

# Interference

Spectrum Management Training Program

**Elective Module EM1-Option 1 : Spectrum Monitoring**

# Outline

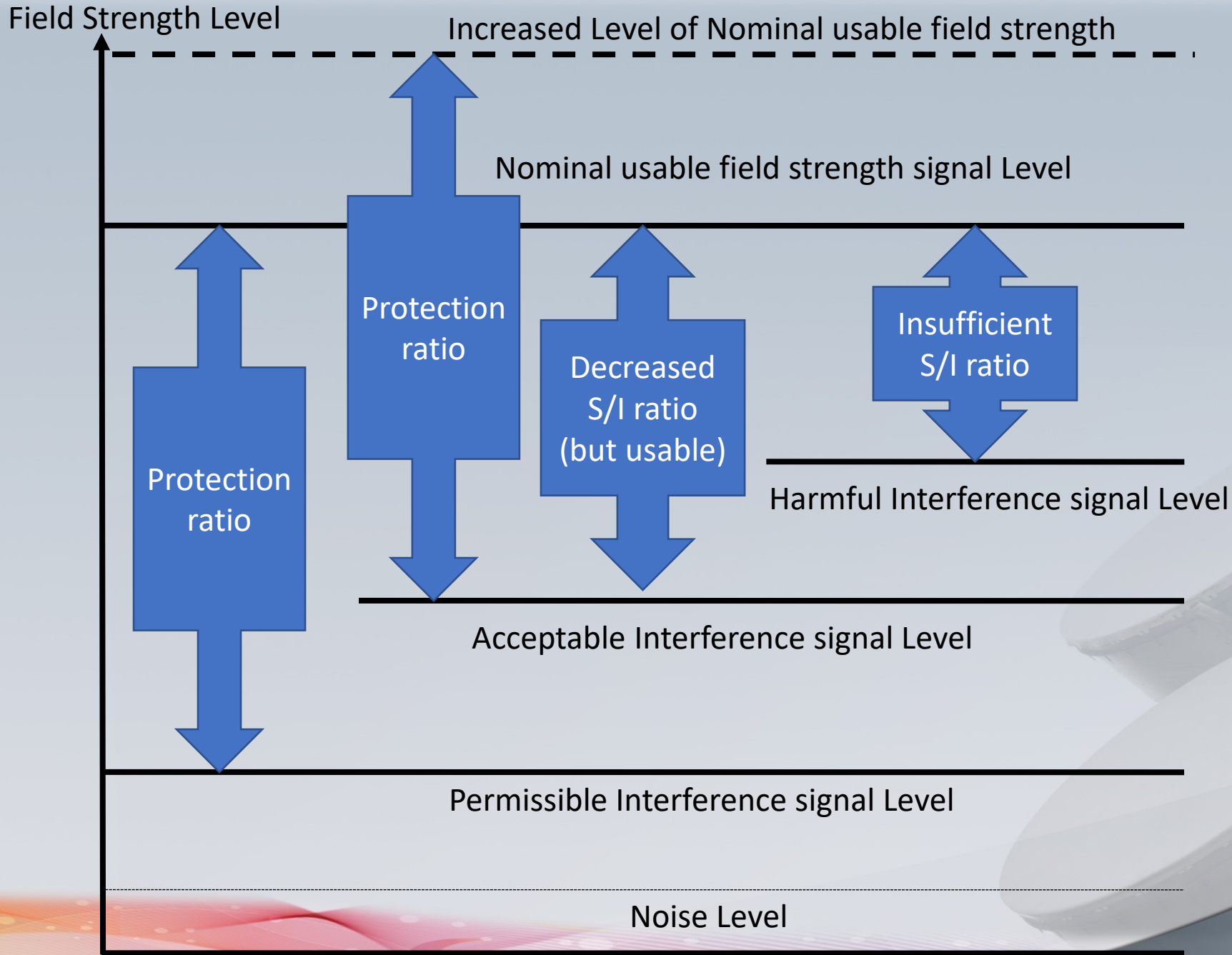
- Definitions
- Impact of Radio Interference
- Source of Radio Interference
- Solving Interference Problems
- Equipment Parameters
- Interference Analysis
- Interference Removal Procedure

