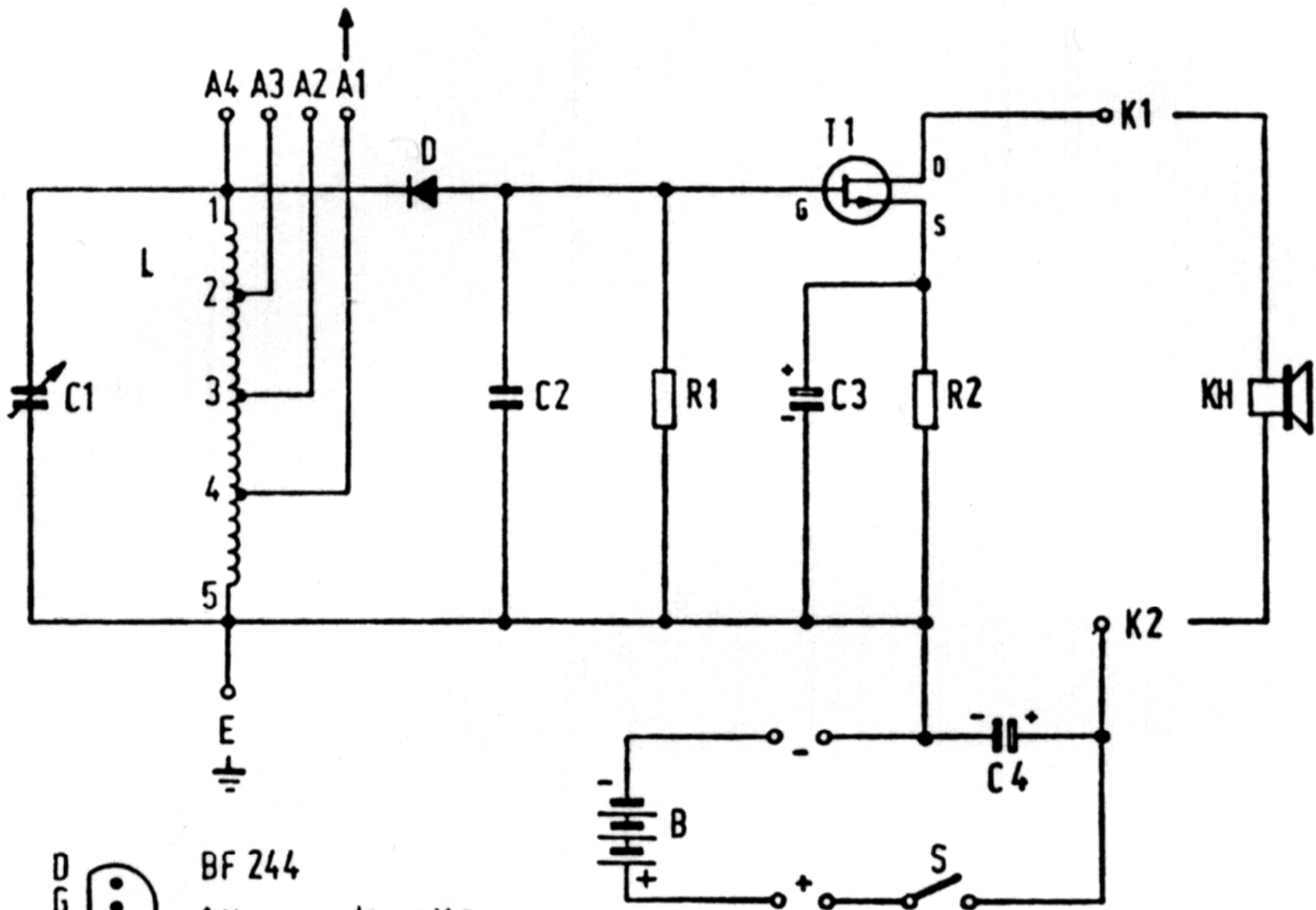


Tecniche radio

Edoardo Milotti

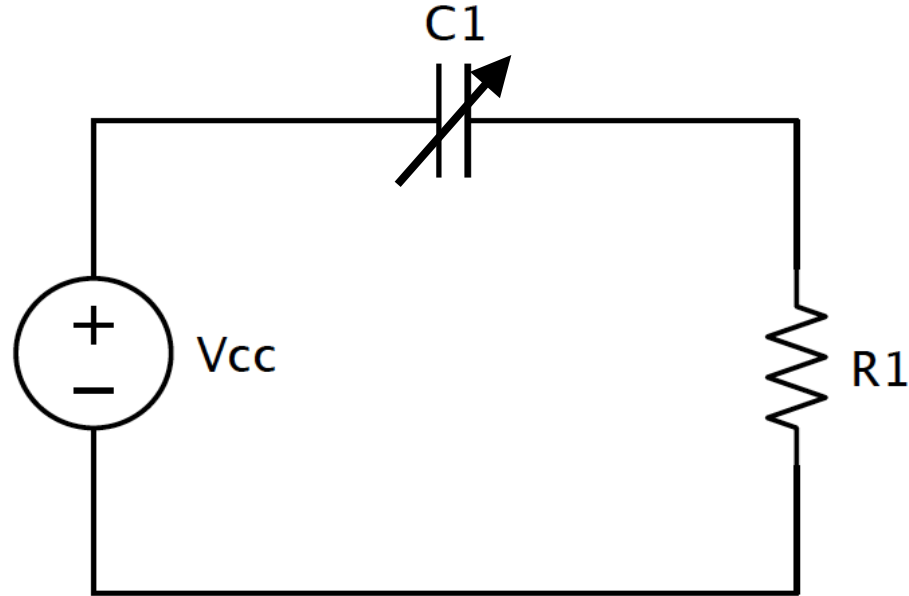
Corso di Metodi di Trattamento dei Segnali

A.A. 2016-17



BF 244
Attacco da sotto

Trasduttore capacitivo (capacitive microphone, electret microphone)



$$V_{cc} = \frac{Q}{C(t)} + IR$$

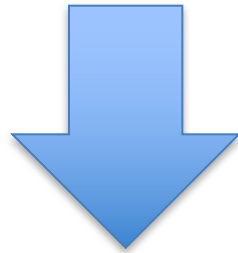
$$V_{cc}C(t) = Q + IRC(t)$$

$$V_{cc} \frac{dC}{dt} = I + IR \frac{dC}{dt} + RC(t) \frac{dI}{dt}$$

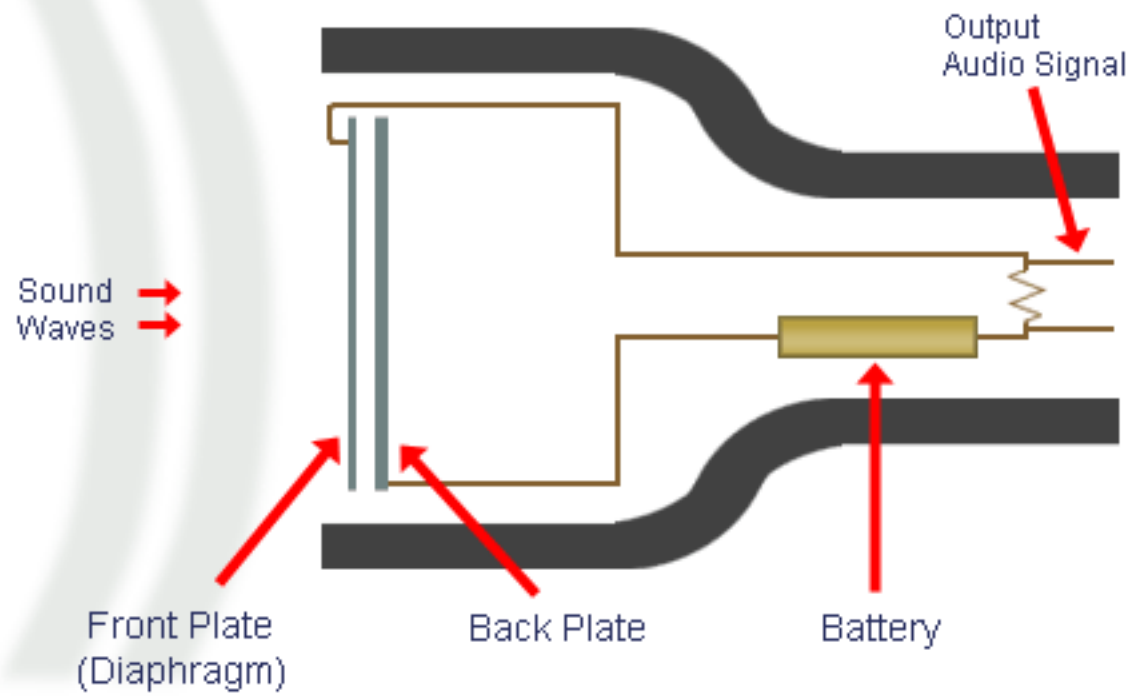
$$V_{cc} \frac{dC}{dt} = I + IR \frac{dC}{dt} + RC(t) \frac{dI}{dt}$$

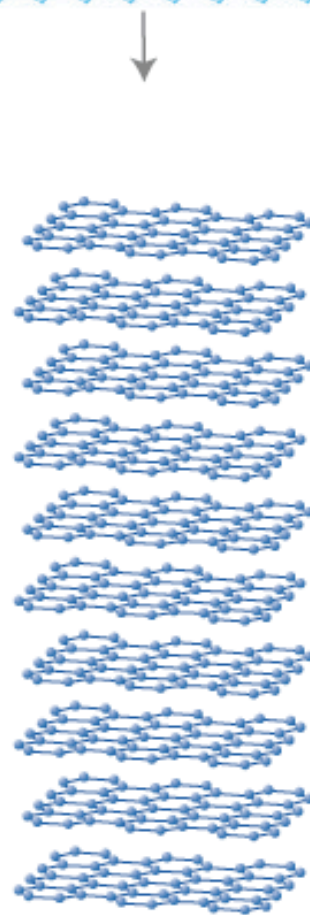
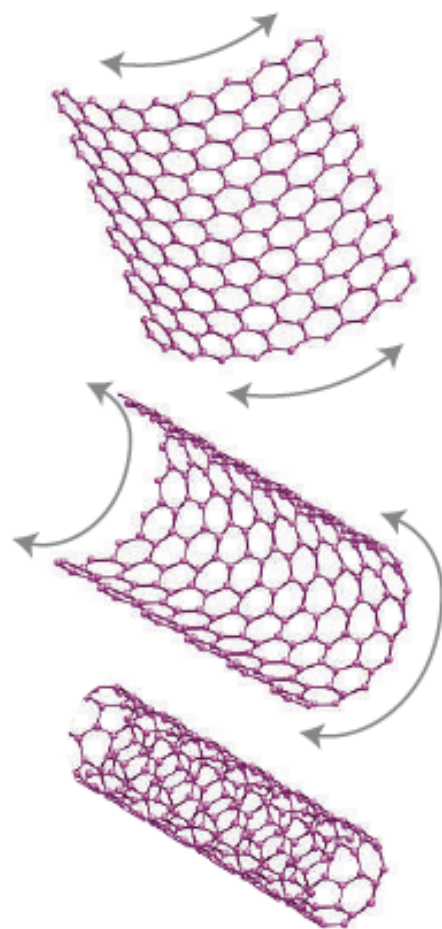
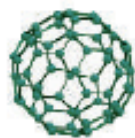
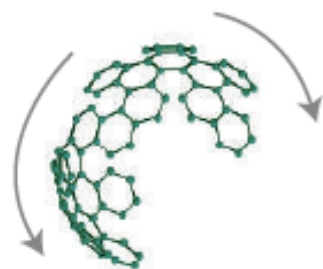
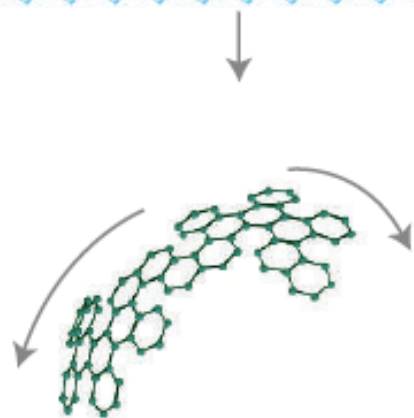
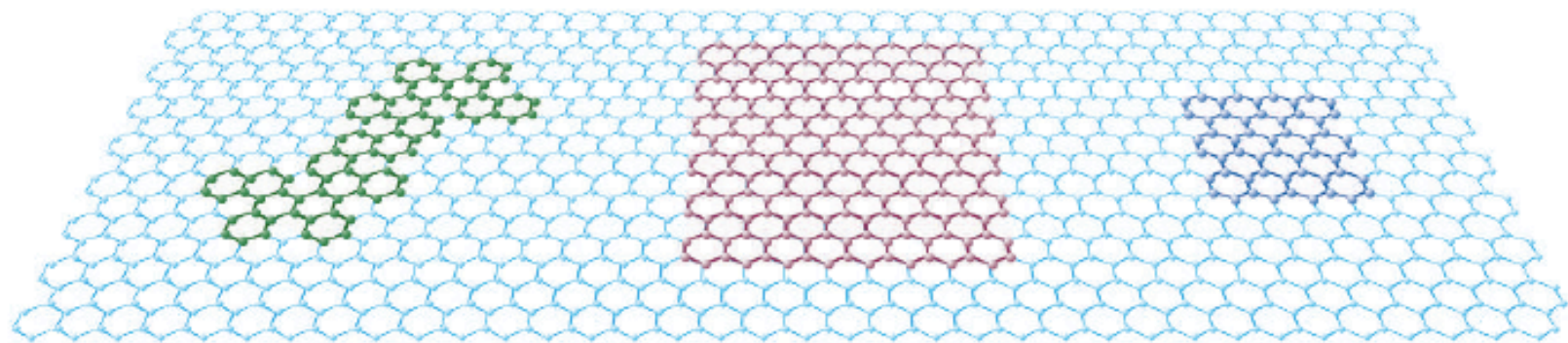


