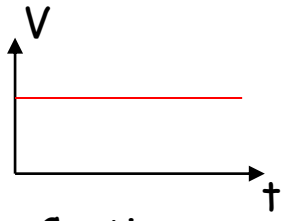
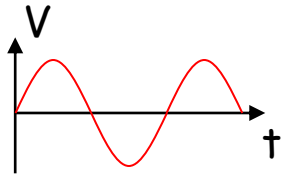
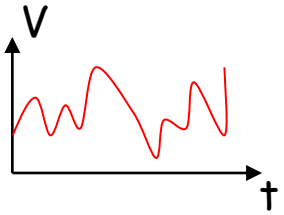
DOMINIO DEL TIEMPO RESPECTO A DOMINIO DE LA FRECUENCIA



Continua

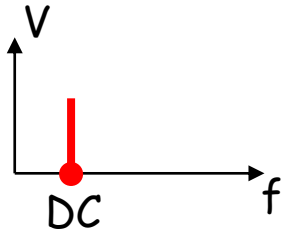


Senoidal



Arbitraria

REPRESENTACIÓN EN EL TIEMPO



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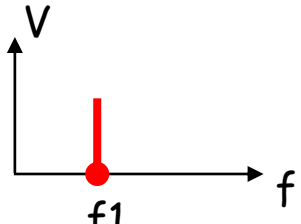

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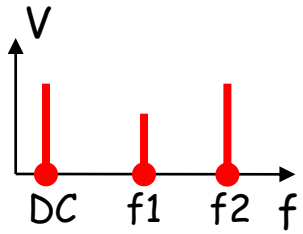
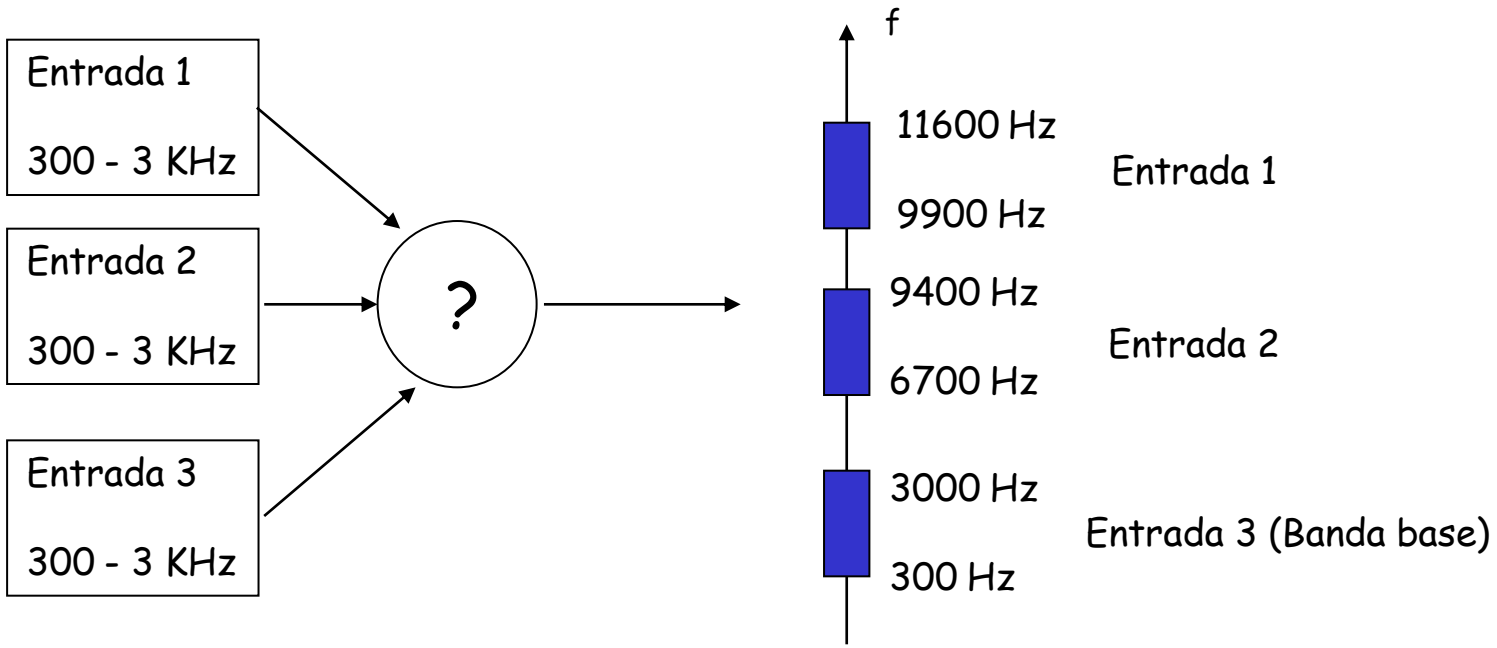


Arbitraria

REPRESENTACIÓN EN FRECUENCIA (ESPECTRO)

Sistemas de Comunicaciones: Modulación

Objetivo de la modulación: Introducir la información en una onda portadora apta para ser transmitida y que actúa como vehículo de la información



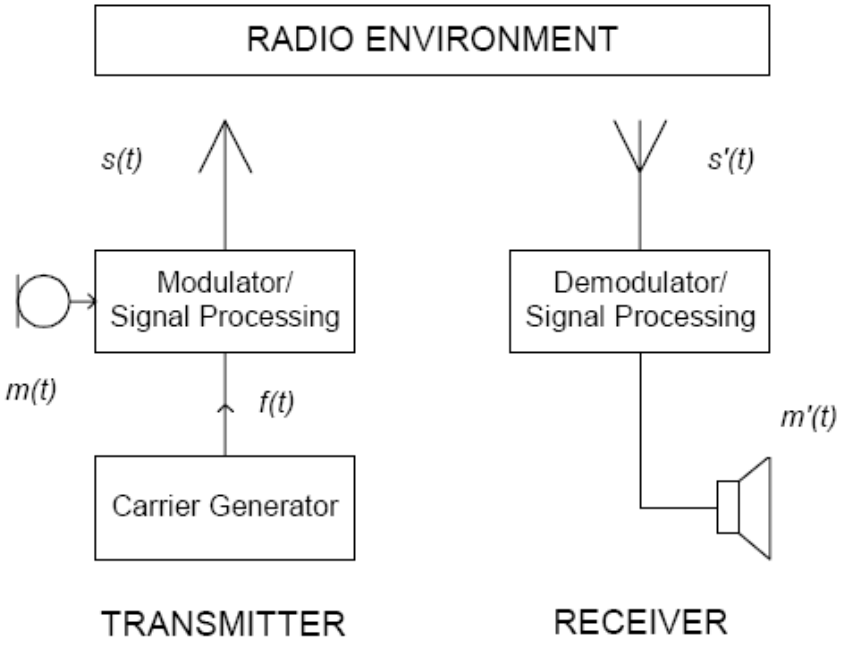
Voz Humana
Para que la voz humana sea compresible es necesario la presencia de armónicos entre 300 Hz y 3KHz.

Objetivos:

- Cambiar la banda de frecuencia en la que se transmite la información (permitir emisión radioeléctrica)

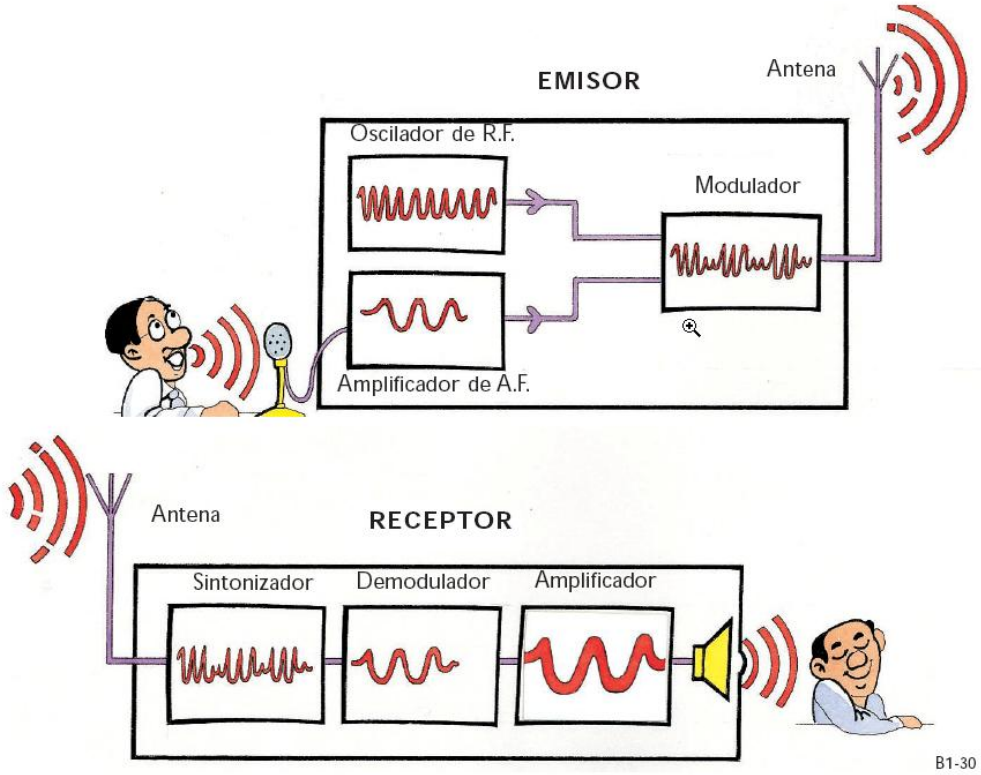
- Aprovechar el medio de transmisión (envíos simultáneos)