# Definitions

- Interference :
  - The effect of unwanted energy due to one or a combination of emissions, radiations or inductions upon reception in a radiocommunication system.
- Permissible Interference:
  - Observed or Predicted interference which complies with quantitative interference and sharing criteria contain in ITU.
- Accepted Interference:
  - Interference at a higher level and which has agreed upon between two or more administrations.

# Definitions

- Harmful Interference:
  - Interference which endangers the functioning of a radionavigation service or of other safety services.
- Protection Ratio:
  - The minimum value of the wanted-to-unwanted signal ratio



# Impact of Radio Interference

- Safety
  - Air navigation
  - Police and emergency services
  - Hospitals
- Cellular phone service
  - Lost air time
  - Dropped calls
  - Reduced service quality
  - Lost revenue
- TV reception
- Other Services

# Sources of Radio Interference

- Non-compliant radios
  - Mistuned
  - Modified
  - Defective
  - Failed
- Defective equipment
  - Microwave ovens
  - Computers
- Radars

# Sources of Radio Interference

- Illegal transmissions
  - Broadcast
  - Two-way
  - Businesses
  - Bank ATMs
- Mechanical
  - Electric motors
  - Electricity generating stations



# Solving Interference Problems

- When a radio system seems to fail:
  - people often jump to conclusion that interference is occurring.
  - people can ask for newer systems to “solve” the interference.
- The first step in investigating an interference report is to be skeptical.
  - Ask careful questions about when “interference” started;
  - Ask careful questions about the “interference” characteristics;
  - Example: “Was radio system “upgraded” when interference began?”
  - Try to eliminate other possibilities before going on a wild goose chase.

# Solving Interference Problems

- Discover the type of Interference:
  - Co-channel interference (using same frequency)
    - unexpected legal signals
    - illegal (unlicensed) signals
    - unexpected (illegal) sidebands from licensed signal
  - Adjacent channel:
    - Using frequency close to the receiver tuned frequency

# Solving Interference Problems

- Discover the type of Interference:
  - Desensitization:
    - Form of electromagnetic interference where a radio receiver is unable to receive the full strength of a radio signal. This is caused by a nearby transmitter with a strong signal on a close frequency, which overloads the receiver and makes it unable to fully receive the desired signal.
  - Out-of-band interference
    - Intermodulation from strong signals

# Solving Interference Problems

- Discover the type of Interference:
  - spurious emission:
    - any radio frequency not deliberately created or transmitted, especially in a device which normally generates other frequencies. A harmonic or other signal outside a transmitter's assigned channel would be considered a spurious emission.

# Solving Interference Problems

- Locate the source of Interference
  - No single technique for solution
  - on-site investigation often needed
  - Intermittent problems, combinations of circumstances
- Use frequency management to minimize interference
  - Realistic engineering models, conservative design,
  - accurate data bases, convenient design tools.

# Equipment Parameters

- A. Carrier Frequency.
- B. Transmitter Power.
- C. Frequency Tolerance.
- D. Bandwidth.
- E. Unwanted Emission.
- F. Intermodulation Products.

# Equipment Parameters

## A. Carrier Frequency:

The operating frequency of transmitters corresponds to their assigned frequency.

## B. Transmitter Power:

Peak envelope power, mean power or carrier power

It Should be limited to the minimum level consist with satisfactory operation of the radio system.