$$C(t) = C_0 + C_1(t); \quad (C_1(t) \ll C_0)$$



$$V_{cc} \frac{dC_1}{dt} \approx I + RC_0 \frac{dI}{dt}$$





Nanotube Radio

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Received August 21, 2007; Revised Manuscript Received October 2, 2007

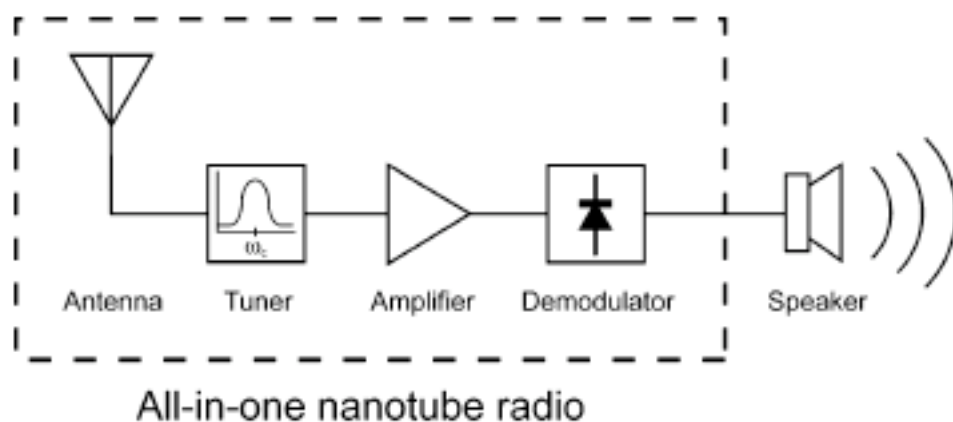
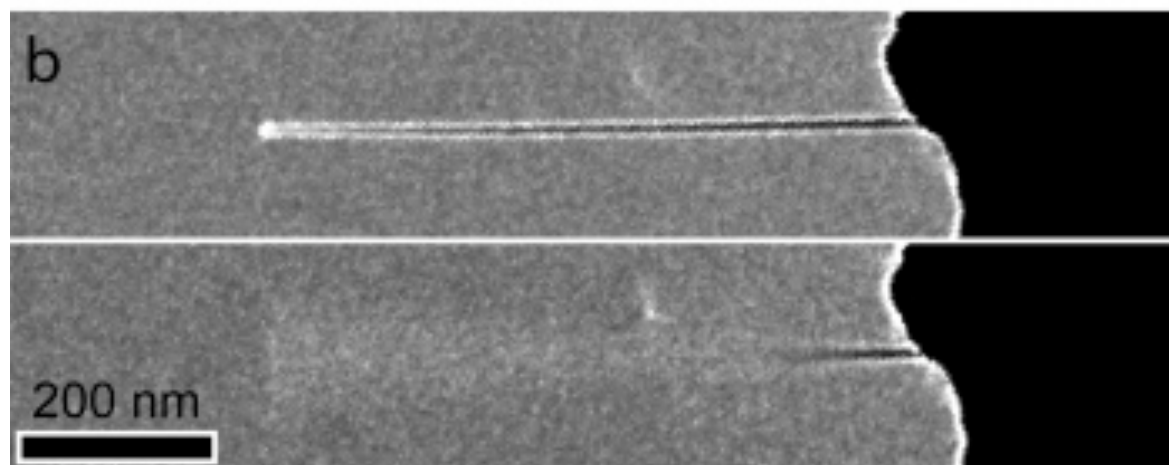
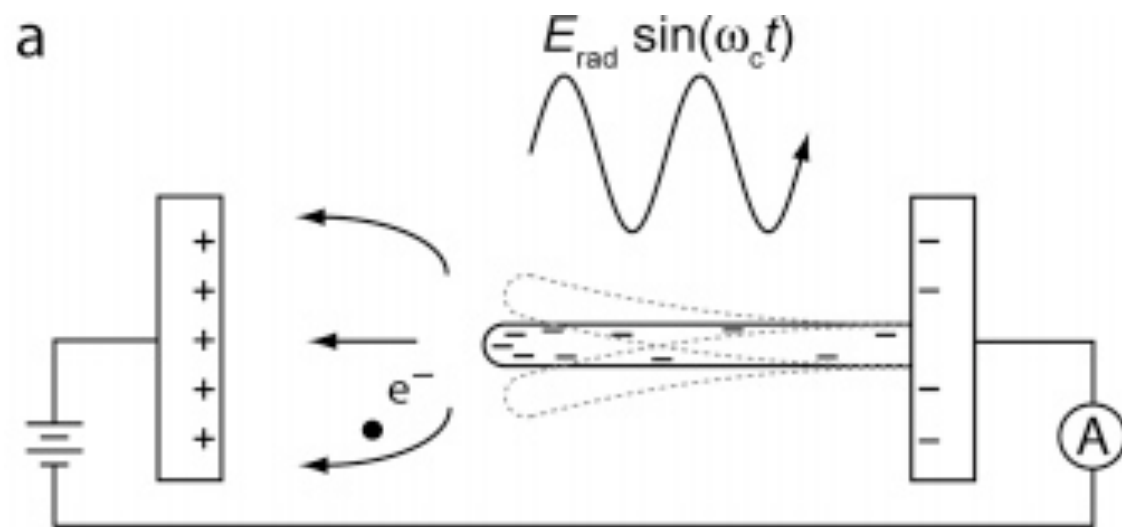
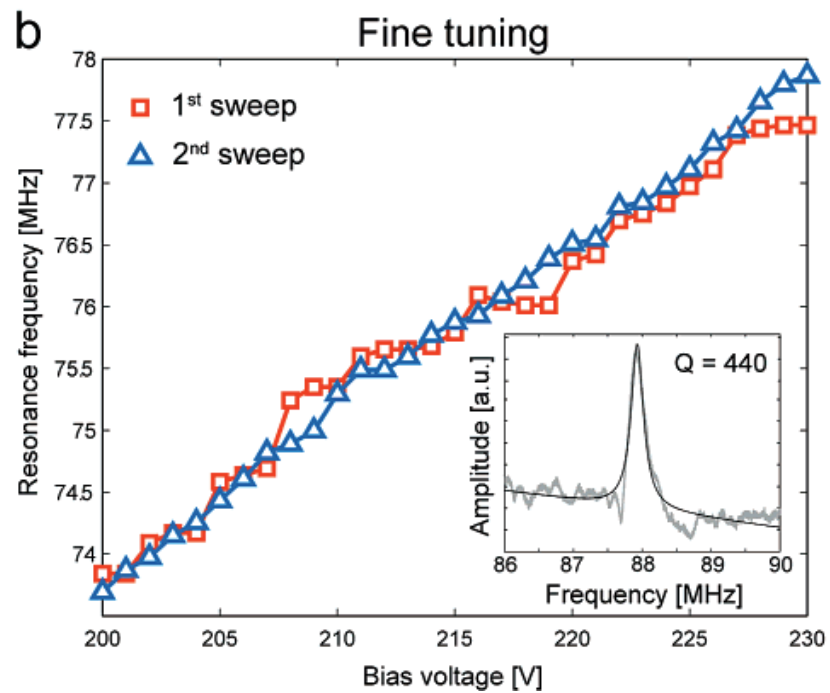
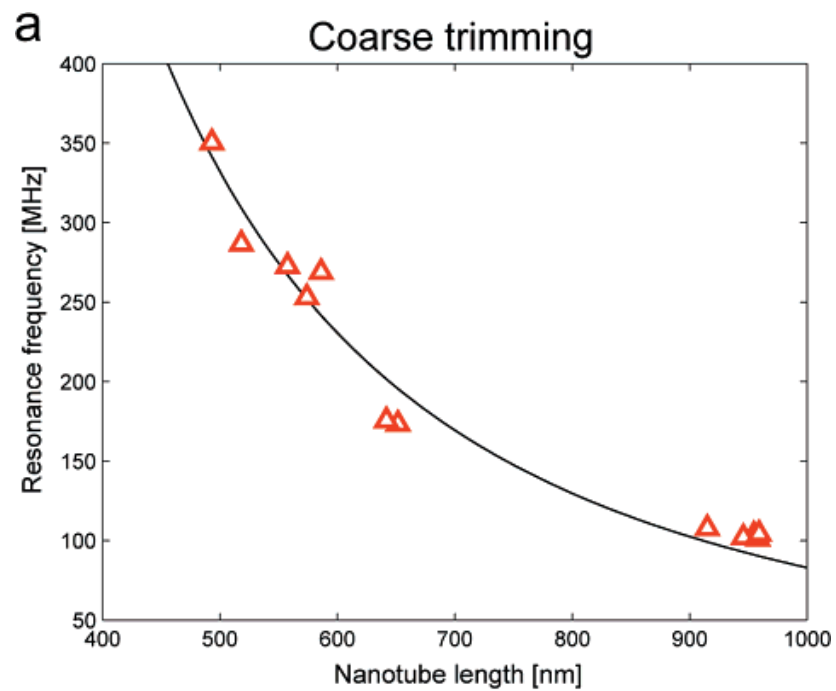
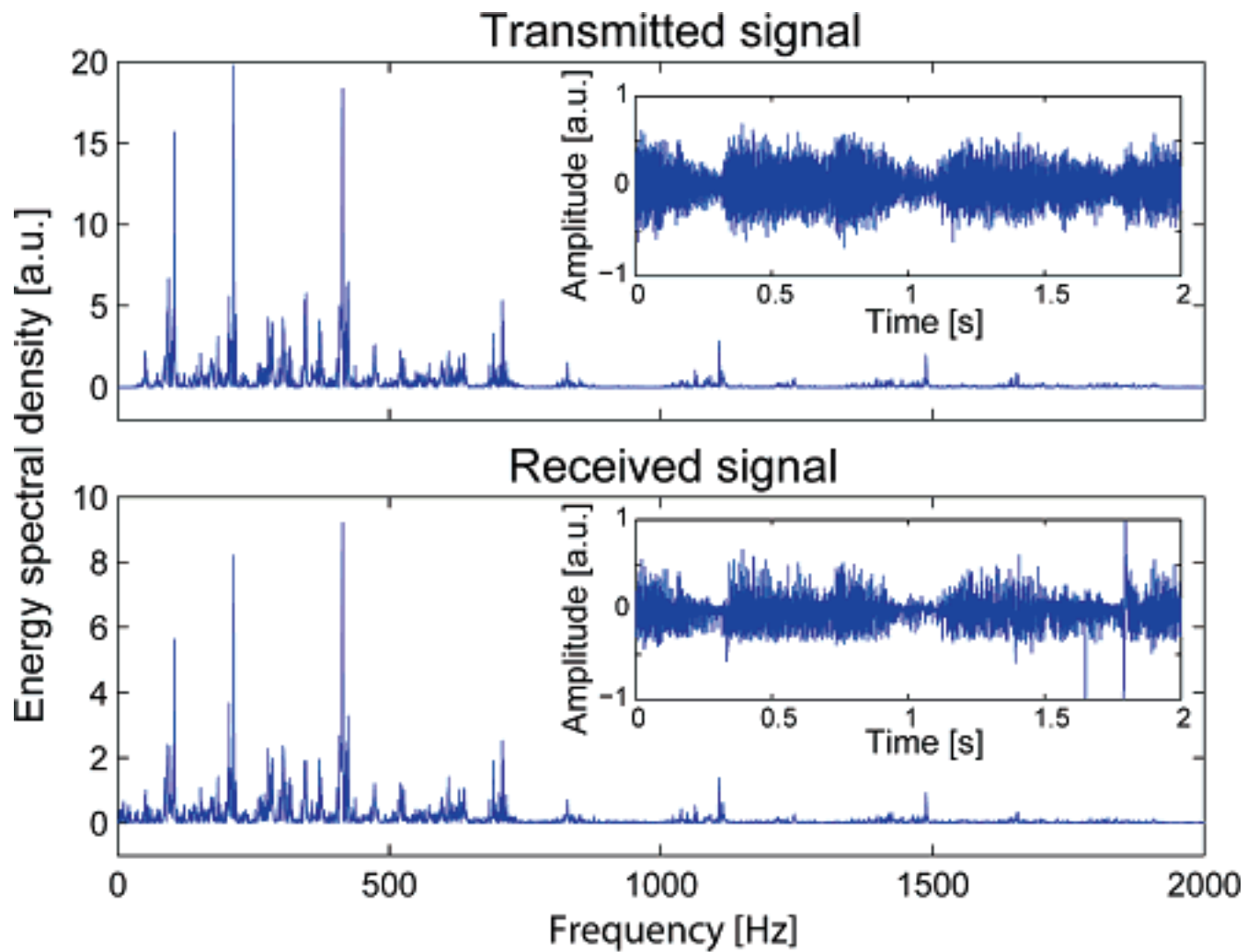


