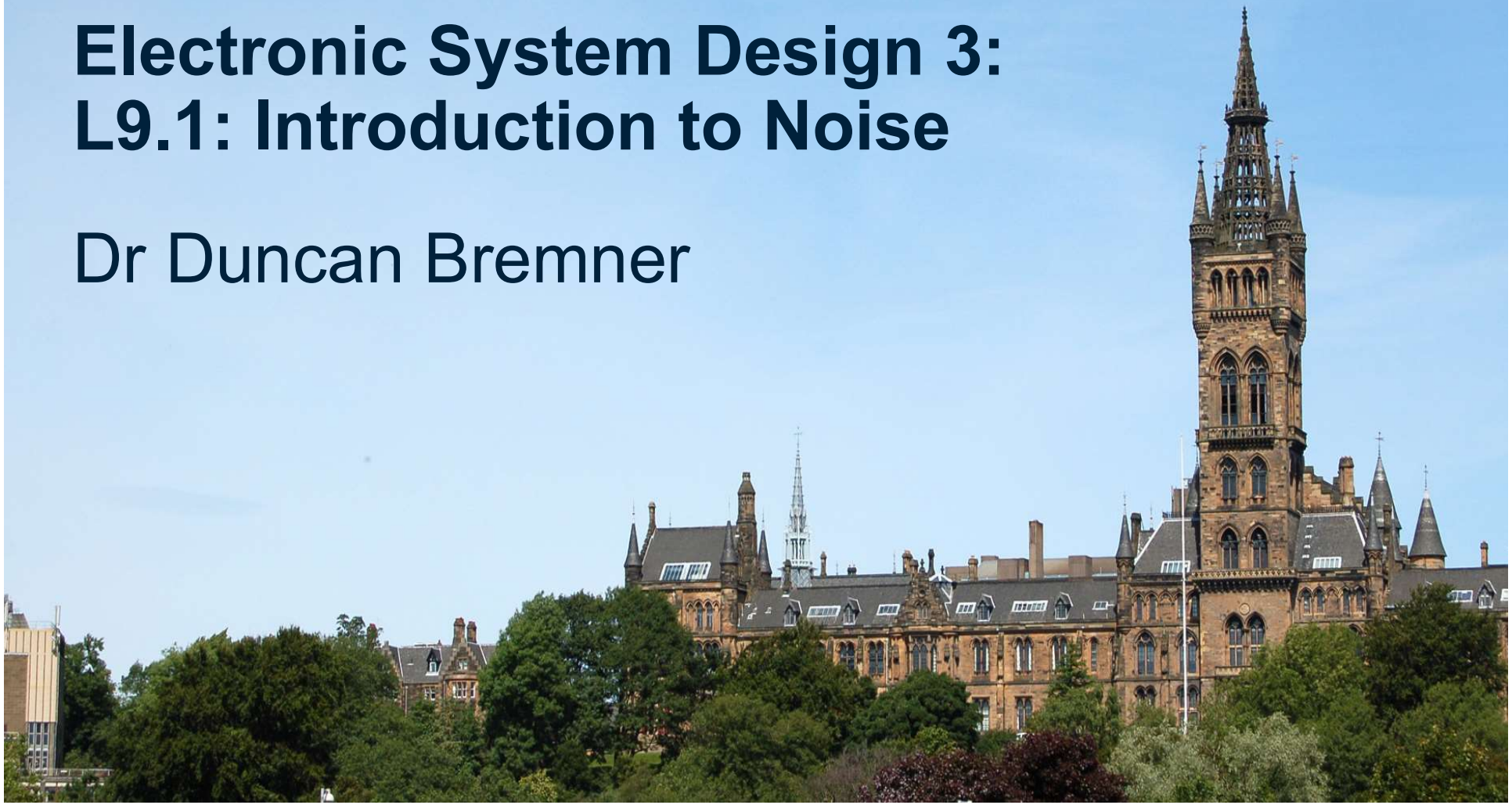
University of Glasgow

Electronic System Design 3: L9.1: Introduction to Noise

Dr Duncan Bremner



Noise

Interference is any unwanted signal which couples into a system:

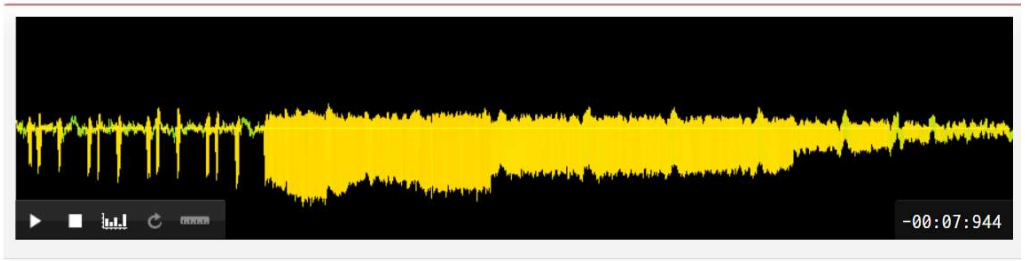
- "Hum" (Mains)
- "Switching noise"
  - Relays
  - Motors
  - Logic
- "RF Interference"
  - Cell phones
  - Transmitters
- "Crosstalk"
  - Stereo channel separation
  - Multiplexed telephones

Eliminate by

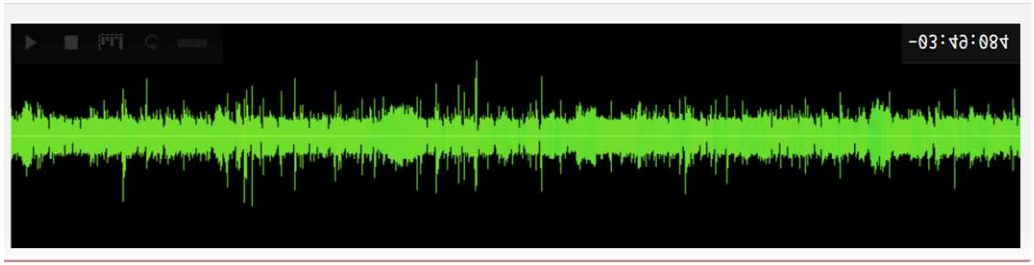
- Screening
- Ground design
- Isolation
- Instrumentation amplifiers
- Physical location

Difficult to predict

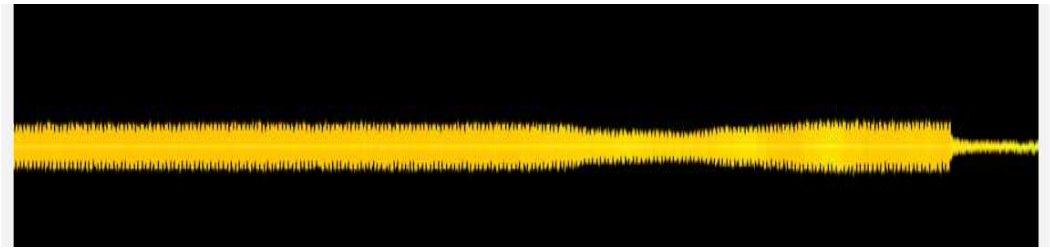
Interference sources



Mobile Phones



Radio Pickup



Mains Borne

Noise (2)

Noise is due to random processes within components of the system

Noise can be predicted and designed for with high accuracy: Noise is not just random junk!

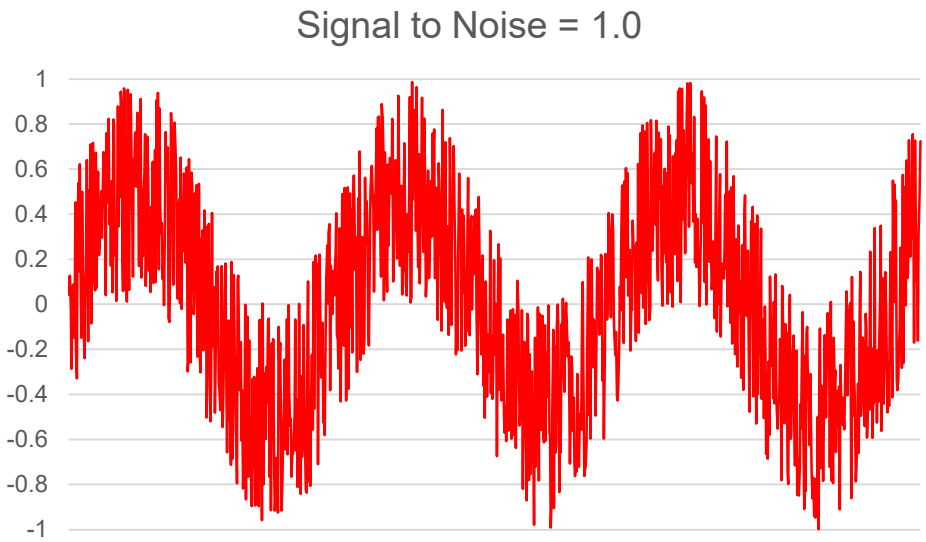
Signal to noise ratio

- Can be an important problem for sensors
- Is an important problem for signal processing
- Is the most important thing in communications