# Equipment Parameters

## C. Frequency Tolerance:

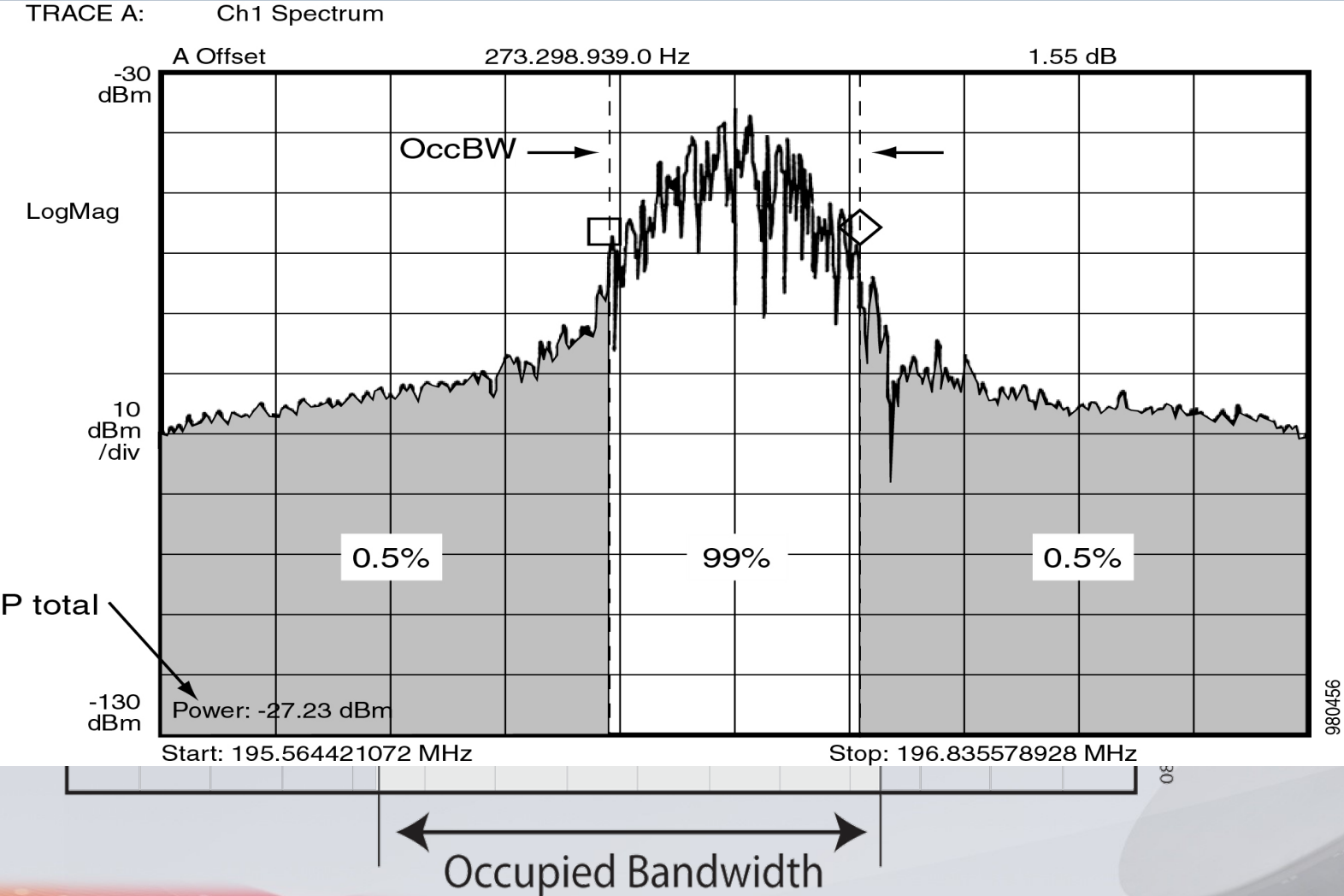
The maximum permissible departure by the center frequency of the frequency band occupied (in Hertz).