Figure 1. Block diagram for a traditional radio. All four essential components of a radio, antenna, tuner, amplifier, and demodulator may be implemented with a single carbon nanotube.











Nanotube Radio for Communications and Medical Applications

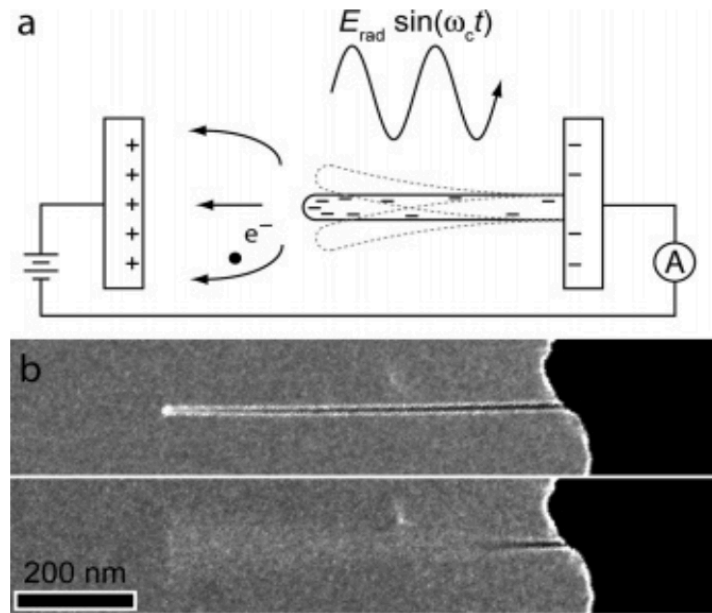
IB-2431, 2432

APPLICATIONS OF TECHNOLOGY:

- All-in-one radio receiver for cell phones/wireless networks/GPS and other electronic devices
- Radio controlled devices that can exist inside the body, e.g. used as drug release triggers, diagnostic instrumentation, interfacing with muscle or brain function
- Ultra small hearing aid
- RF antenna, tunable pass filter, amplifier, or demodulator
- Mass spectrometer
- Chemical sensor

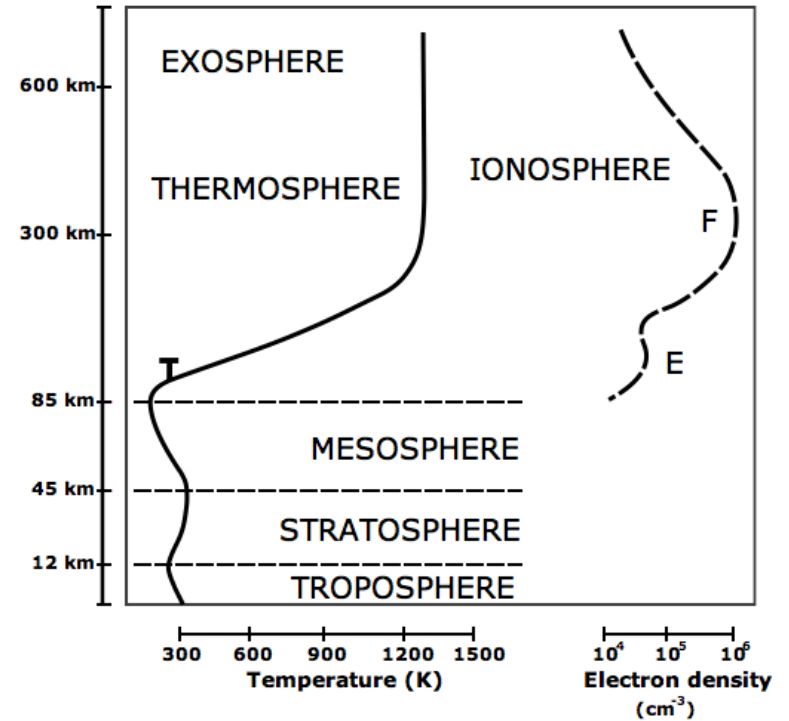
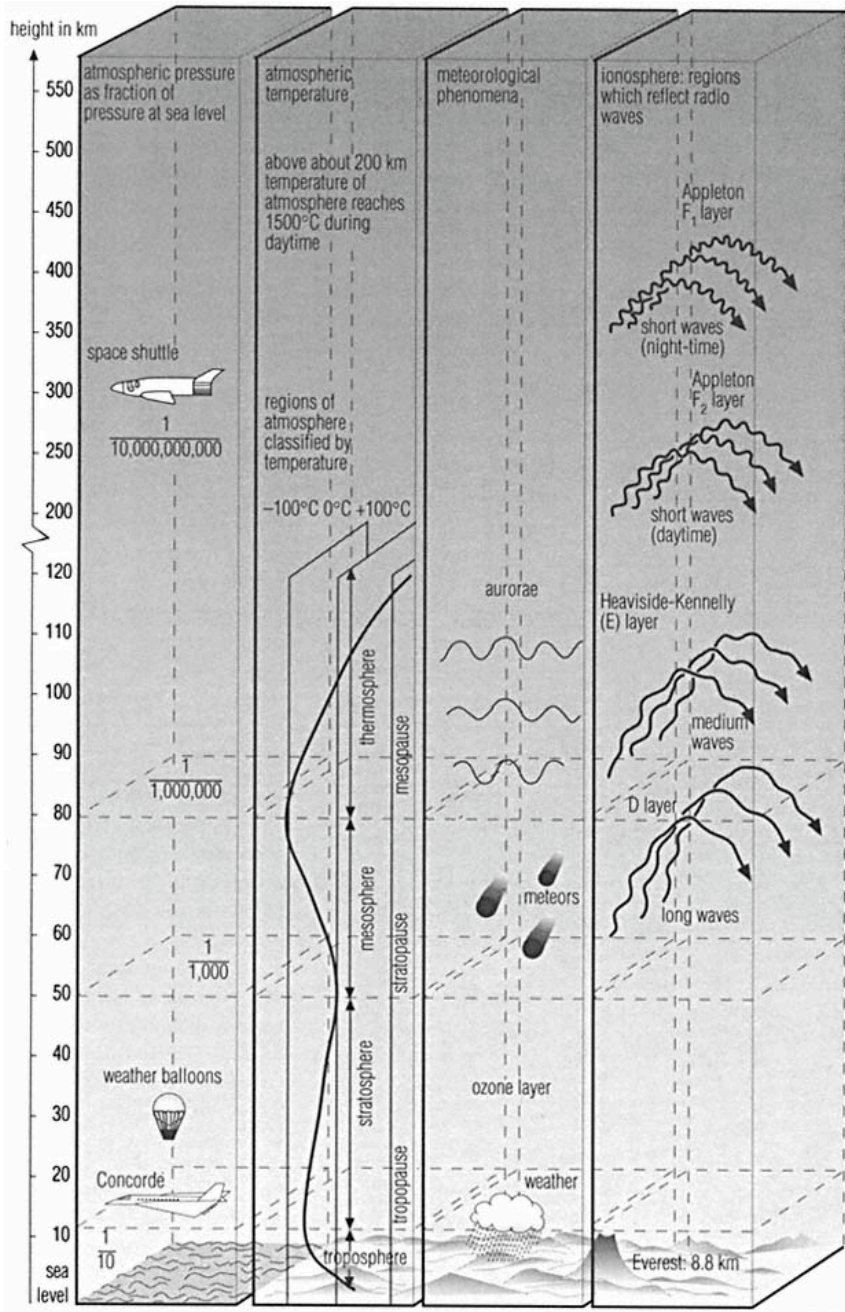
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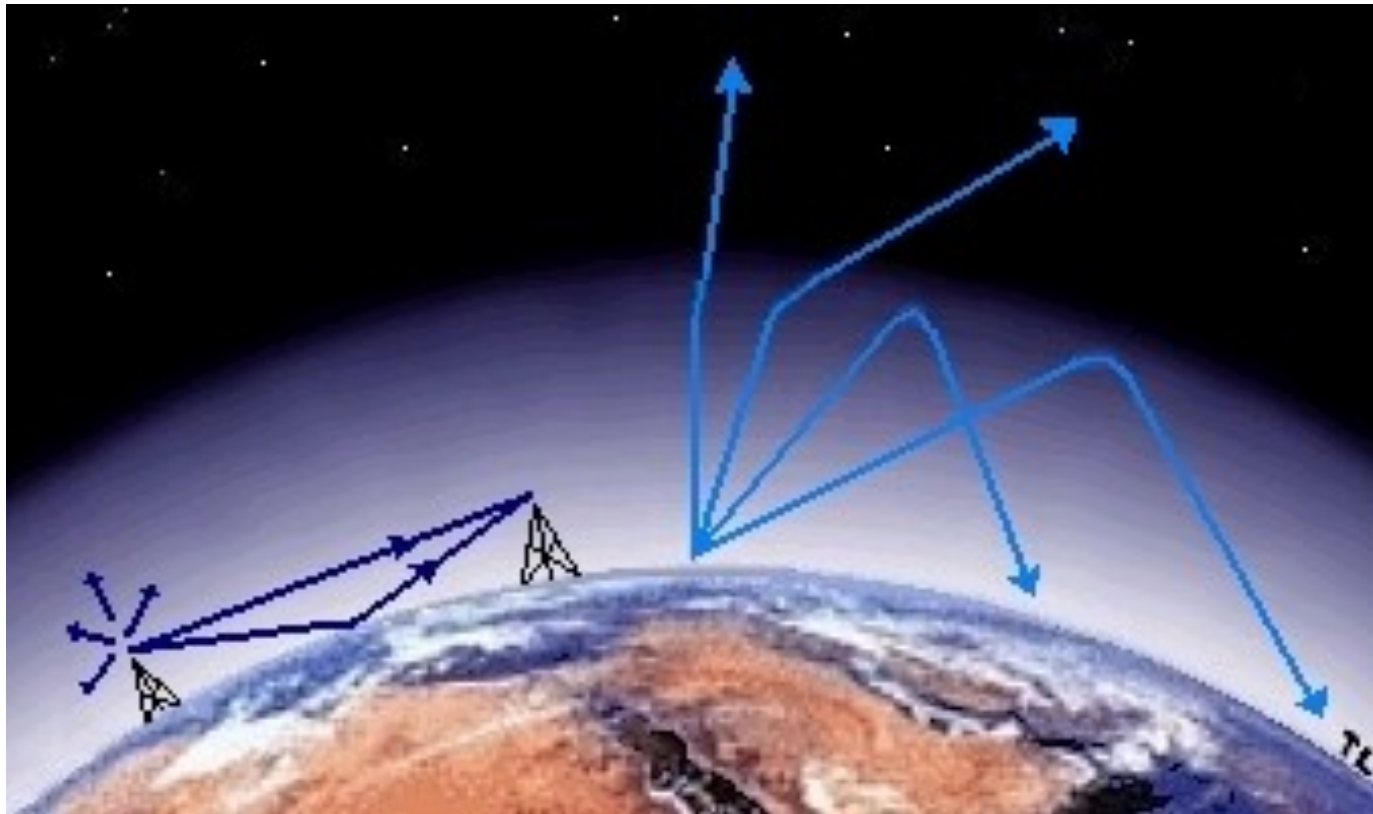
- Orders of magnitude smaller than previous radios – can fit inside a living cell
- Eliminates wiring/thermal problems associated with unifying a micro or nano-scale radio system
- Extremely low power requirements
- Can be tuned after fabrication and during operation
- Can be manufactured individually or in arrays
- Smaller, more inexpensive and more sensitive than state-of-the-art mass spectrometers or chemical sensors



