Receiver Noise

Say we reject completely the image signal and all spurious signals. So a single signal will appear at the detector/demodulator.

Q: One signal! So assuming a perfect detector, the demodulated signal $\hat{i}(t)$, will have no error (i.e. $\hat{i}(t) = i(t)$), right??

A: No! Unfortunately, there will always be another signal at the detector $\Rightarrow$ noise!
Noise at the detector will always be present, and therefore the detected signal $\hat{i}(t)$ will always contain error $\epsilon$, where:

$$\epsilon = \hat{i}(t) - i(t) \neq 0$$

(We can reduce this error, but we cannot eliminate it!!)

Q: Where does this noise come from??

A: Two sources! External and Internal.

External noise - is noise that is coupled into the Rx through the receiver antenna.
In addition to the human-made signals occupying virtually every frequency of the RF/microwave spectrum, the entire e.m. spectrum is awash in random energy (i.e. noise).

This random energy has neither a specific frequency, nor direction, but instead is spread out across all directions and frequencies!

As a result, we can point our antenna in a specific direction,
and we can **tune** our receiver to a specific frequency, but we will still receive a portion of this e.m. noise!

**Q:** What is the source of this external noise??

**A:** There are 3 sources! — terrestrial, extra-terrestrial, and human-made.

**Terrestrial noise** — Every warm object radiates e.m. energy (one method of heat transfer)!!

(Definition of warm ⇒ above)

{absolute zero.}
- The power and frequency of the emitted e.m. noise depends on the temperature of the object.
- For objects on the Earth, the temperature is such that objects radiate mainly in the infrared region of the e.m. spectrum.
- But, objects on the Earth also emit some energy across the entire e.m. spectrum (e.g., optical and u-wave regions).

Extra-terrestrial - There are very warm objects in space! E.g., the sun, stars, planets, etc. They also radiate e.m. noise that (eventually) reaches the Earth.
Human-made - We humans make a lot of noise (both e.m. and otherwise). In addition to the information signal, transmitters radiate noise that was internally generated!

**Internal Noise**

The receiver itself generates noise!!

Q: Why? A: We will find out that resistors and semiconductors generate noise.

(Any device which absorbs power will also emit power (in the form of noise)).