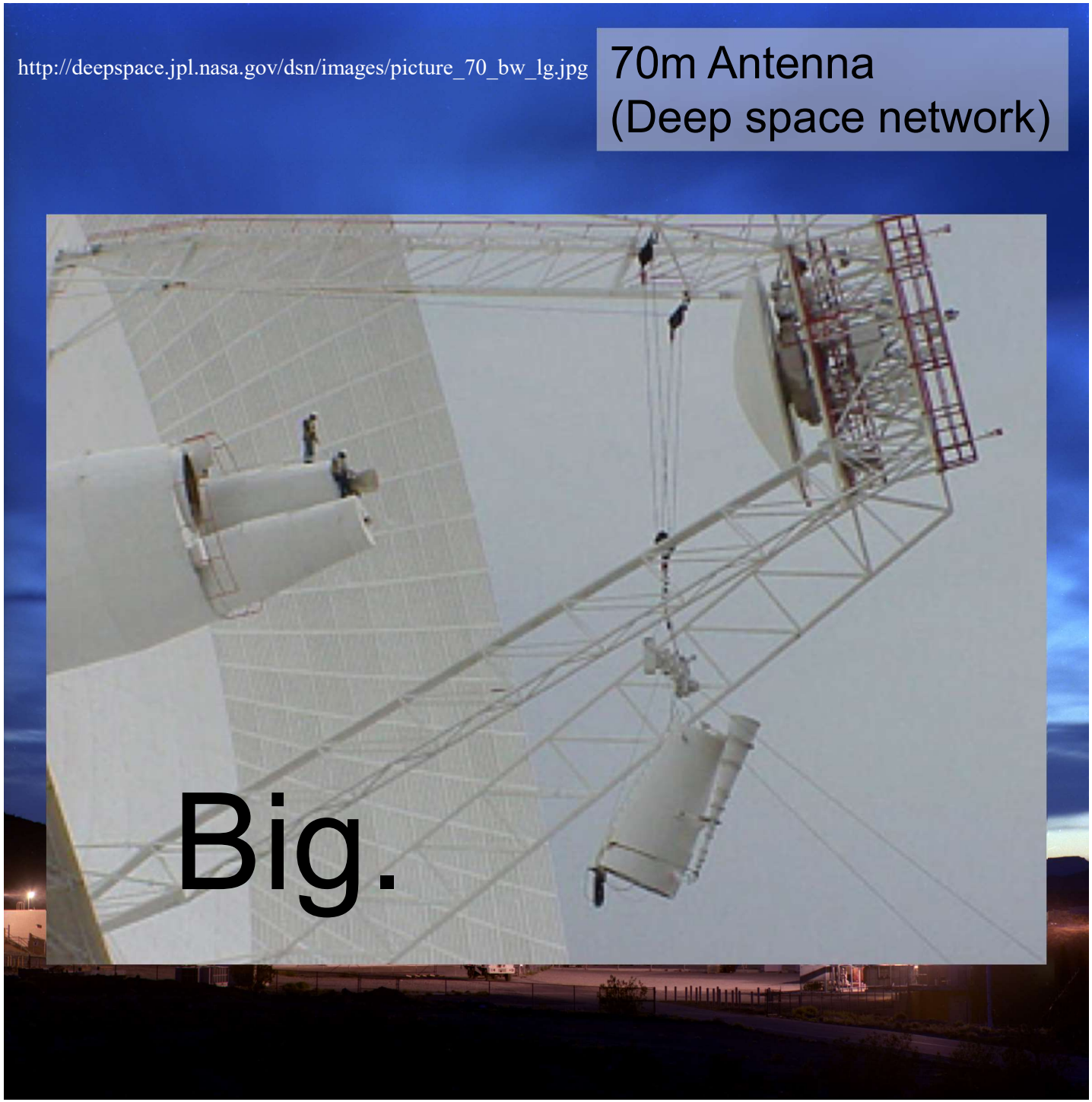
Example of noise

Play Audio Clip

1. White Noise (equal amplitude at all frequencies)
2. White Noise + 1kHz tone (Signal Level = Noise level)
3. Definition: Signal to Noise Ratio = 1 (0dB)



Noise (3)



3dB of noise
on your amplifier
and it's a 100m
antenna…….