(a) Schematic of the nanotube radio. Radio transmissions tuned to the nanotube's resonance frequency force the charged nanotube to vibrate. Field emission of electrons from the tip of the nanotube is used to detect the vibrations and also amplify and demodulate the signal. A current measuring device, such as a sensitive speaker, monitors the output of the radio.

(b) Transmission electron micrographs of a nanotube radio off resonance (top) and on resonance (bottom) during a radio transmission.





banda		frequenza	lunghezza d'onda	propagazione
VLF	Very Low Frequency	3–30 kHz	100–10 km	onde guidate tra terra e ionosfera;
LF	Low Frequency	30–300 kHz	10–1 km	onde guidate tra terra e strato D della ionosfera; onde di superficie;
MF	Medium Frequency	300–3000 kHz	1000–100 m	onde di superficie; rifrazione ionosferica negli strati E ed F di notte, quando l'assorbimento dello strato D si attenua;
HF	High Frequency (Short Wave)	3–30 MHz	100–10 m	rifrazione ionosferica nello strato E e negli strati F1, F2;
VHF	Very High Frequency	30–300 MHz	10–1 m	raramente rifrazione ionosferica nello strato E, estremamente rara negli strati F1, F2 durante attività solare, fino a 80 MHz; generalmente onda diretta;
UHF	Ultra High Frequency	300–3000 MHz	1–0.1 m	onda diretta;
SHF	Super High Frequency	3–30 GHz	100–10 mm	onda diretta;
EHF	Extremely High Frequency	30–300 GHz	10–1 mm	onda diretta limitata da assorbimento atmosferico.

UNITED STATES FREQUENCY ALLOCATIONS

THE RADIO SPECTRUM

RADIO SERVICES COLOR LEGEND

AERONAUTICAL MOBILE	INTER-SATELLITE	RADIO ASTRONOMY
AERONAUTICAL MOBILE SATELLITE	LAND MOBILE	RADIO DETERMINATION SATELLITE
AERONAUTICAL RADIONAVIGATION	LAND MOBILE SATELLITE	RADIOLOCATION
AMATEUR	MARITIME MOBILE	RADIOLOCATION SATELLITE
AMATEUR SATELLITE	MARITIME MOBILE SATELLITE	RADIONAVIGATION
BROADCASTING	MARITIME RADIONAVIGATION	RADIONAVIGATION SATELLITE
BROADCASTING SATELLITE	METEOROLOGICAL AIDS	SPACE OPERATION
EARTH/EXPLORATION SATELLITE	METEOROLOGICAL SATELLITE	SPACE RESEARCH
FIXED	MOBILE	STANDARD FREQUENCY AND TIME SIGNAL
FIXED SATELLITE	MOBILE SATELLITE	STANDARD FREQUENCY AND TIME SIGNAL SATELLITE

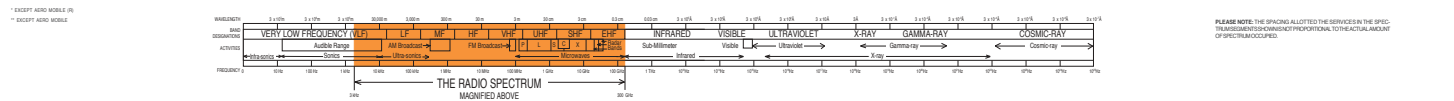
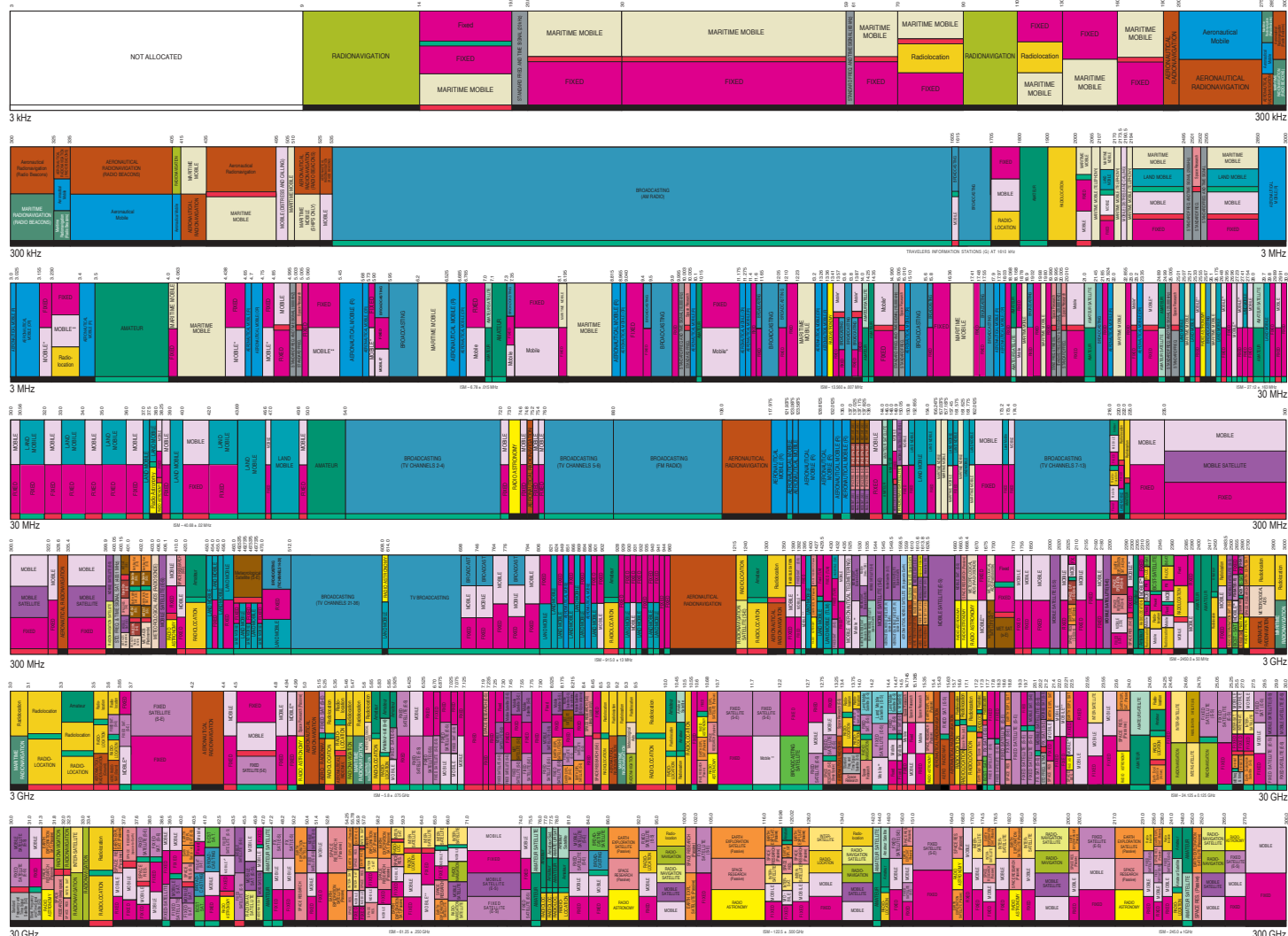
ACTIVITY CODE

GOVERNMENT EXCLUSIVE	GOVERNMENT/NON-GOVERNMENT SHARED
NON-GOVERNMENT EXCLUSIVE	

ALLOCATION USAGE DESIGNATION

SERVICE	EXAMPLE	DESCRIPTION
Primary	FIXED	Capital Letters
Secondary	Mobile	1st Capital with lower case letters

This chart is a specific implementation of the portions of the Table of Frequency Allocations used by the FCC and ICA, as such, it does not completely reflect all aspects, i.e., footnote and recent changes made to the Table of Frequency Allocations. Therefore, for complete information, users should consult the Table to determine the current status of U.S. allocations.



PLEASE NOTE: THE SPACING ALLOCATED SERVICES IN THE SPECTRUM DIAGRAM IS FOR CONCEPT PROPORTIONAL TO THE ACTUAL AMOUNT OF SPECTRUM OCCUPIED.