Modulation



- = process of translation the message from baseband signal to bandpass (modulated carrier) signal at frequencies that are very high compared to the baseband frequencies.
- Demodulation is the reverse process
  - Note: An information-bearing signal is non-deterministic, i.e. it changes in an unpredictable manner.

Sistemas de Comunicaciones: Modulación



La secuencia de comunicación es la siguiente:

1. Producir la información

2.- Codificarla convirtiéndola en un mensaje

3.- Modularla y emitirla

4.- propagación (cable, línea de transmisión, radiación, etc)

5.- Recibirla

6.- Decodificarla

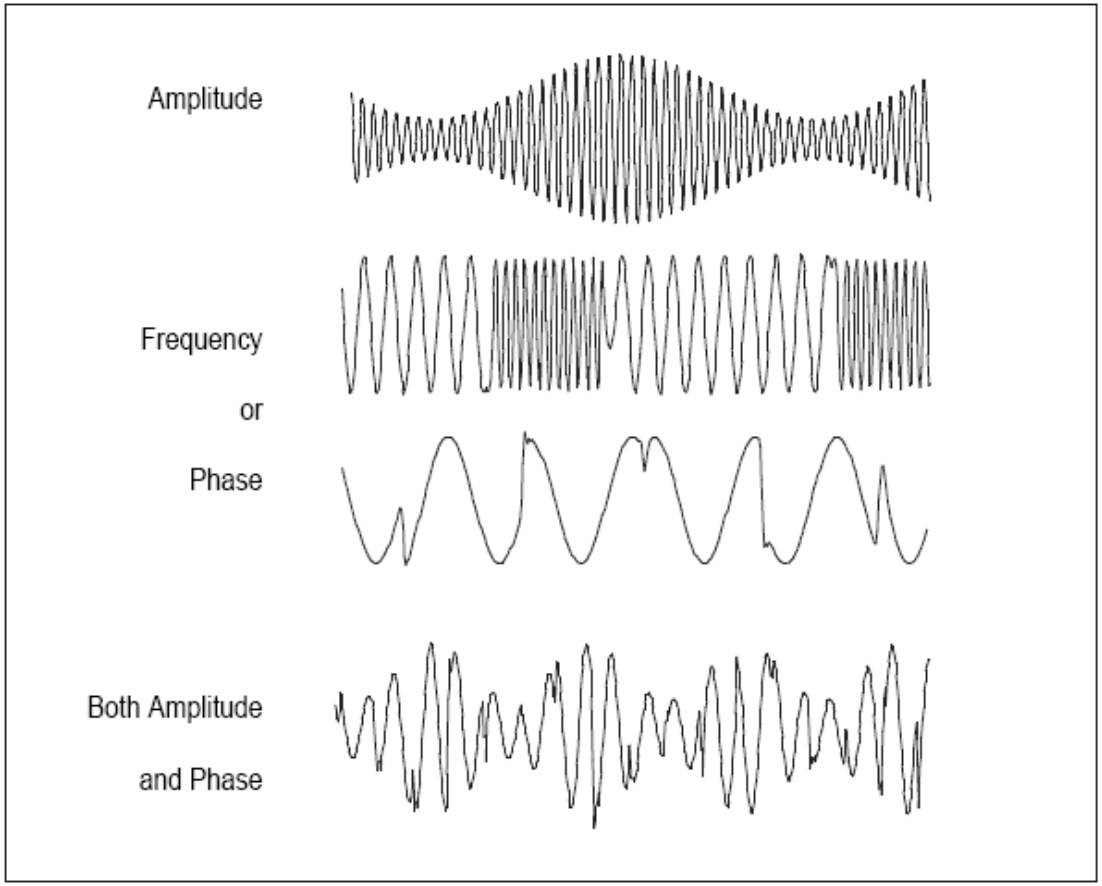
7. Amplificarla y regenerarla

Métodos básicos de modulación

La información viaja en la portadora con algunos de sus parámetros

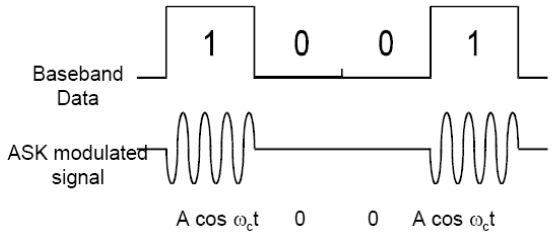
Modulación de amplitud (AM)

Modulación angular:
- Modificamos frecuencia (FM)
- Modificamos fase (PM)

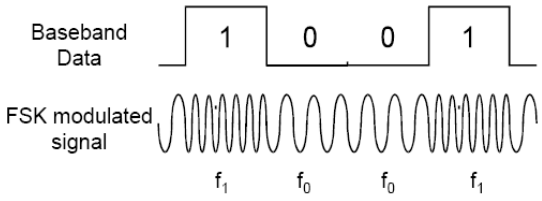


Resumen de métodos de modulación digital

Amplitude Shift Keying (ASK)

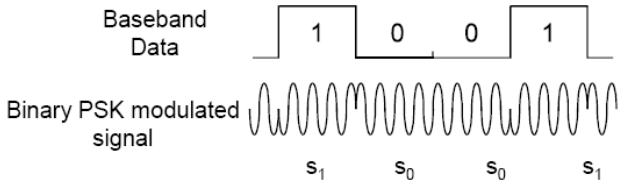


Frequency Shift Keying (FSK)



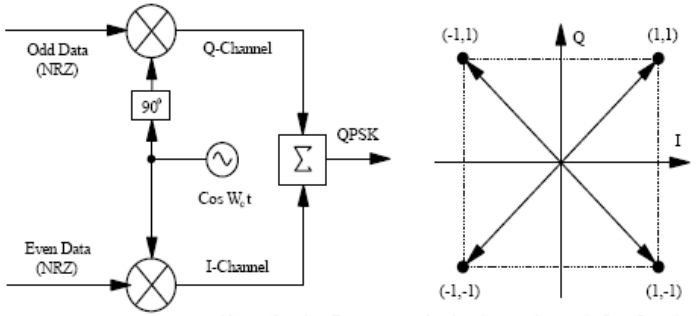
where $f_0 = A\cos(\omega_c - \Delta\omega)t$ and $f_1 = A\cos(\omega_c + \Delta\omega)t$

Phase Shift Keying (PSK)



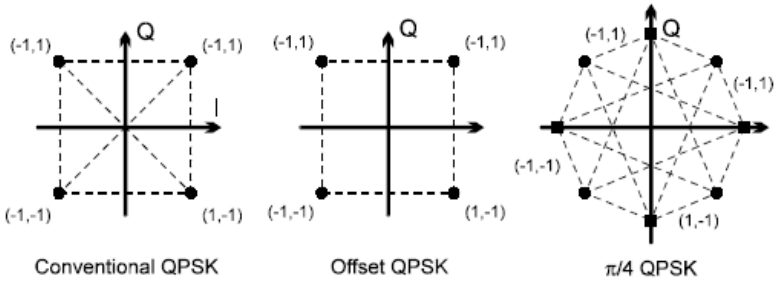
where $s_0 = -A\cos\omega_c t$ and $s_1 = A\cos\omega_c t$