## D. Bandwidth:

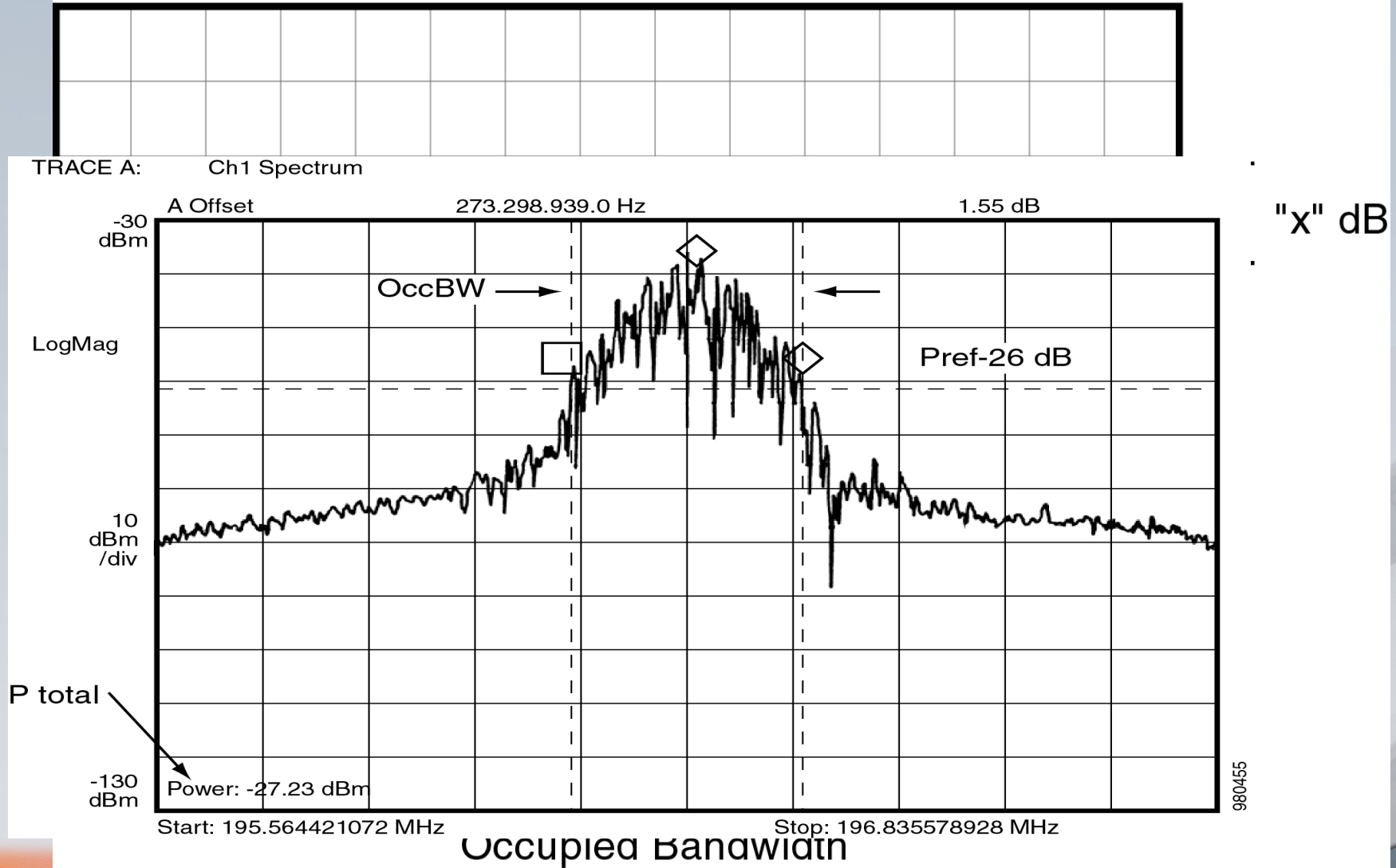
For a given class of emission, the width of the frequency band which is just sufficient to ensure the transmission of information at the rate and with the quality required under specified conditions.(RR)