FMLIST Ricerca

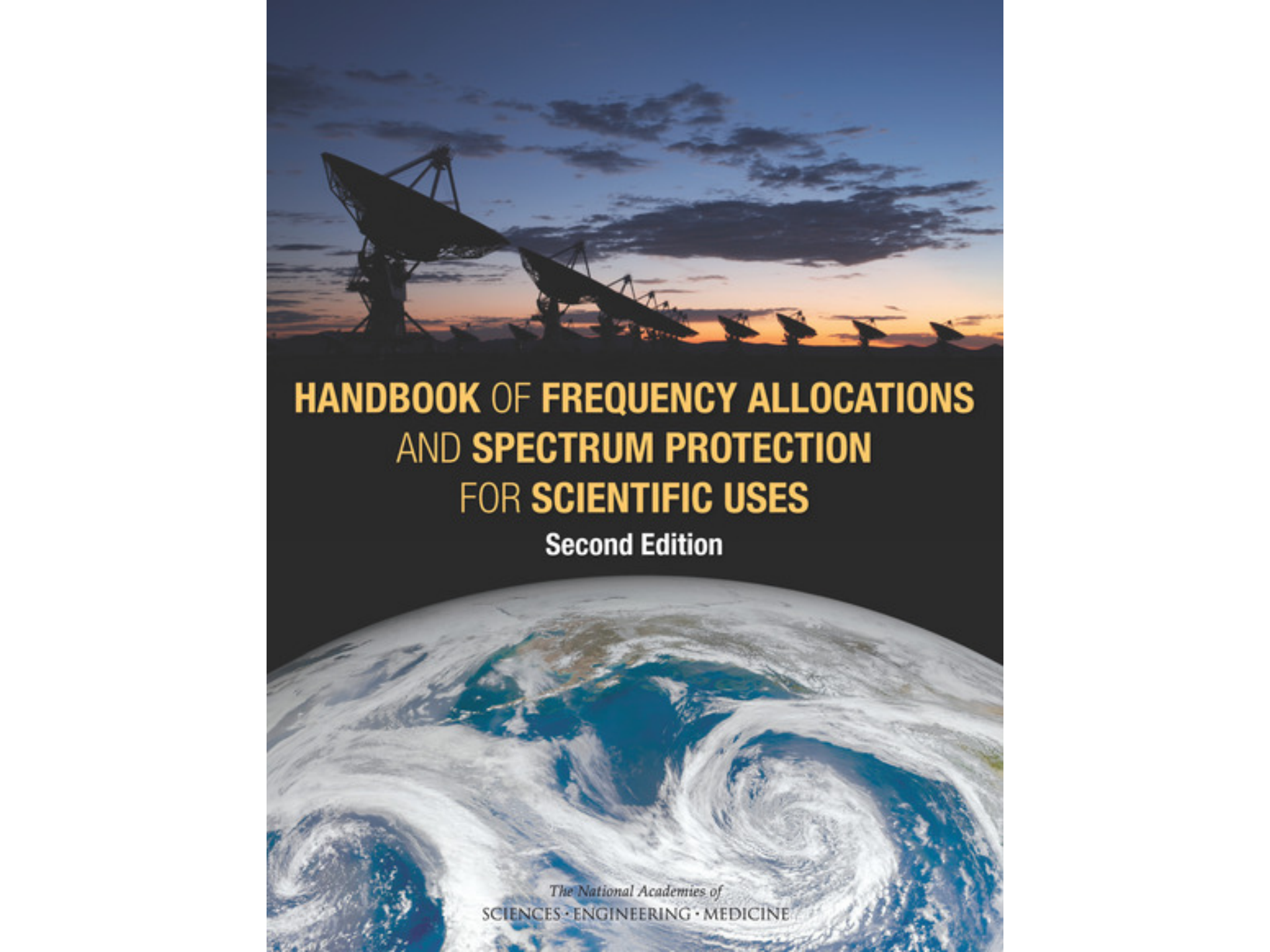
Italia

--> Condizioni d'uso

MHz	Radio	Postazione	RDS-PS	PI
87.70	RAI Radio1 Friuli-Venezia Giulia	Muggia/Chiampore (RAI) (TS)	RAI_RADIO1_	5201
88.00	Radio Birikina	Muggia/Strada per Chiampore (TS)	BIRIKINA_RADIO_BK [artist] [title_]	536E
88.40	Radio DeeJay	Trieste/Conconello (Via della Bellavista) (TS)	DEEJAY_	5214
88.70	RAI GR Parlamento	Muggia/Chiampore (RAI) (TS)	RAI-GRP_	5206
89.00	Radio Fantasy	Trieste/Conconello (Via della Bellavista) (TS)	FANTASY_	53F9
89.40	Radio DeeJay	Muggia/Strada per Chiampore (TS)	DEEJAY_	5214
89.70	RMC - Radio Monte Carlo	Muggia/Strada per Chiampore (TS)	RMC_1_	5213
90.00	Radio Vasco	Trieste/Conconello (Via della Bellavista) (TS)	VASCO_	50F6
90.30	Radio Italia	Trieste/Conconello (Via della Bellavista) (TS)	R_ITALIA	5220
90.60	Radio SorRiso	Muggia/Strada per Chiampore (TS)	SorRisoO [artist] [title_]	5372
91.00	Radio Radicale	Trieste/Conconello (Via della Bellavista) (TS)	RADIO_*_RADICALE	5210
91.50	RAI Radio1 Friuli-Venezia Giulia	Trieste/Monte Belvedere (RAI) (TS)	RAI_RADIO1_	5401
91.80	Radio Capital	Muggia/Strada per Chiampore (TS)	CAPITAL_	5219
92.20	Radio Zeta - L'Italiana	Trieste/Conconello (Via della Bellavista) (TS)	R-ZETA_ITALIANA	5299
92.40	RAI Radio2	Muggia/Chiampore (RAI) (TS)	RAI_RADIO2_	5202
92.70	Radio Padania Libera (off)	Trieste/Conconello (Via della Bellavista) (TS)	RADIO_PADANIA_LIBERA	5276
93.00	Radio 24	Trieste/Conconello (Via della Bellavista) (TS)	RADIO_24	5245
93.30	Radio Nuova Trieste-inBlu	Trieste/Via Civirani (TS)	RADIO_NUOVA_TRIESTE	5001
93.60	RAI Radio2	Trieste/Monte Belvedere (RAI) (TS)	RAI_RADIO2_	5202
93.90	Radio Romantica	Trieste/Conconello (Via della Bellavista) (TS)	ROMANTICA_ROMNTICA	561E
94.30	Radio Kiss Kiss	Muggia/Strada per Chiampore (TS)	KISSKISS	5225
94.50	Radio Birikina	Trieste/Conconello (Via della Bellavista) (TS)	BIRIKINA_RADIO_BK [artist] [title_]	536E
94.80	R101	Trieste/Conconello (Via della Bellavista) (TS)	R_101_	5215
95.00	R101	Muggia/Strada per Chiampore (TS)	R_101_	5215
95.40	m2o	Trieste/Conconello (Via della Bellavista) (TS)	M_DUE_O	5233
95.60	Radio Stereocittà	Muggia/Strada per Chiampore (TS)	*STEREO* CITTITA*	520B
95.80	RAI Radio3	Trieste/Monte Belvedere (RAI) (TS)	RAI_RADIO3_	5203
96.20	Virgin Radio	Muggia/Strada per Chiampore (TS)	VIRGIN_	5241
96.50	RAI Radio3	Muggia/Chiampore (RAI) (TS)	RAI_RADIO3_	5203
96.80	Virgin Radio	Trieste/Conconello (Via della Bellavista) (TS)	VIRGIN_	5241
97.00	Radio Attività Sport	Muggia/Strada per Chiampore (TS)	RADIO_ATTIVITA_SPORT_	51FF
97.30	Radio Padania Libera	Muggia/Strada per Chiampore (TS)	RADIO_PADANIA_LIBERA_	5276
97.50	Radio Attività News	Muggia/Strada per Chiampore (TS)	RADIO_ATTIVITA_N_E_W_S	9750
97.90	Radio Attività News	Trieste/Conconello (Via della Bellavista) (TS)	RADIO_ATTIVITA_N_E_W_S	9750
98.30	Radio Attività Sport	Trieste/Conconello (Via della Bellavista) (TS)	RADIO_ATTIVITA_SPORT_	51FF
98.60	RAI Radioquattro - Trieste	Muggia/Chiampore (RAI) (TS)	RAI_MF4_	5404
98.80	Easy Network	Muggia/Strada per Chiampore (TS)	E_A_S_Y_NETWORK_	5361
99.00	Easy Network	Trieste/Conconello (Via della Bellavista) (TS)	E_A_S_Y_NETWORK_	5361
99.30	Radio 105	Trieste/Conconello (Via della Bellavista) (TS)	_105_	5211
99.60	Radio 105	Muggia/Strada per Chiampore (TS)	_105_	5211
99.90	RDS - Radio Dimensione Suono	Trieste/Conconello (Via della Bellavista) (TS)	*_RDS_*_	5264
100.20	Radio Maria	Trieste/Conconello (Via della Bellavista) (TS)	R.MARIA_	51CC
100.50	Radio 24	Duino Aurisina/Frazione Prepetto (TS)	RADIO_24	5245
100.50	Radio SorRiso	Trieste/Conconello (Via della Bellavista) (TS)	SorRisoO [artist] [title_]	5372
100.60	Radio 24	Monrupino/Località Rocca di Monrupino (TS)	RADIO_24	5245
100.80	RMC - Radio Monte Carlo	Trieste/Conconello (Via della Bellavista) (TS)	RMC_	5213
101.10	Radio Punto Zero (Tre Venezie)	Trieste/Conconello (Via della Bellavista) (TS)	R.P.ZERO	5365
101.50	Radio Punto Zero (Tre Venezie)	Muggia/Strada per Chiampore (TS)	R.P.ZERO	5365
101.80	Radio Bella e Monella	Trieste/Conconello (Via della Bellavista) (TS)	BELLLA_E_MONELLA_	5370
102.00	RTL 102.5	Trieste/Conconello (Via della Bellavista, 29) (TS)	RTL102.5	5218
102.30	RTL 102.5	Muggia/Strada per Chiampore (TS)	RTL102.5	5218
102.30	RTL 102.5	Trieste/Conconello (Via della Bellavista, 29) (TS)	RTL102.5	5218
102.60	Radio Company	Trieste/Conconello (Via della Bellavista) (TS)	COMPANY_	5350
102.90	Radio Company	Muggia/Strada per Chiampore (TS)	COMPANY_	5350
103.30	RDS - Radio Dimensione Suono	Muggia/Strada per Chiampore (TS)	*_RDS_*_	5264
103.90	RAI Radioquattro - Trieste	Trieste/Monte Belvedere (RAI) (TS)	RAI_MF4_	5404
104.10	Radio Nuova Trieste-inBlu	Trieste/Via Besenghi (TS)	RADIO_NUOVA_TRIESTE	5001
104.50	Radio Fragola (Popolare Network)	Trieste/Conconello (Via della Bellavista) (TS)	FRAGOLA_POPOLARE_NETWORK_	524A
104.80	Radio Fragola (Popolare Network)	Muggia/Strada per Chiampore (TS)	FRAGOLA_POPOLARE_NETWORK_	524A
105.00	Radio Capital	Trieste/Conconello (Via della Bellavista) (TS)	CAPITAL_	5219
105.20	Radio Invidia	Trieste/Conconello (Via della Bellavista) (TS)	INVIDIA_	5354
105.50	Radio Radicale	Muggia/Strada per Chiampore (TS)	RADIO_*_RADICALE	5210
105.80	Radio Italia	SoloMusicalItaliana (TS)	R_ITALIA	5220
106.10	Radio Ottanta	Trieste/Conconello (Via della Bellavista) (TS)	OTTANTA_	535A
106.40	Radio Ottanta	Muggia/Strada per Chiampore (TS)	OTTANTA_	535A
106.70	RAI GR Parlamento	Trieste/Monte Belvedere (RAI) (TS)	RAI-GRP_	5206
107.00	Radio Maria	Muggia/Strada per Chiampore (TS)	R.MARIA_	51CC
107.30	Radio LatteMiele FVG (Radio Azzurra) Friuli-Venezia Giulia	Muggia/Strada per Chiampore (TS)	LATMIELE_RADIO_LM_RADIOFVG_ITALIANA	5355
107.80	RTL 102.5	Muggia/Strada per Chiampore (TS)	RTL102.5	5218