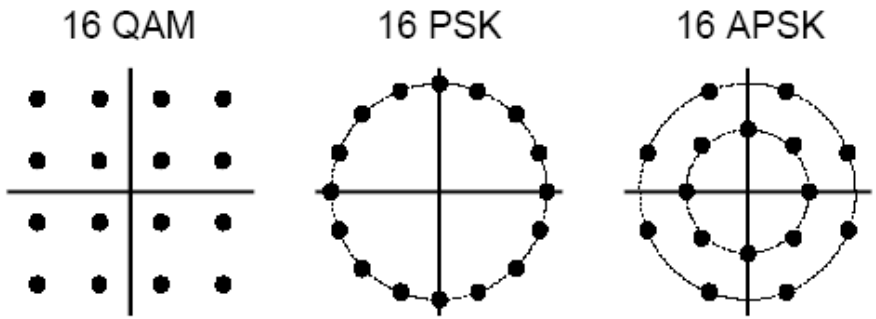
Modulation - QPSK



Wc = Carrier Frequency, I = In phase channel, Q = Quadrature channel

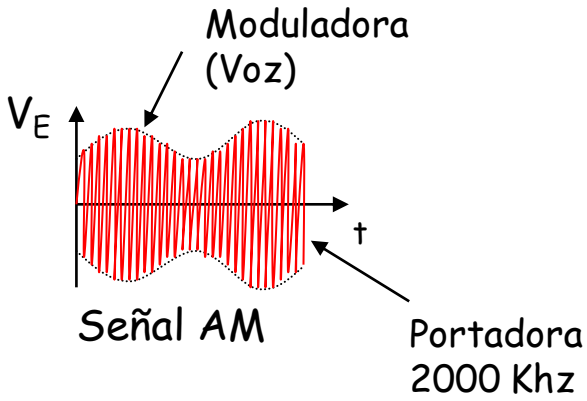
Types of QPSK

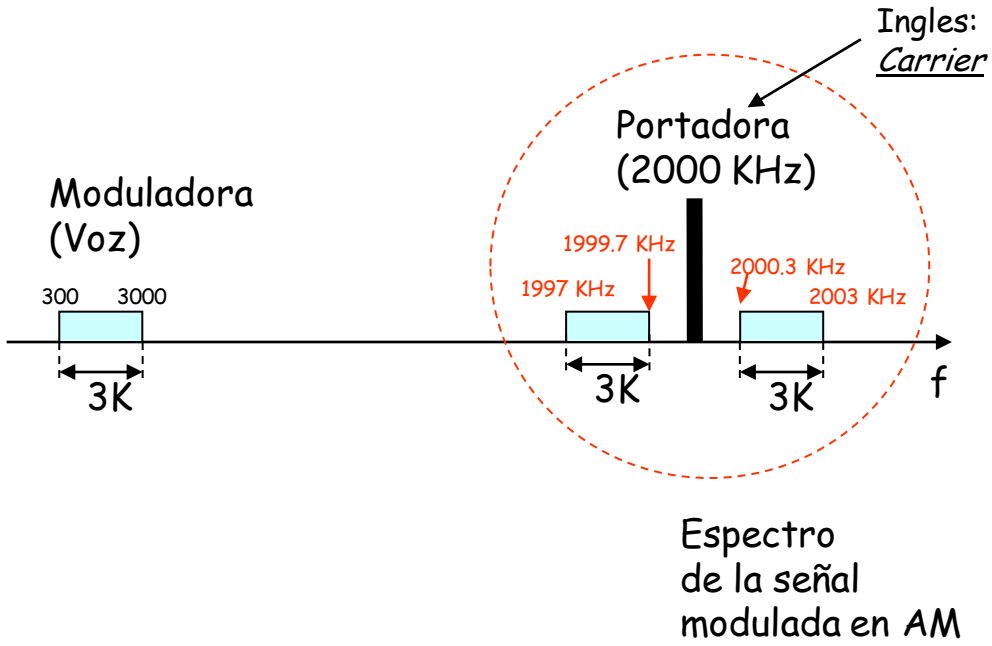




"se envían 3 bits de cada vez"

Métodos de modulación: AM





Colocamos la información en el entorno de la frecuencia portadora.

Aparece en dos bandas: banda latera superior y banda lateral inferior

LSB banda lateral inferior (Fportadora - Fmoduladora)
USB banda lateral superior (Fportadora + Fmoduladora)

Conclusiones:
1.- El ancho de banda de una señal modulada en AM es básicamente 2 fm
2.- La información está contenida en cada una de las bandas laterales

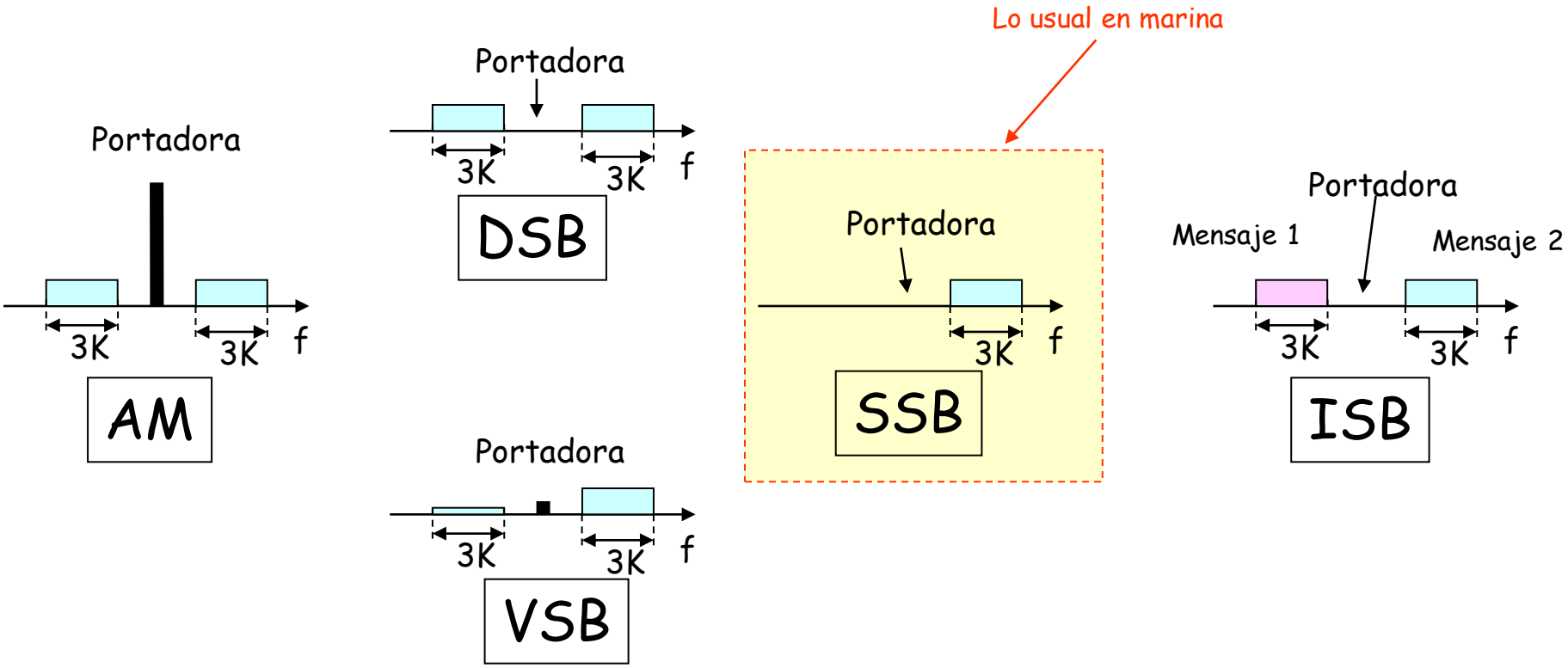
Métodos de modulación: SSB

De lo anterior de deduce:

1.- Puede no transmitirse la portadora sin perder información (DSB, double side band ó VSB vestigial side band)

2.- Puede suprimirse la portadora y una de las bandas laterales (SSB, single side band en español BLU))

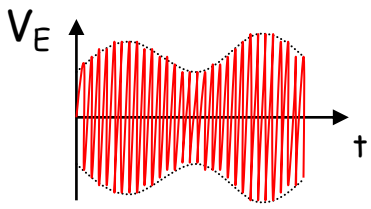
3.- Puede transmitirse información diferente en cada una de las bandas laterales (ISB, independent side band)