Noise (4)

Noise arises from several sources

- "Thermal noise": Random thermal motion of electrons (like Brownian motion) A.K.A. "Johnson Noise"

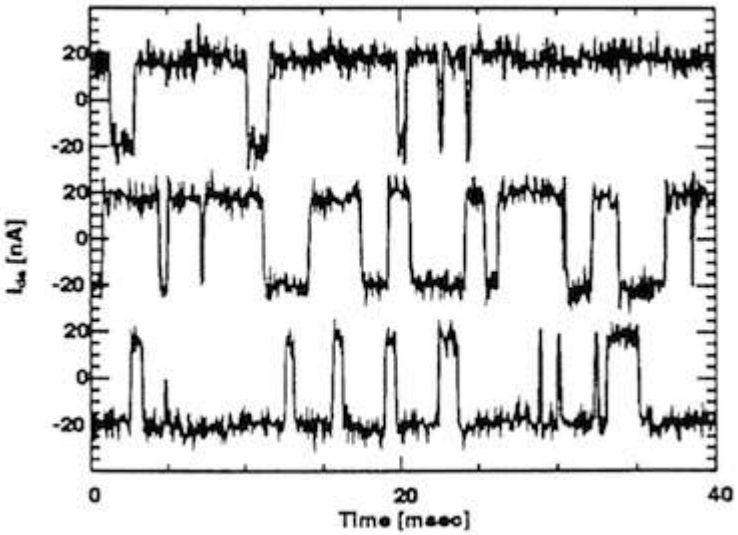
- "Shot noise": Random emission of electrons over a barrier (p-n junction, tunnel barrier). E.g. Photodiode

- "Flicker noise": Random capture & emission of charges by defect modulates conduction of device. E.g. trap in MOS devices.

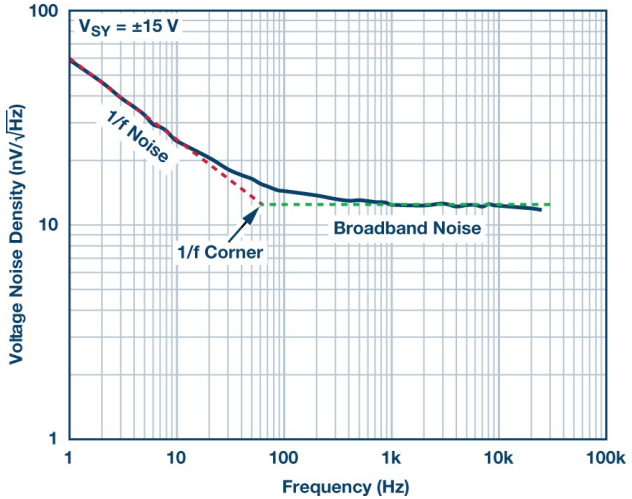
- "Popcorn Noise" Bursts of current in active devices.
  ~ Flicker noise but individual events resolved

Thermal noise is always present. Shot, Flicker, popcorn noise Require current to be flowing.

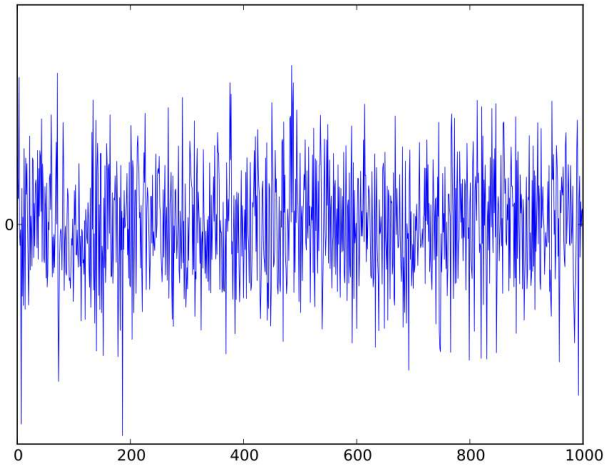
Characteristics of some noise types



Popcorn (Burst) Noise



1/f (Flicker) Noise



Johnson (Thermal) Noise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Thank you
谢谢
INSPIRING PEOPLE