

INTRODUCTION

MICROWAVES (MWs)

- **extremely short waves**
- $\lambda \approx 1/3\text{m}$ to mm or even less
- $f \geq 1\text{GHz}$ but $<$ optical freq.
- Include UHF, SHF & EHF bands

At MWs

**Lumped element circuit theory
becomes inaccurate**

**Distributed circuit elements
become more relevant**

**Tx-line theory becomes more
useful for design and analysis of
systems**

**Open-wire and coaxial lines are
replaced by waveguides and
planar lines**

**Lumped-element tuned
circuits are replaced by
cavity resonators**

**Effects of reflection,
refraction, polarization and
absorption become more
significant**

**Frequency bands are segments of
frequency spectrum**

**Help in identification of
applications and technologies used
in different frequency ranges**

EXTREMELY LOW FREQUENCY (ELF)

SUPPER LOW FREQUENCY (SLF)

ULTRA LOW FREQUENCY (ULF)

VERY LOW FREQUENCY (VLF)

LOW FREQUENCY (LF)

MEDIUM FREQUENCY (MF)

HIGH FREQUENCY (HF),

VERY HIGH FREQUENCY (VHF),

ULTRA HIGH FREQUENCY (UHF),

SUPPER HIGH FREQUENCY (SHF),

EXTREMELY HIGH FREQUENCY (EHF)

TERA HZ FREQUENCY (THF)

GENERAL RULE

**Frequency (f) of a band lies
between**

$$3 \times 10^{n-1} \text{ to } 3 \times 10^n \text{ Hz}$$

where n is the number of band
Example

For HF (n = 7)

f lies between 3 to 30 MHz

Symbols assigned to different bands

by NATO

A to M in continuity

by IEEE

**HF, VHF, UHF, L, S, C, X, K_u, K, K_a, Q,
V and W**

Frequency ranges

cm wave: 3 to 30GHz

mm wave: 30 to 300GHz

sub mm wave: 300 to 3000GHz

ADVANTAGES

In Communication

**Very reliable for signal's
transmission & reception**

**Consumes lesser BW of
information channel**

**Permits more channels than at
lower carrier frequencies**

IN RADARS

MW antennas - extremely directive

**A pencil beam of 1° beamwidth
can be obtained from an antenna of:**

6900feet diameter at 10 MHz

6.9ft diameter At 10 GHz

**Neither reflected nor absorbed by
ionosphere.**

**Suitable for space communication,
including radio-astronomy and satellites**

**Widely used for telephone network, TV
systems, railway and military applications
through LOS and Tropo links & Satellites.**

**Provides insight into the nature of
molecules and their interaction**

**Provides valuable information
about relaxation processes and
electron spin resonance
phenomena**

**Due to existence of molecular resonances
at MWs in certain crystal materials
energy can be generated or converted
by means of atomic oscillations
in and around avalanche conditions
Gunn, Read, Impatt diodes, etc. are based
on this property.**

**More easily directed, controlled and
concentrated**

**Extensively used in industry
for heating, drying, testing, analysis
and processing**

**Also used for cooking and physical
diathermy**

**Microwave techniques
may also be used in
extremely fast computer
applications**

**Pulses with very small widths are
used in high speed logic circuits**

COMPONENTS OF MW SYSTEM

Microwave generation

Microwave processing

Microwave transmission

Microwave measurements

Microwave antennas

APPLICATIONS

MICROWAVE APPLICATIONS

ASTRONOMY

- Deep space probe
- Galactic exploration
- ⋮

COMMUNICATION

- Telephone systems
- Computer networks
- Low noise transmission
- TV & Radio broadcast
- Direct broadcast Satellites
- High definition TV
- Wireless applications
- ⋮

DOMESTIC

- Moisture detection
- Soil treatment
- pesticides
- Crop protection
- Food preservation
- Microwave ovens
- Cloth dryers
- ⋮

INDUSTRIAL

- Process control
- Drying
- Curing
- Waste treatment
- Monitoring
- ⋮

MEDICAL

- Heart stimulation
- Hemorrhaging
- Hyperthermia
- Imaging
- Sterilization
- Thermography
- ⋮



Application	Freq. band(s)	Frequency range(s) in GHz
Air borne weather avoidance radar	C	5.4
Anti aircraft weapon system	MMW	94 & 140
Astronomical radars	P,L, S & C	0.408, 0.43, 0.7, 1.295, 2.388, 8
Automatic Toll Collection	P & C	0.905 & 5 – 6
Battle field surveillance radar	MMW	70
Cellular Phone	P	0.824 – 0.849 & 0.869 – 0.895
Cellular Video	Ka	28
Collision Avoidance Radar	MMW	60, 77 & 94
Direct Broadcast Satellite	X	11.7 – 12.5
Global Digital Satellite	C	4-8

Global Positioning Satellite	L	1.575 & 1.227
Ground Based Radar, Navigation	X	8-12
GSM	P	0.890 – 0.915 & 0.935 – 0.960
Instrumentation radars	S & C	2.9, 5.6, 1 – 4
Missile guidance seeker system with radiometric sensors	MMW	35 & 94
Paging	P	0.931-0.932
Personal Communication System	L & S	1.85 – 1.99 & 2.18 –2.20

Radio altimeters	C	4.2 – 4.4
Ship borne navigation radars	X	9.345 – 9.405
Special Telecom Services	Ka	27-40
Surveillance and acquisition radar	MMW	94
Synthetic Aperture Radar	P	0.23 - 1
VSAT Networks	Ku	12-18
Wide Area Computer Networks	MMW	60
Wireless Local Area Network	S	2-4
Wireless Local Area Networks	S & C	2.4-2.48 & 5.4