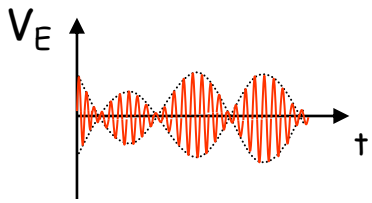


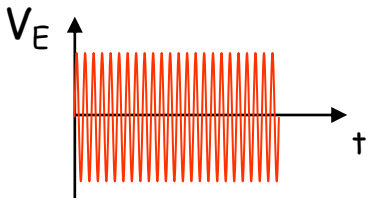
Métodos de modulación: SSB

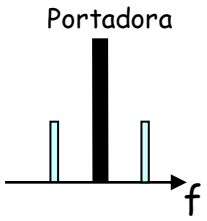
Ejemplo: representación temporal y espectro con 1 tono de audio

Un Tono modulado en AM, en DSB y en SSB

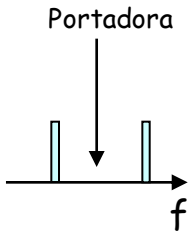




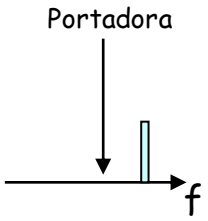




AM



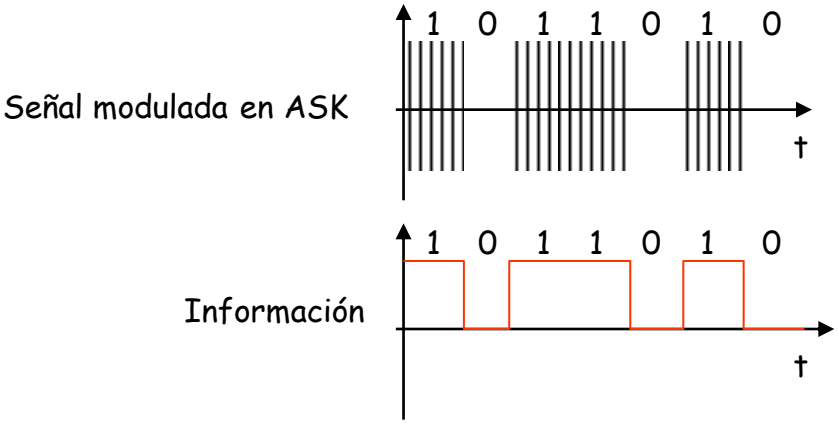
DSB



SSB

Métodos de modulación: ASK

Utilizando modulación de amplitud se puede transmitir información digital.

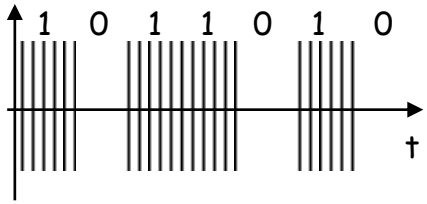


Amplitude-Shift-Keying (ASK)

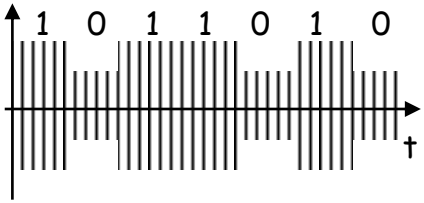
Dos tipos básicos:

m = 100 % (transmisión A1A)

m < 100 % (transmisión A2A)



m = 100 %
(Transmisión A1A)



m < 100 %
(Transmisión A2A)

Como realizar la transmisión y la recepción de una señal radioeléctrica en AM (y sus derivados SSB y ASK)

1.- ¿Como se realizan estas conversiones?

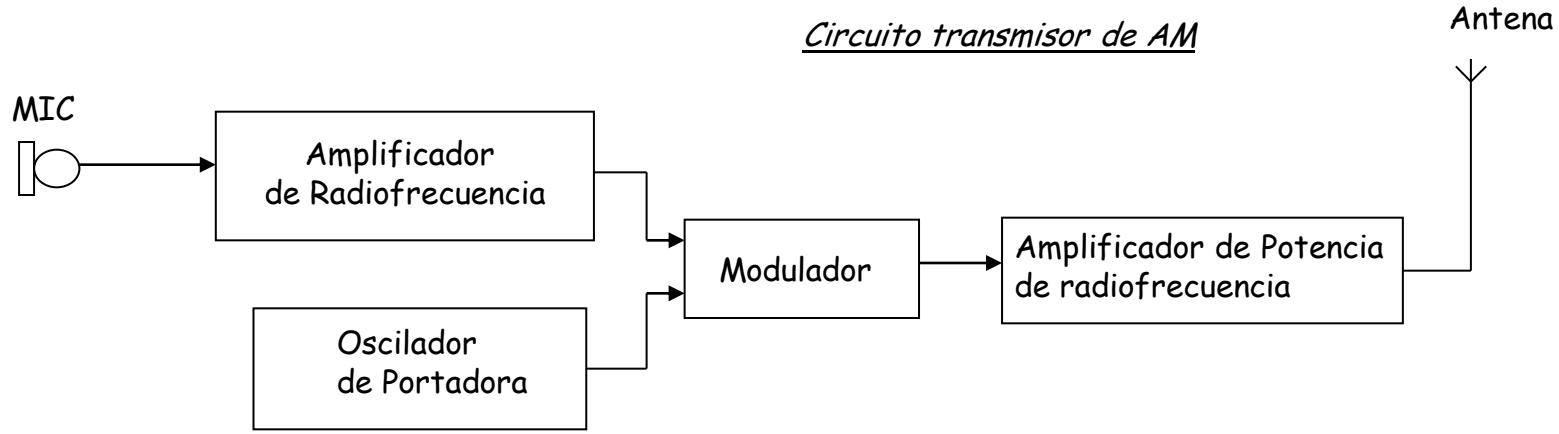
2.- ¿Cuales son los principales bloques básicos que deben utilizarse?

3.- ¿Como se agrupan estos bloques básicos para realizar las modulaciones y demodulaciones? ¿Alternativas?

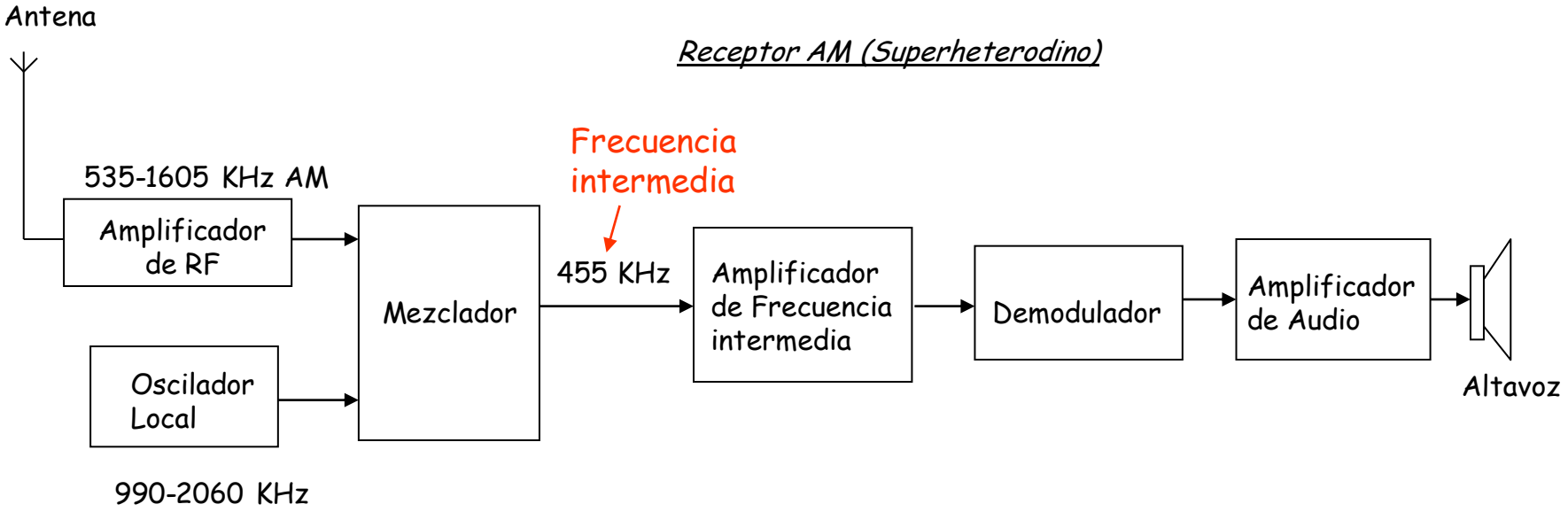
4.- ¿Como realizamos un receptor y un transmisor completo?¿Alternativas?