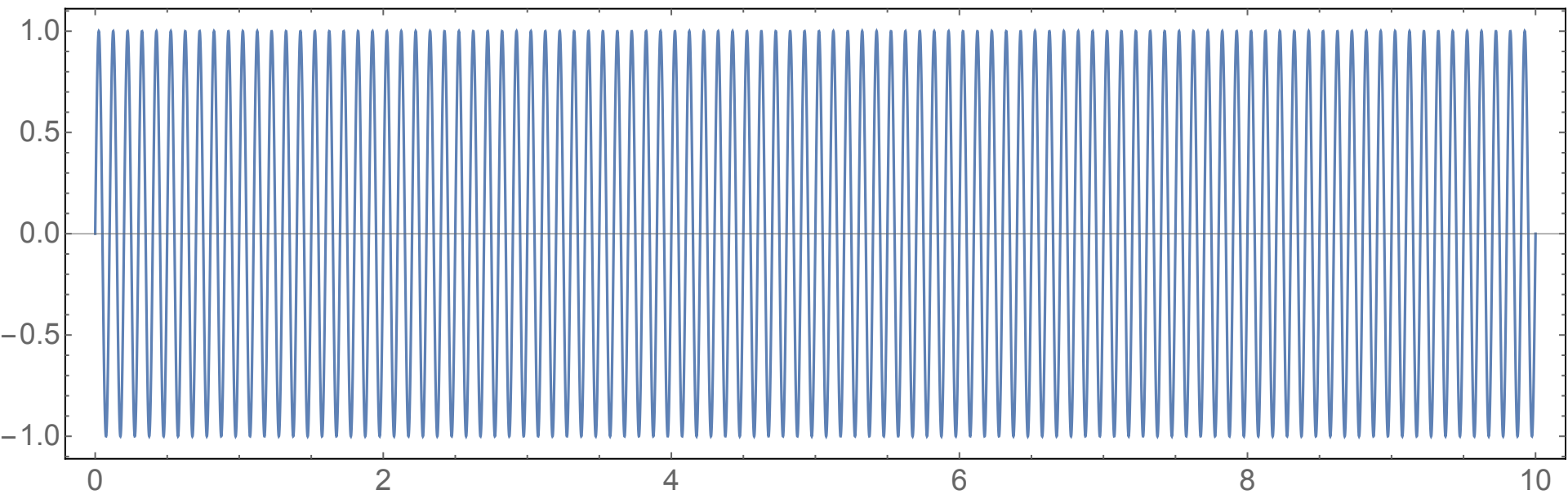
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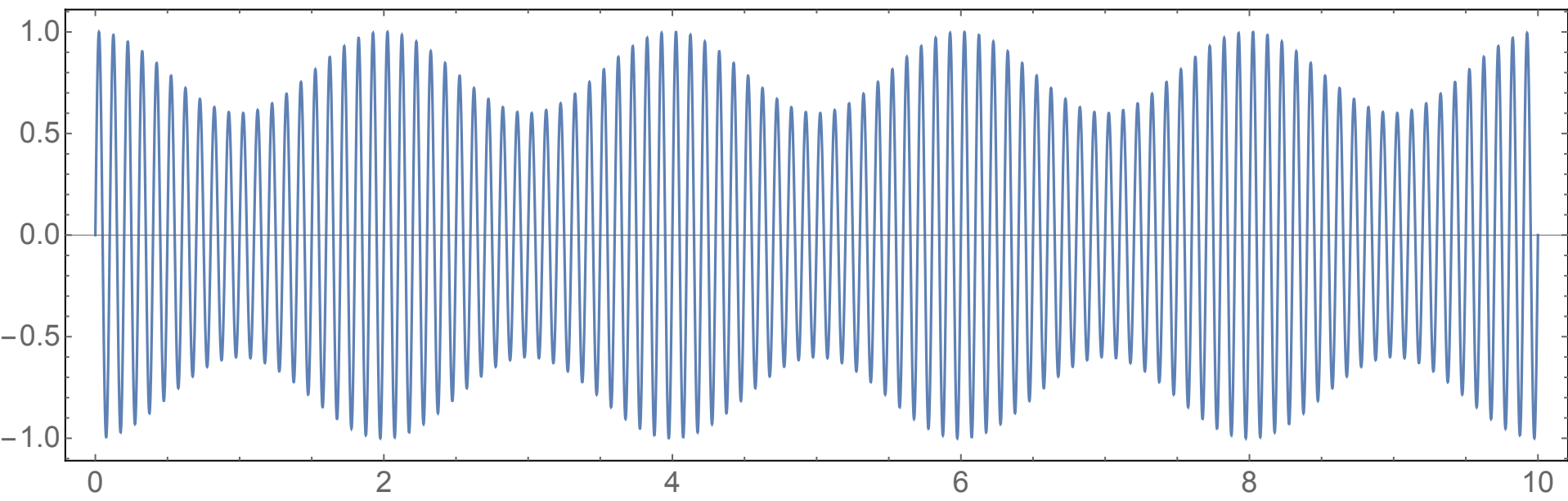
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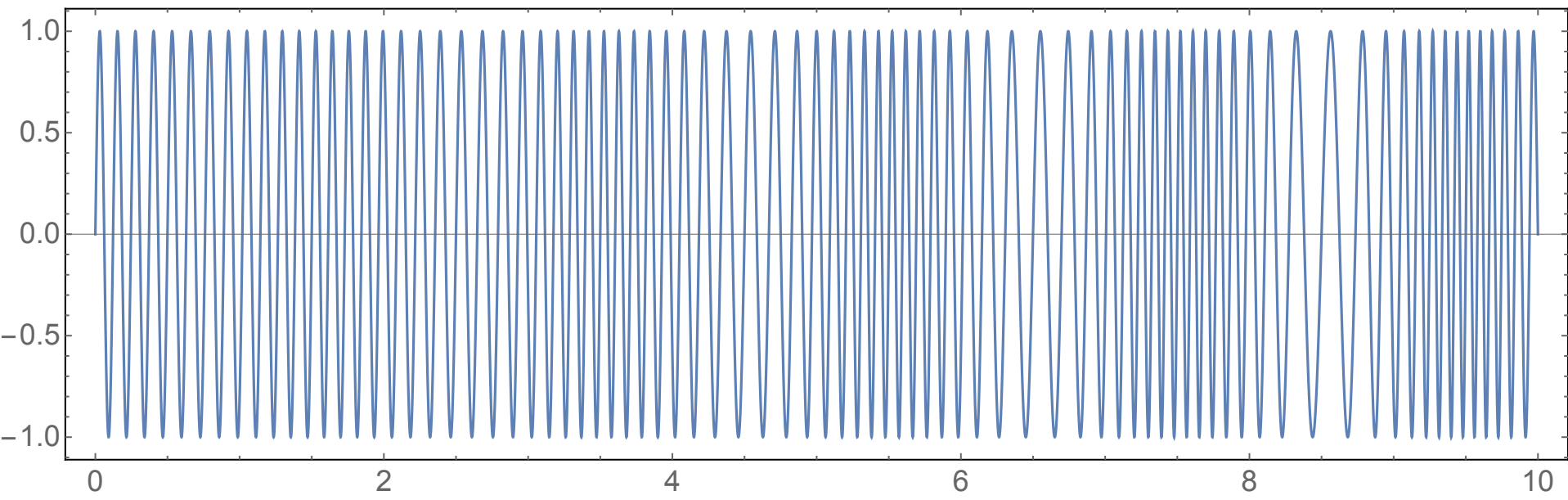