# The $\beta$ Method ( $\beta$ typically equals 99%)



# The "x" dB Method



# Equipment Parameters

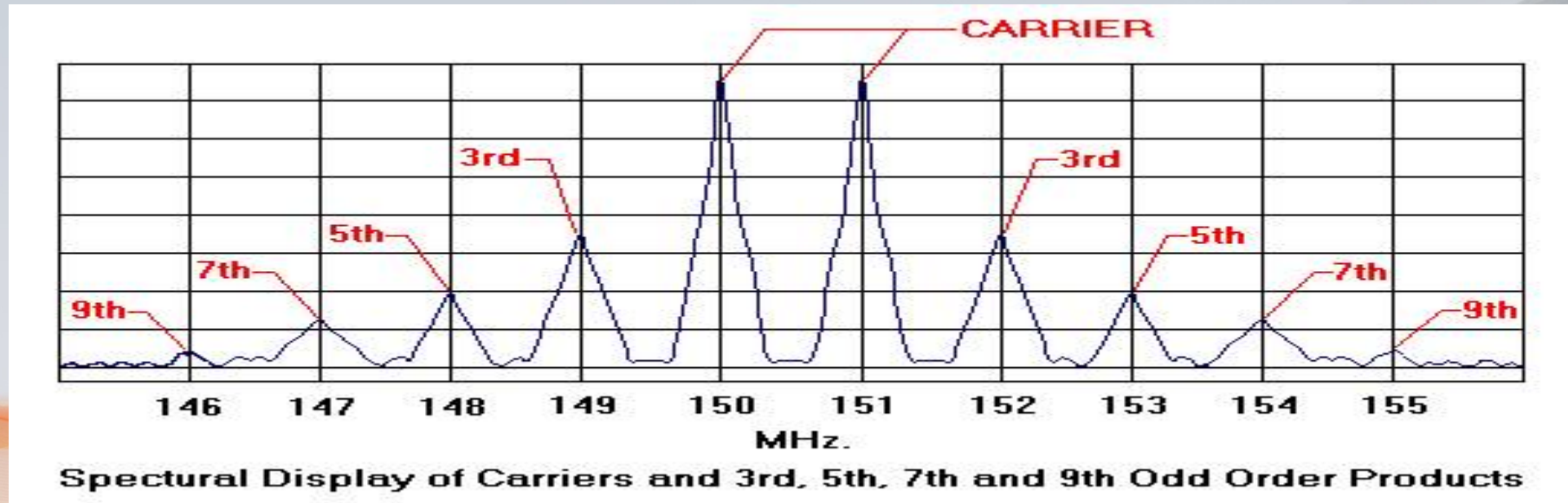
## E. Unwanted emissions:

- **Out of band:** main component of the unwanted emissions close to the fundamental emission.
- **Spurious emission:** any radio frequency not deliberately created or transmitted, especially in a device which normally does create other frequencies. A harmonic or other signal outside a transmitter's assigned channel would be considered a spurious emission.

# Equipment Parameters

## F. Intermodulated products:

Unwanted frequency components that are generated from the interaction of two or more spectral components acting on a device with non-linear behaviour.



# Interference Analysis

- The parameters effect on interference:
  - Center frequency.
  - Separation of carrier frequencies.
  - Frequency stability.
  - Types of emissions.
  - Power level.
  - Level of emission outside the bandwidth.
  - Antenna height.
  - Front to back ratio.

$$I = P_t + G_t + G_r - L_b(d) - \text{FDR} - L_s$$

- $P_t$  :interferer transmit power (dBm)
- $G_t$  : the gain of the interferer antenna in the direction of the receiver (dBi)
- $G_r$  : the gain of the receiver antenna in the direction of the interferer (dBi)
- $L_b(d)$ : the basic loss for a separation distance  $d$  between the receiver and the interferer (dB)
- $\text{FDR}(\Delta F)$ : the frequency dependent rejection (dB)
- $L_s$  : are any additional losses (dB)

# Interference removal procedure