Métodos de modulación: SSB

Circuito transmisor de AM

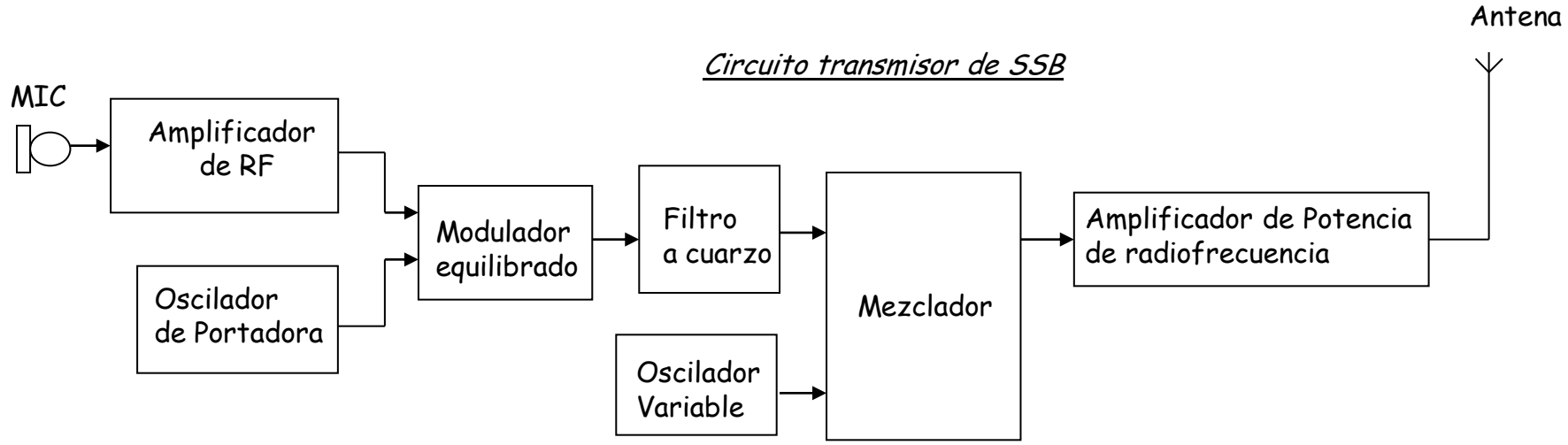


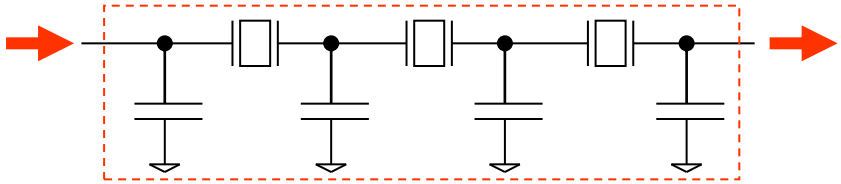
Receptor AM (Superheterodino)



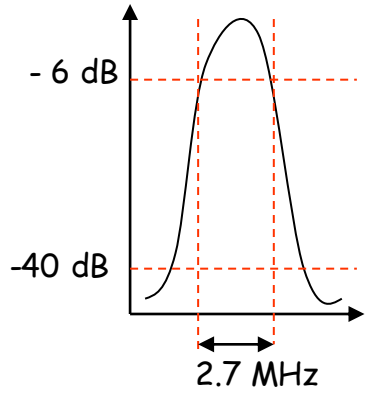
Métodos de modulación: SSB

Circuito transmisor de SSB



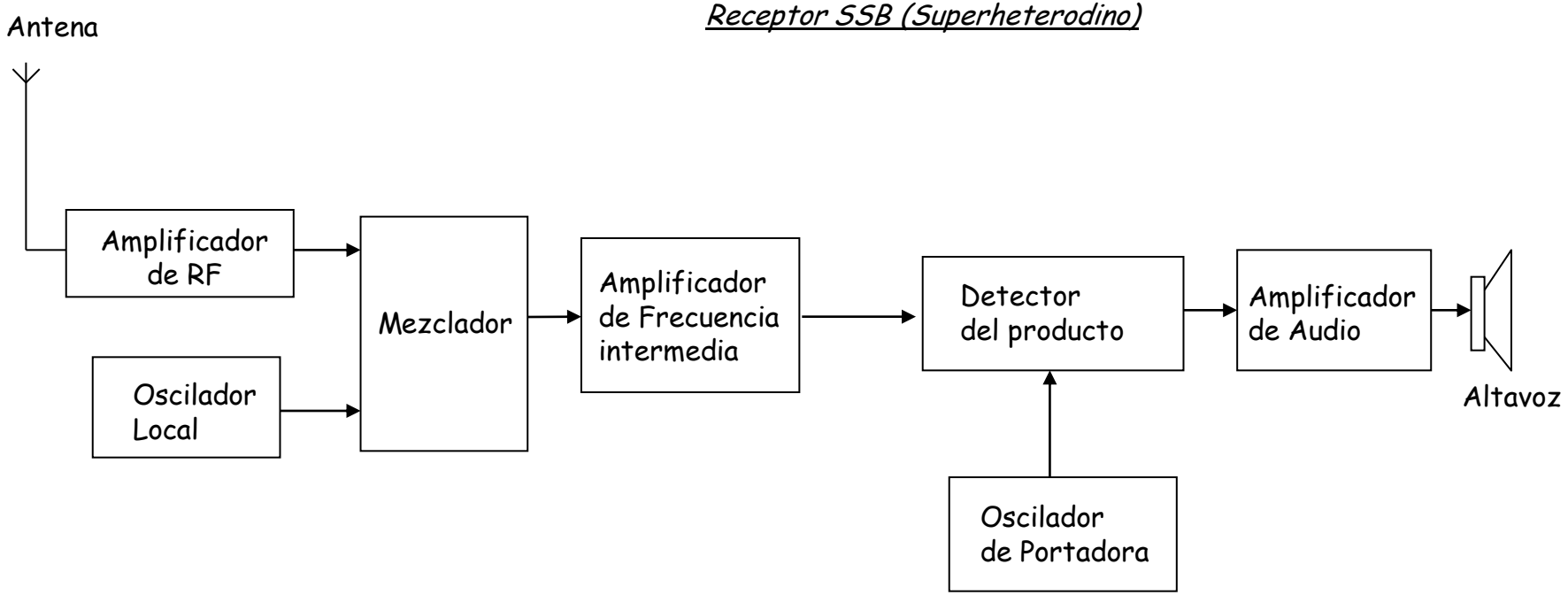


Ejemplo: Filtro de cuarzo en escalera



Métodos de modulación: SSB

Receptor SSB (Superheterodino)



Puesto que la portadora no ha sido transmitida es necesario generarla (oscilador de portadora)

Métodos de modulación: ASK

Los canales de *llamada selectiva digital (DSC)* ("Digital Selective Calling") transmiten información digital.
(Por ejemplo: 2187.5 KHz DSC en MF)

MF/HF DSC: 2187.5 KHz, 4207.5 KHz, 6312.0 KHz, 8414.5 KHz, 12577.0 KHz 16804.5 KHz

Las comunicaciones *radiotelegráficas*, que transmiten código Morse vía radio emplean también estos métodos de modulación.

Se emplean para este caso frecuencias de 400 Hz y de 1020 Hz que posteriormente se modulan en SSB.
(Esto se conoce como AFSK "Audio Frequency Shift Keying". Tipo de transmisión J2B).

Al final el espectro de AFSK es parecido al de FSK.

El *Radio teletipo* (RTTY) similar al transmisor telegráfico, asigna a cada carácter un código binario (p.e. ASCII en 7 bits).

Se emplea mucho una codificación restringida a 5 bits (32 caracteres).

Métodos de modulación: SSB

Los márgenes de frecuencia naval en SSB caen en la banda de HF (3 - 30 MHz) y en MF (300 KHz - 3 MHz).

En MF la onda terrestre esta muy atenuada. En tierra alcanza 100 - 300 K y en el mar 600 Km.

En HF la onda de superficie está fuertemente atenuada. La onda ionosférica se refleja en las capas superiores.

Hay zonas de silencio muy definidas.