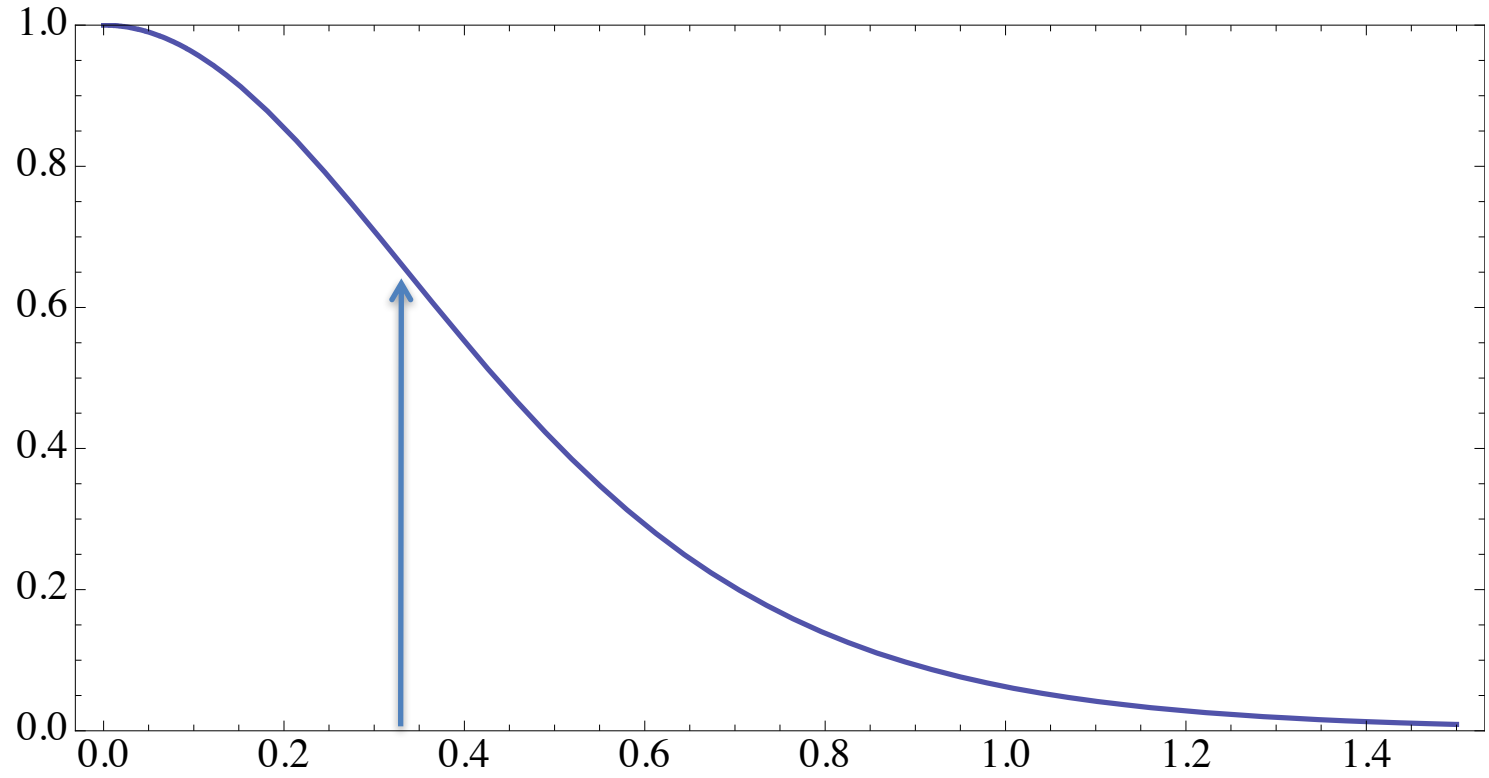
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AND SPECTRUM PROTECTION
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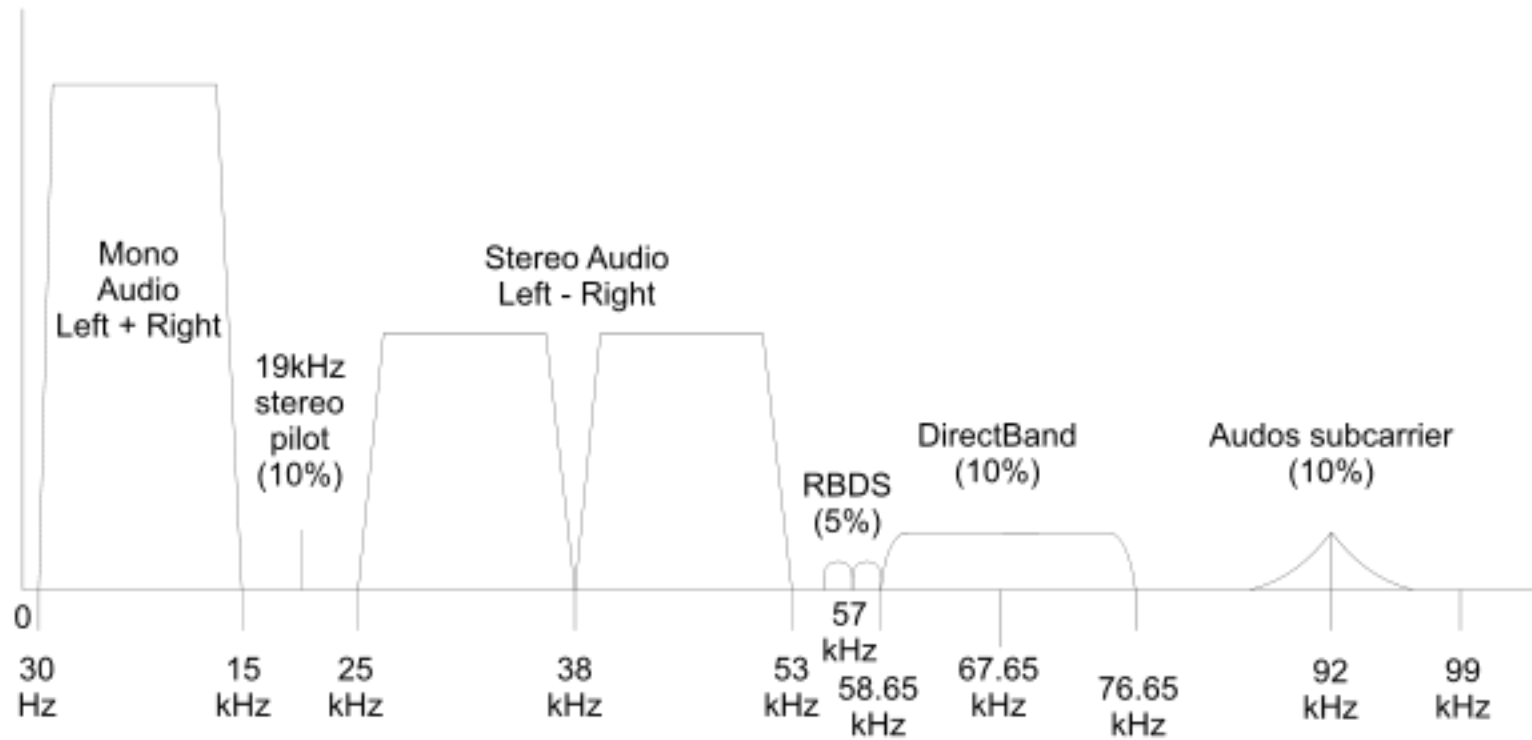




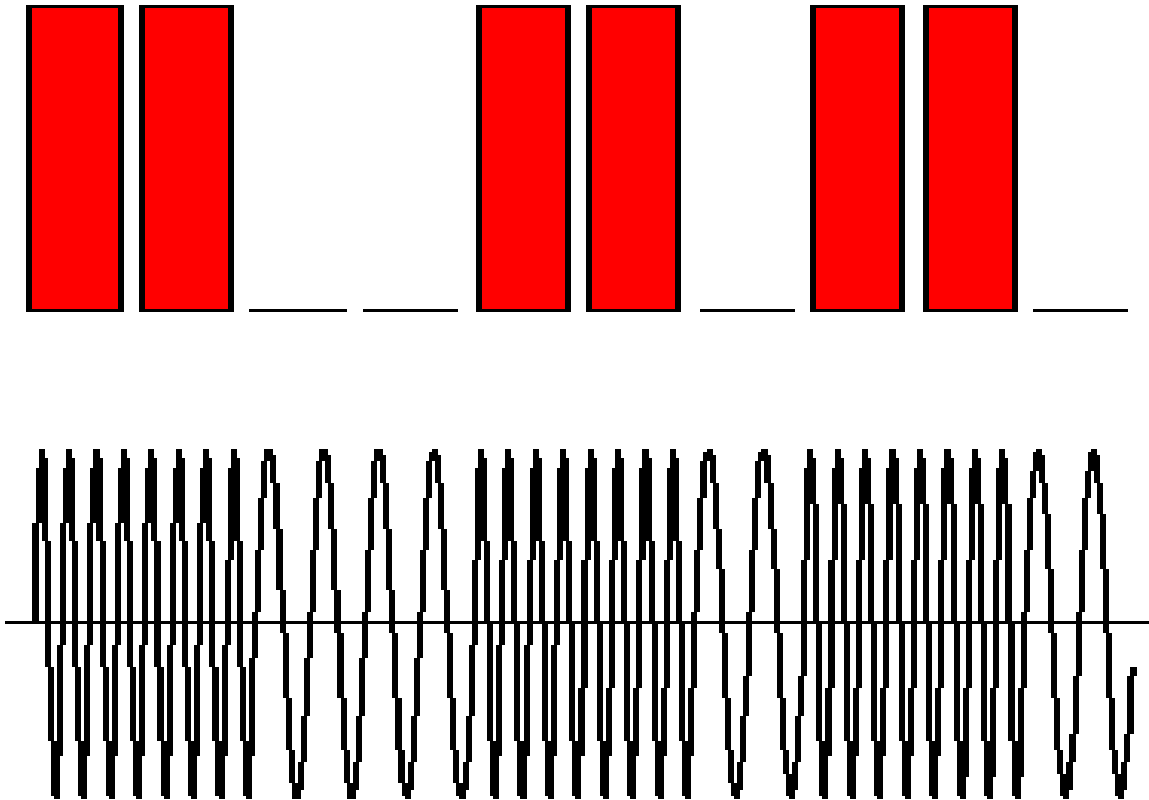


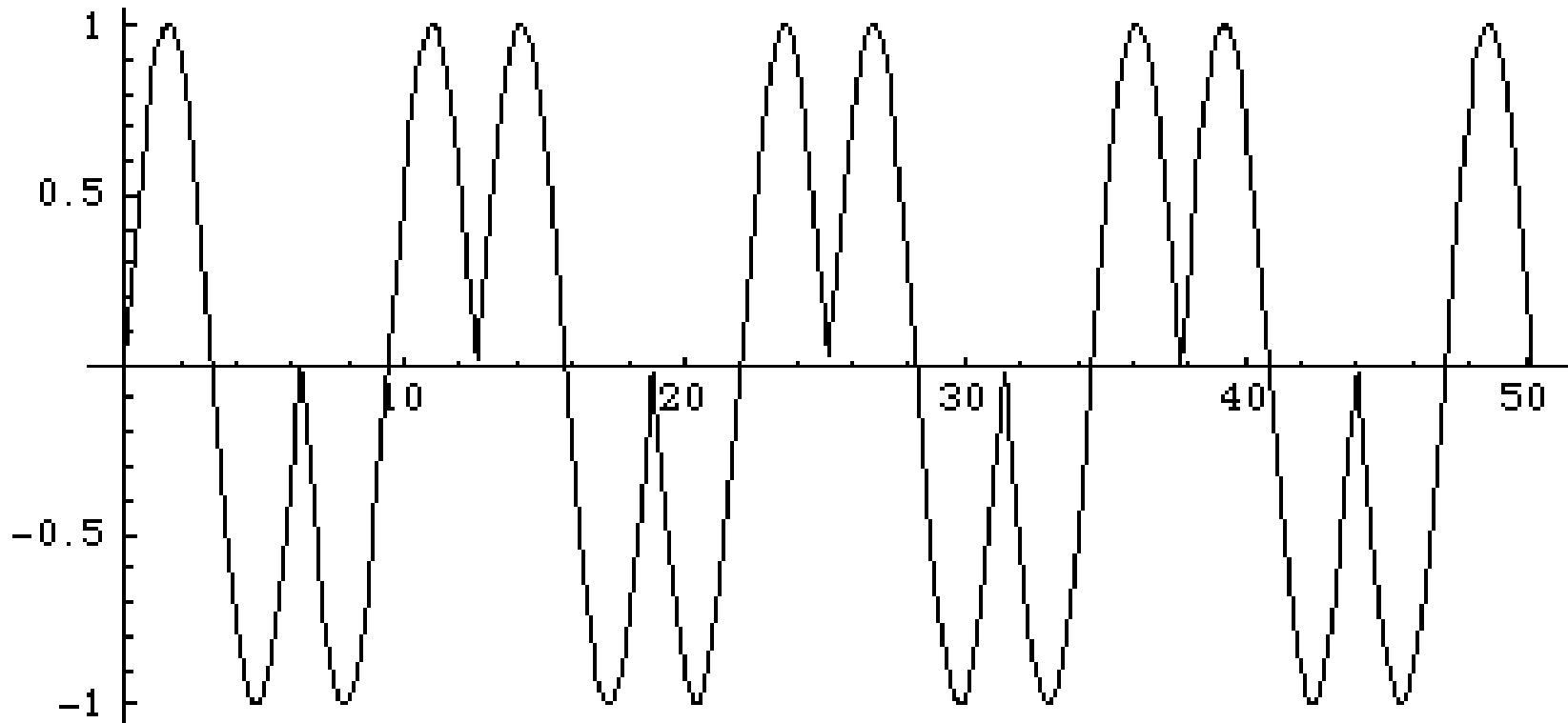


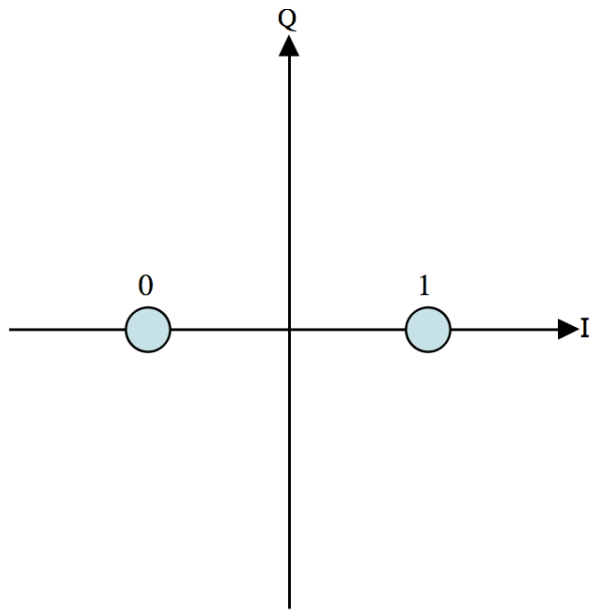
Spettro di una trasmissione FM



Modulazione FSK (Frequency Shift Keying)