Los márgenes de frecuencia naval en SSB son:

1.6 - 4.2 MHz

6, 8, 12, 16, 22 y 25 MHz

Métodos de modulación: SSB

Marine Distress Frequencies (Radio Telephone (R/T) & DSC)

Band	R/T Frequency	DSC Frequency	Day Time Range	Night Time Range
MF	2182 kHz	2187.5 kHz	150 nm	500 nm
HF4	4125 kHz	4207.5 kHZ	300 nm	1000 nm
HF6	6215 kHz	6312 kHz	600 nm	1500 nm
HF8	8291 kHz	8414.5 kHZ	1000 nm	2000 nm
HF12	12290 kHz	12577 kHz	2500 nm	
HF16	16420 kHz	16804.5 kHz		
VHF	156.800 MHz (Ch16)	156.525 MHz (Ch 70)	30 nm	30 nm

Tipo de transmisión:

J3E (SSB)
H3E (AM)

Symbol	Class of Emission
J3E	Single Sideband radiotelephony(LSB)
J3E	Single Sideband radiotelephony(USB)
H3E	Equivalent to AM radiotelephony. Only at 2182 kHz for transmitting, any frequency for receiving.
J2B	Radio Telex
F3C	Reception of weather facsimile broadcast

Marine SSB frequencies

The frequencies used for marine communications are internationaly agreed by the International Telecommunication Union (ITU). Below you will find a list of HF frequencies. In the main most frequencies are Duplex and intended for ship to shore use. Some bands do have simplex channels which can be used for either ship to shore or intership working.

Simplex ship to ship HF frequencies, shared with fixed services

In the Caribbean 8104 MHz is the Safety, Information and Calling frequency used by yachtsmen. Best time to monitor is from 07:30 to 0930 local time.

4000 kHz	4024 kHz	4048 kHz	8101 kHz	8125 kHz	8149 kHz	8173 kHz
4003 kHz	4027 kHz	4051 kHz	8104 kHz	8128 kHz	8152 kHz	8176 kHz
4006 kHz	4030 kHz	4054 kHz	8107 kHz	8131 kHz	8155 kHz	8179 kHz
4009 kHz	4033 kHz	4057 kHz	8010 kHz	8134 kHz	8158 kHz	8182 kHz
4012 kHz	4036 kHz	4060 kHz	8113 kHz	8137 kHz	8161 kHz	8185 kHz
4015 kHz	4039 kHz		8116 kHz	8140 kHz	8164 kHz	8188 kHz
4018 kHz	4042 kHz		8119 kHz	8143 kHz	8167 kHz	8191 kHz
4021 kHz	4045 kHz		8122 kHz	8146 kHz	8170 kHz	

Primary HF ship to ship frequencies

Ch	4 Mhz	6 Mhz	8 Mhz	12 Mhz	16 Mhz	18 Mhz	22 Mhz	25 Mhz
A	4146 kHz	6224 khz	8294 kHz	12353 kHz	16528 kHz	18825 kHz	22159 kHz	25100 kHz
B	4149 kHz	6227 kHz	8297 kHz	12356 kHz	16531 kHz	18828 kHz	22162 kHz	25103 kHz
C		6230 kHz		12359 kHz	16534 kHz	18831 kHz	22165 kHz	25106 kHz
D				12362 kHz	16537 kHz	18834 kHz	22168 kHz	25109 kHz
E				12365 kHz	16540 kHz	18837 kHz	22171 kHz	25112 kHz
F					16543 kHz	18840 kHz	22174 kHz	25115 kHz
G					16546 kHz	18843 kHz	22177 kHz	25118 kHz

SIMPLEX MARINE HF SSB CHANNELS

These frequencies are shared and are not available for the exclusive use of any station.

4 MHz Band	6 MHz Band	8 MHz Band	12 MHz Band
4A	**6A**	**8A**	**12A**
4146 kHz	**6224 kHz**	**8294 kHz**	**12,353 kHz**
4149	6227	8297	12,356
	6230		12,359
			12,362
			12,365

16 MHz	18/19 MHz Band	22 MHz Band	25/26 MHz Band
16A	**18A**	**22A**	**25A**
16,528 kHz	**18,825 kHz**	**22,159 kHz**	**25,100 kHz**
16,531	18,828	22,162	25,103
16,534	18,831	22,165	25,106
16,537	18,834	22,168	25,109
16,540	18,837	22,171	25,112
16,543	18,840	22,174	25,115
16,546	18,843	22,177	25,118

These simplex frequencies below are used for distress and safety communications, and (except for 2182 kHz) are not normally guarded.

2182 kHz	**8291 kHz**
4125	**12,290**
6215	**16,420**

Maritime SSB Simplex Channels

Channel	4 MHz	Channel	6 MHz	Channel	8 MHz	Channel	12 MHz
4A	4146 kHz	6A	6224 kHz	8A	8294 kHz	12A	12,353 kHz
4B	4149 kHz	6B	6227 kHz	8B	8297 kHz	12B	12,356 kHz
4C	4417 kHz	6C	6230 kHz			12C	12,359 kHz
			6516 *(daytime only)*			12D	12,362 kHz
						12E	12,365 kHz
	4065,4089,4116,4408 Mississippi River		6209,6212,6510,6513 Mississippi River		8201,8213,8725,8737 Mississippi River		12,362 12,365 Mississippi River

Channel	16 MHz	Channel	18 MHz	Channel	22 MHz	Channel	25/26 MHz
16A	16,528	18A	18,825	22A	22,159	25A	25,100
16B	16,531	18B	18,828	22B	22,162	25B	25,103
16C	16,534	18C	18,831	22C	22,165	25C	25,106
16D	16,537	18D	18,834	22D	22,168	25D	25,109
16E	16,540	18E	18,837	22E	22,171	25E	25,112
		18F	18,840	22F	22,174	25F	25,115
	16,543, 16,546 Mississippi River						
		18G	18,843	22G	22,177	25G	25,118

Maritime SSB Frequencies Shared with Fixed Services

4 MHz Carrier Frequency kHz	8 MHz Carrier Frequency kHz
4000	8101
4003	8104
---	8107
4009	8110
4012	---
4015	8116
4018	8119
4021	8122
4024	8125
4027	---
4030	8131
4033	8134
4036	8137
4039	8140
4042	8143
4045	8146
4048	8149
4051	8152
4054	8155
4057	8158
4060	8161
---	8164
---	8167
---	8170
---	8173
---	8176
---	8179
---	8182
---	8185
---	8188
---	8191

Global Maritime Distress & Safety System (GMDSS)
Simplex DSC & Radiotelephone Frequencies

DSC	VOICE	DSC	VOICE
2187.5	2182	8414.5	8291
4207.5	4125	12,577	12,290
6312.0	6215	16,804.5	16,420

Distress frequencies

All distress frequencies including 2182 kHz are shown below:

Telephony SSB (kHz, Carrier)	DSC (kHz, Center)	Telex (kHz, Center)
2 182	2 187.5	2 174.5
4 125 <ITU 421>	4 207.5	4 177.5
6 215 <ITU 606>	6 312	6 268
8 291 <ITU 833>	8 414.5	8 376.5
12 290 <ITU 1221>	12 577	12 520
16 420 <ITU 1621>	16 804.5	16 695

MF band SSB working carrier frequencies

CH NO	Ship Receive (kHz)	Ship Transmit (kHz)
241	1635	2060
242	1638	2063
243	1641	2066
244	1644	2069
245	1647	2072
246	1650	2075
247	1653	2078
248	1656	2081
249	1659	2084
250	1662	2087
251	1665	2090
252	1668	2093
253	1671	2096
254	1674	2099
255	1677	2102
256	1680	2105
257	1683	2108
258	1686	2111
259	1689	2114
260	1692	2117
261	1695	2120
262	1698	2123
263	1701	2126
264	1704	2129
265	1707	2132
266	1710	2135
267	1713	2138
268	1716	2060
269	1719	2063
270	1722	2066

CH NO	Ship Receive (kHz)	Ship Transmit (kHz)
271	1725	2069
272	1728	2072
273	1731	2075
274	1734	2078
275	1737	2081
276	1740	2084
277	1743	2087
278	1746	2090
279	1749	2093
280	1752	2096
281	1755	2099
282	1758	2102
283	1761	2105
284	1764	2108
285	1767	2111
286	1770	2114
287	1773	2117
288	1776	2120
289	1779	2123
290	1782	2126
291	1785	2129
292	1788	2132
293	1791	2135
294	1794	2138
295	1797	2060

ICOM

HF MARINE TRANSCEIVER

IC-M802

Standard 4 × 8 remote controller

The IC-M802 offers an industry-standard 4-inch tall (10.16 cm) remote controller. When set up with the IC-M502 VHF radio, Icom offers you a complete communications station.

Large LCD with dot matrix characters

You can easily read the alphanumeric name of any of the 1355 ITU channels at a glance with the large LCD display. Nighttime operation is no problem with 10 levels (plus OFF) adjustable backlit display and keypad.

Easy to use in all conditions

The IC-M802 offers two large dials – bank and channel – for easy channel selection. Up to 16 banks of 20 (max.) each for user channels, and 17 banks for ITU channels are available.

Built-in digital selective calling

For added safety at sea, the IC-M802 offers the latest in one-touch DSC emergency communications technology. (ITU Class E standard.) The emergency button is covered by a red, spring loaded hatch to avoid accidental DSC activation.

Digital signal processor advantage

The speech compressor, utilizing DSP, increases average talk power. Flexible filter settings provide for narrow band signals like e-mail, SITOR, FSK and other operation without an optional filter.

150W (PEP) of powerful output

150 Watts of power offers superior worldwide communications. A one piece, die cast aluminum chassis and a large cooling fan allow continuous transmission at full output power – very important for data communications, like e-mail.

One-touch e-mail access

An SSB first! The IC-M802 can be set to memorize your HF e-mail access frequency, mode and bandwidth settings. At sea e-mail has never been easier.

* Please consult with an HF e-mail provider for details.

Automatic antenna tuner, AT-140

An optional automatic antenna tuner, AT-140, easily connects to the IC-M802. When the tuner cannot tune the antenna, the IC-M802 bypasses the tuner and displays a warning indicator on the LCD.

Other features

- Wide band receive coverage (0.5 – 29.9999MHz)
- Remote control mic allows you to select channels directly
- Accessory RS-232C port allows connection of modem, etc.
- GPS input, NMEA 0183 version 3.01
- A headphone jack in front of the controller

Icom Inc.

HF MARINE TRANSCEIVER

IC-M802

SPECIFICATIONS

GENERAL

- Frequency coverage (Unit : MHz):
  - Rx 0.5–29.9999 (continuous)
  - Tx 1.6– 2.9999, 4.0– 4.9999, 6.0– 6.9999
    8.0– 8.9999, 12.0–13.9999, 16.0–17.9999
    18.0–19.9999, 22.0–22.9999, 25.0–27.5000
- Type of emission : J3E (SSB), J2B (AFSK), F1B (FSK), A1A (CW), H3E (AM*) (*Rx only)
- Number of channels : 1355 (max.)
  (160 programmable channels; 249 ITU SSB duplex; 72 ITU SSB simplex; 662 ITU FSK duplex; 160 e-mail; 21 ITU 4MHz simplex; 31 ITU 8MHz simplex)
- Antenna impedance : 50Ω (SO-239)
- Power supply requirement : 13.6V DC ±15%
- Max. current drain (at 13.6V DC):
  - Tx (Max. power) 30A (typ.)
  - Rx (Max. audio) 3.0A
- Operating temp. range : –30°C to +60°C; –22°F to +140°F
  Guaranteed range : –20°C to +55°C; –4°F to +131°F
- Frequency stability : ±10Hz (at –20°C to +55°C)
- Dimensions (W×H×D; projections not included):
  - Main unit 240×94×238.4mm; 9⁷⁄₁₆×3¹⁵⁄₁₆×9³⁄₈ in
  - Controller 220×110×84.4mm; 8²¹⁄₃₂×4¹¹⁄₃₂×3⁵⁄₁₆ in
  - Speaker 110×110×84.4mm; 4¹¹⁄₃₂×4¹¹⁄₃₂×3⁵⁄₁₆ in
- Weight :
  - Main unit 4.7kg; 10.36lb
  - Controller 570g; 1.26lb
  - Speaker 370g; 0.81lb

TRANSMITTER

- Output power : 150, 60, 20W PEP (Selectable)
- Spurious emissions : –62dB
- Unwanted sideband : 55dB
- Carrier suppression : 40dB
- Microphone impedance : 2.4kΩ

Supplied accessories:

- Separation cable, OPC-1106 (5m; 16.4ft)
- Hand microphone, HM-135
- External speaker, SP-24
- Mounting bracket kits
- Microphone hanger
- DC power cables
- ACC plugs
- Spare fuses

RECEIVER

- Sensitivity (at 10dB S/N) :

	J3E, A1A	J2B, F1B	H3E	DSC (J2B)
0.5 – 1.5999MHz	6.3µV	–	32µV	0.5µV (at 1% error rate)
1.6 – 1.7999MHz	0.89µV	0.89µV	6.3µV	
1.8 – 3.9999MHz	0.5µV	0.5µV	3.2µV	
4.0 – 29.9999MHz			–	

- Spurious response rejection ratio:
  Tx/Rx (1.6–29.9999MHz) More than 70dB
  DSC (Except 1st IF image) More than 50dB
- Audio output power (at 13.6V DC) : 4.0W at 10% distortion with a 4Ω load
- Audio output impedance : 4–8Ω
- Clarity variable range : ±150Hz
- GPS interface : NMEA 0183 version 3.01

All stated specifications are subject to change without notice or obligation.

◇ Receiving a signal

① Select the desired channel via [GRP] and [CH], or keypad.
- Turn ON/OFF the squelch function or adjust the squelch level as desired.

② When a signal is received, "RX" indicator appears and audio is output from the connected speaker.
- Rotating [VOL] to adjust the audio output level at this moment is recommended.
- S-meter shows the received signal strength.

③ Use the following functions, if desired:

- ***Noise blanker***

  Push [F] then [1 NB] to turn the noise blanker ON and OFF.
  - "NB" appears when the noise blanker is activated.
  - See page 48 for the noise blanker level adjustment.

- ***AGC (Automatic Gain Control) OFF function***

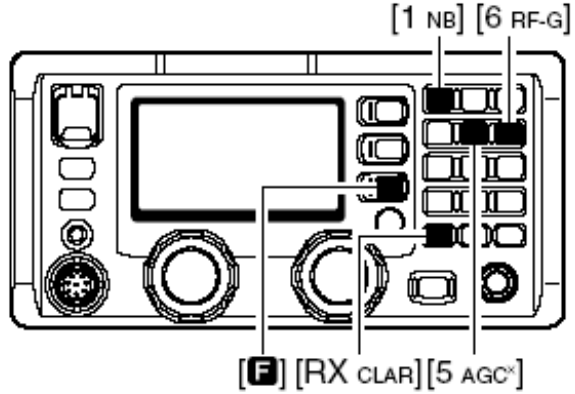
  Push [F] then [5 AGC] to turn the AGC OFF function ON and OFF.
  - "AGC" appears when the AGC-OFF function is activated (deactivating AGC).

- ***RF gain level***

  Push [F], [6 RF-G] to enter the RF gain adjustment mode, then rotate [CH] to adjust the gain.
  - Adjust the gain within 0 (low sensitivity) to 9 (maximum sensitivity) range.
  - Push [MODE SET] to exit the adjustment mode.

- ***Clarity***

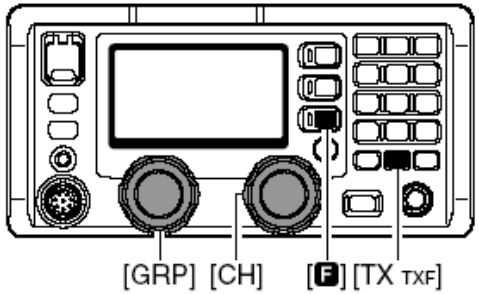
  Push [F], [RX CLAR] to switch the clarity function ON and OFF, then rotate [CH] for critical tuning.



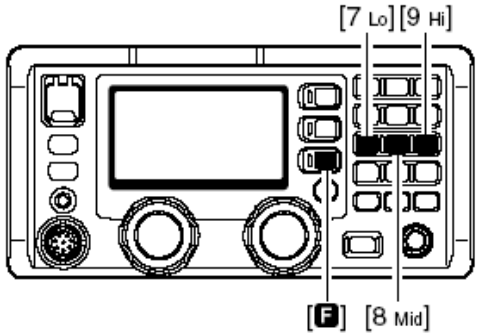
◇ Transmitting in voice

① Select the desired channel via [GRP] and [CH], or keypad.

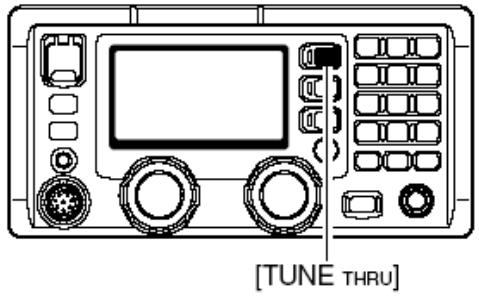
② Push [F], then push and hold [TX TXF] for a while to monitor the transmit frequency of the selected channel.
- The transmit frequency is displayed and "TX" blinks.
- When the channel is busy, wait until it becomes clear, or change the channel.