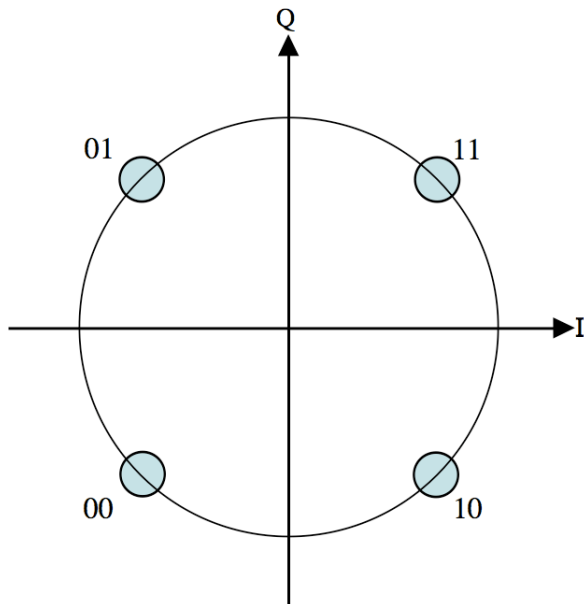




BPSK = Binary Phase Shift Keying

sfasamenti di 180°

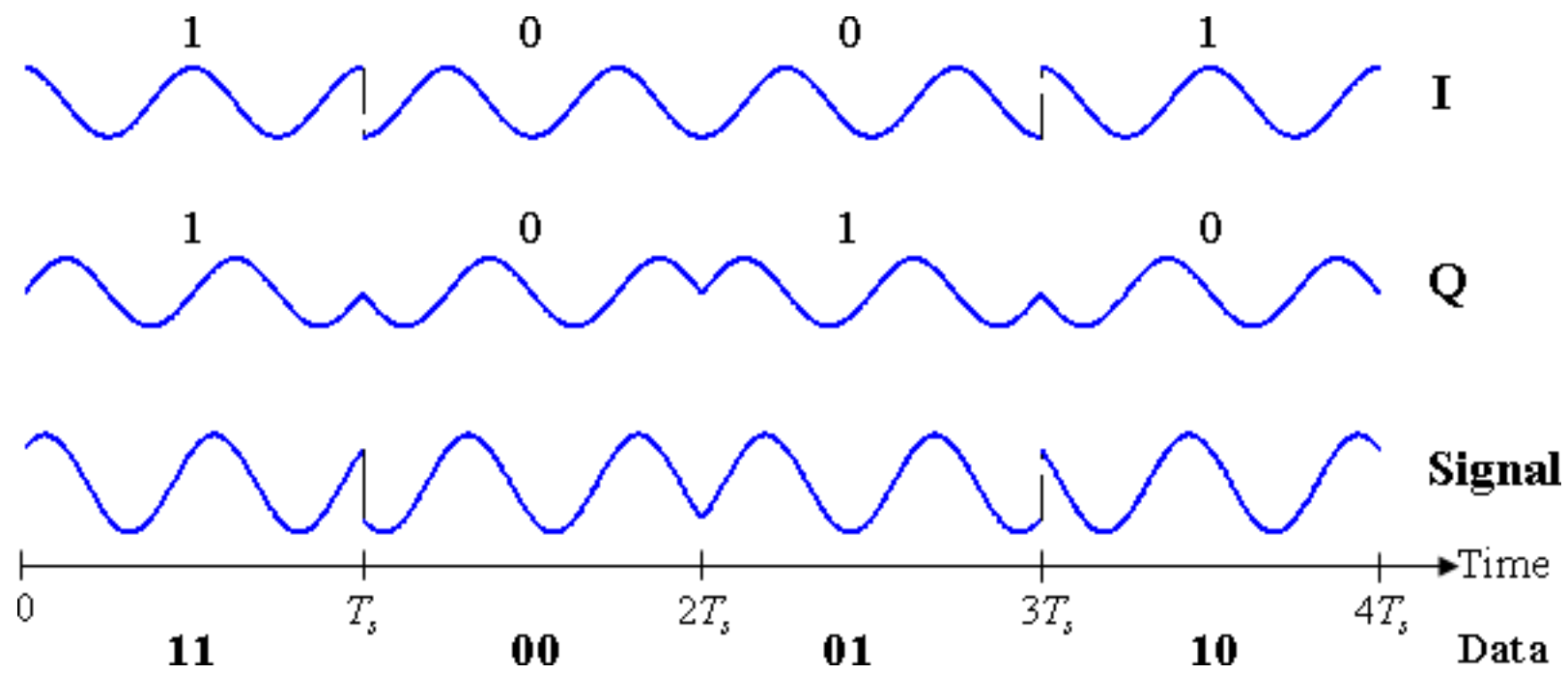
viene codificato un bit alla volta

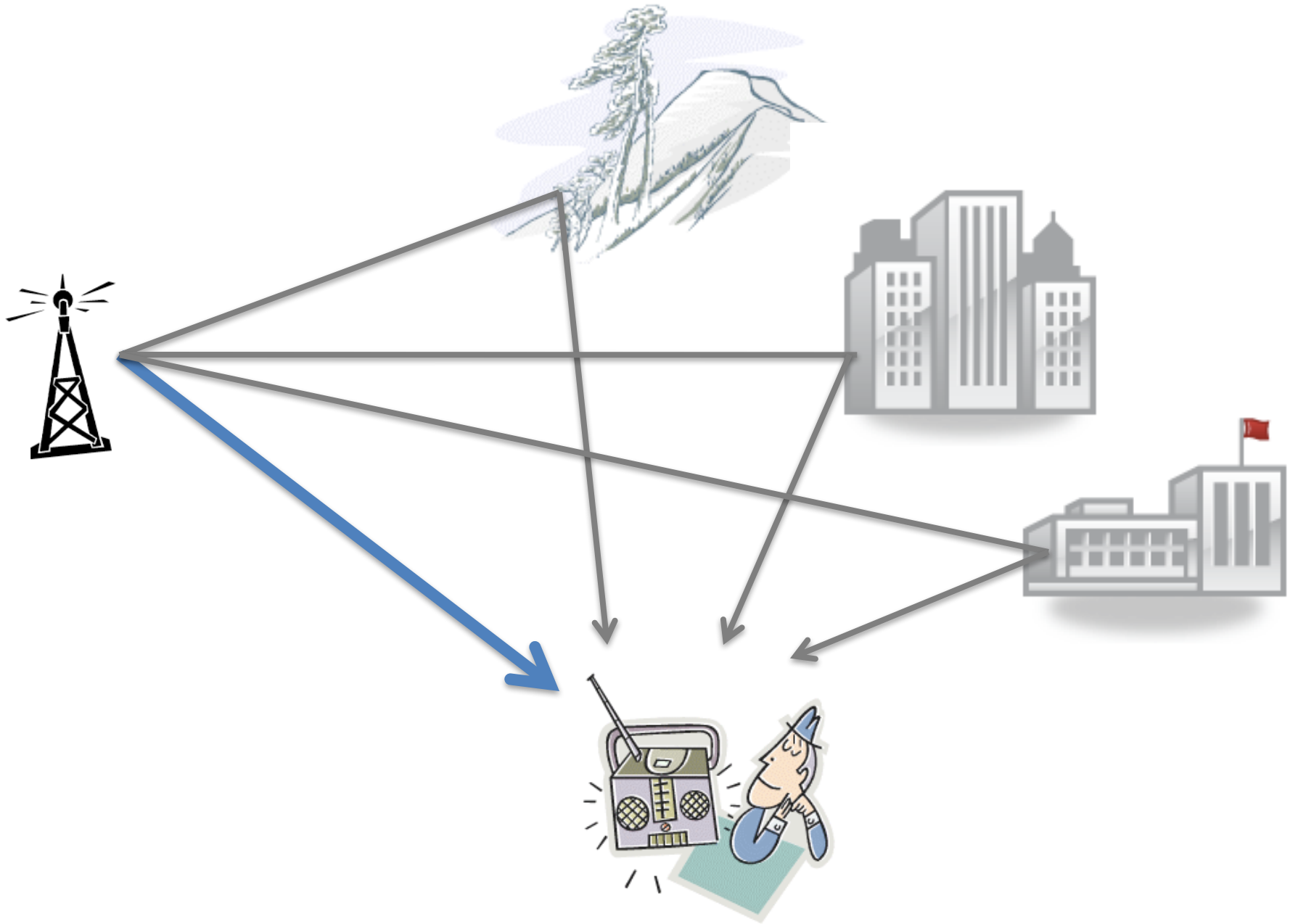


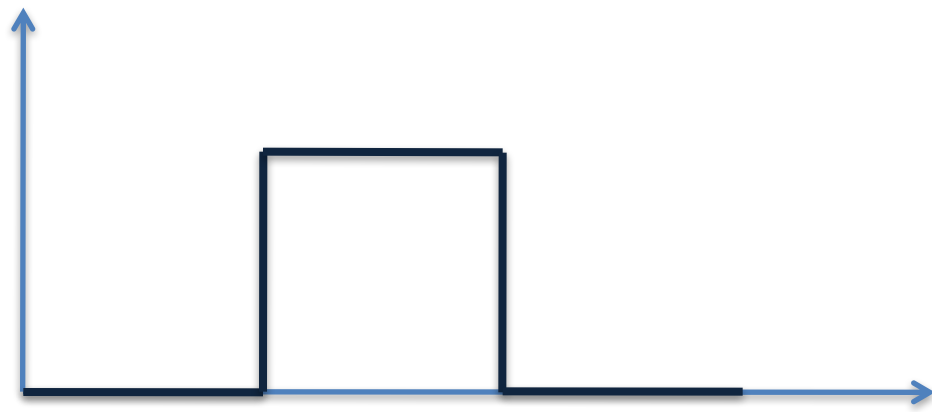
QPSK = Quadrature Phase Shift Keying

sfasamenti di 90°

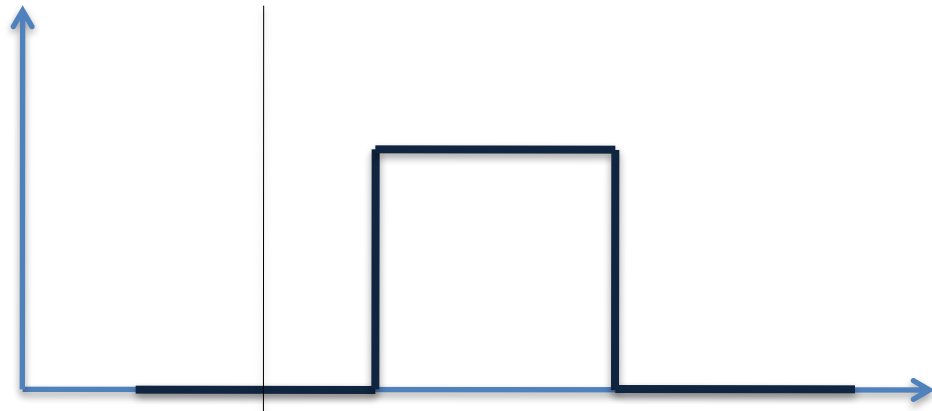
vengono codificati gruppi di 2 bit







segnale diretto



riflessione

Δt

A horizontal blue double-headed arrow is positioned below the horizontal axis. Two vertical black lines extend upwards from the ends of this arrow to the horizontal axis, marking the start and end of the time delay Δt .