③ Push [F] then one of [7 Lo], [8 Mid] or [9 Hi] to select low, middle or high output power, respectively.



④ When the optional AT-140 is connected, push [TUNE THRU] to start manual tuning.
- "TUNE" appears when the antenna is tuned.
- "TUNE" blinks when a tuning error has occurred.
- Automatic tuning function is also available.



⑤ Push and hold [PTT] on the microphone to transmit.
- "TX" appears.
- If "SWR" appears during transmit, check your antenna system.

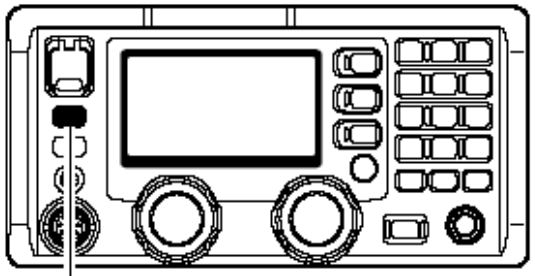
⑥ Speak into the microphone at your normal voice level.

⑦ Release [PTT] to return to receive.
- "TX" disappears.

■ Receiving a DSC

➥For waiting for a DSC call, such as an individual, group or all ships call on the desired frequencies, push [DSC] to enter DSC watching mode.

- Monitoring the frequencies, 2187.5, 4207.5, 6312.0, 8414.5, 12577.0 and 16084.5 kHz, for distress, urgency, etc., no operation is necessary with the transceiver. These frequencies are monitored at all times.

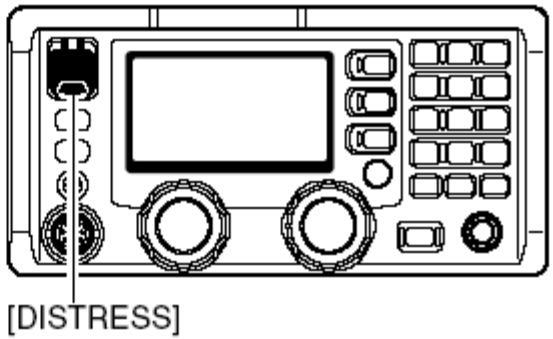


■ Transmitting a distress call

◇ Simple distress call

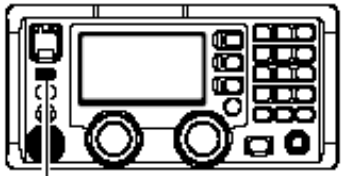
➥Lift up the distress switch cover, then push and hold [DISTRESS] for 5 sec.

- After 5 sec., a distress call is sent.

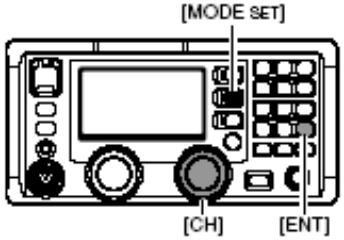


◇ Regular distress call

① Push [DSC] to enter DSC watch mode.



② Push [MODE SET] to enter DSC menu.



③ Rotate [CH] to select "Distress" then push [ENT]

④ Rotate [CH] to select the desired nature then push [ENT].

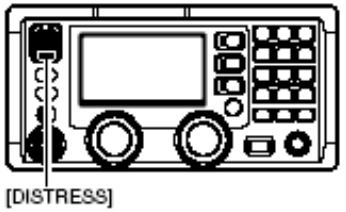
⑤ Verify your position and the UTC time, then push [ENT].

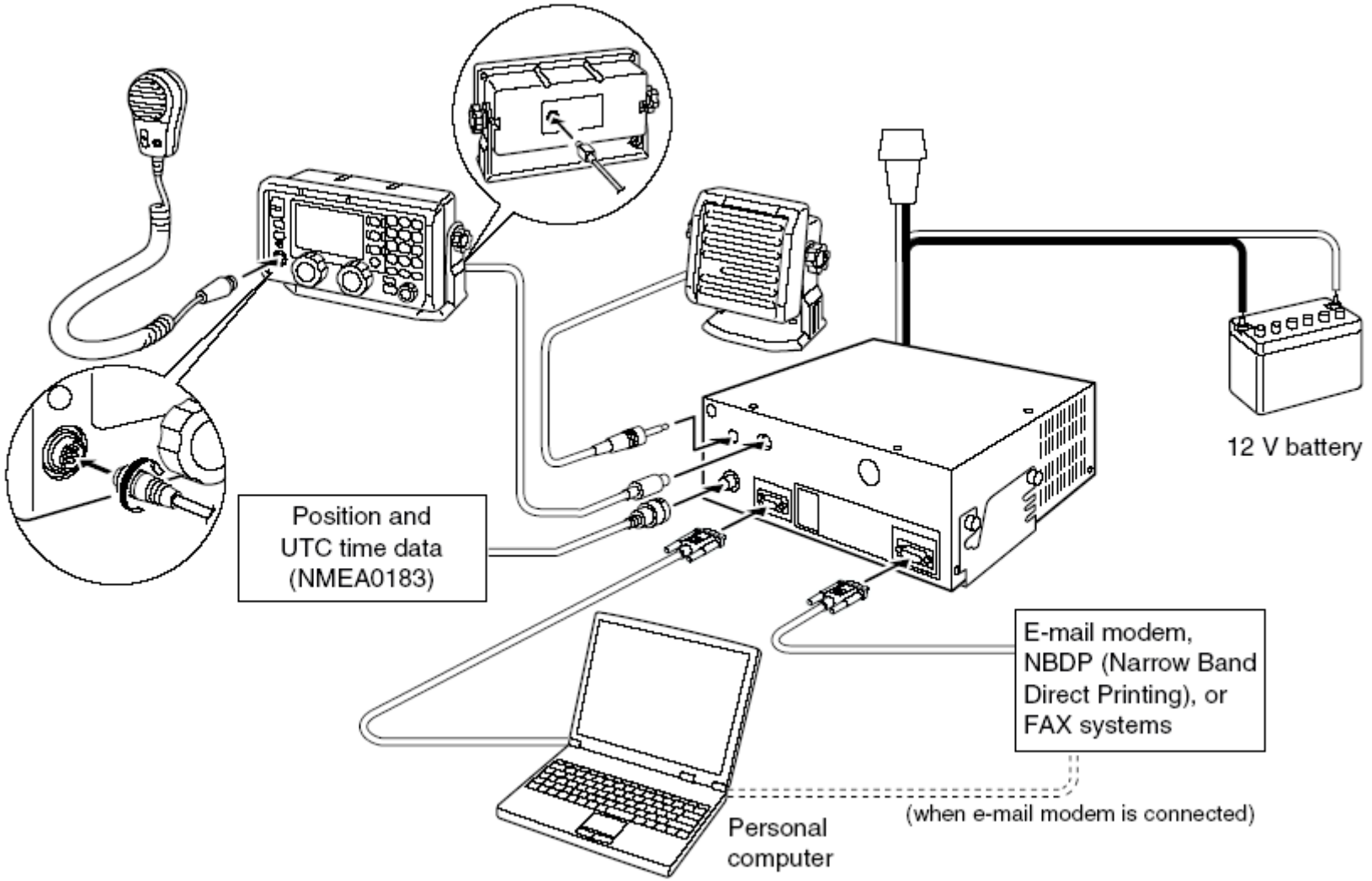
- When no NMEA0183 ver. 3.01 data is applied to [GPS], your position and UTC time should be input in this step.
  - -Use the keypad and [CH] when changing your position or the time.
  - - Move the cursor with [CH] rotation.
  - -[3 SCAN], [6 RF-G], [7 Lo] and [9 Hi] is used for the 'East,' 'North,' 'South' and 'West' selection.

⑥ Rotate [CH] to select the DSC calling frequencies, then push [ENT].

- After pushing [ENT], return to DSC menu as shown in step ③.

⑦ Lift up the distress switch cover, then push and hold [DISTRESS] for 5 sec.




12 V battery
Position and
UTC time data
(NMEA0183)
E-mail modem,
NBDP (Narrow Band
Direct Printing), or
FAX systems
(when e-mail modem is connected)
Personal
computer

◇ MN-100/MN-100L ANTENNA MATCHERS