History of Ham Radio

(1955 -1985)

Tino Zottola, VE2GCE

Nov 15, 2021

Agenda

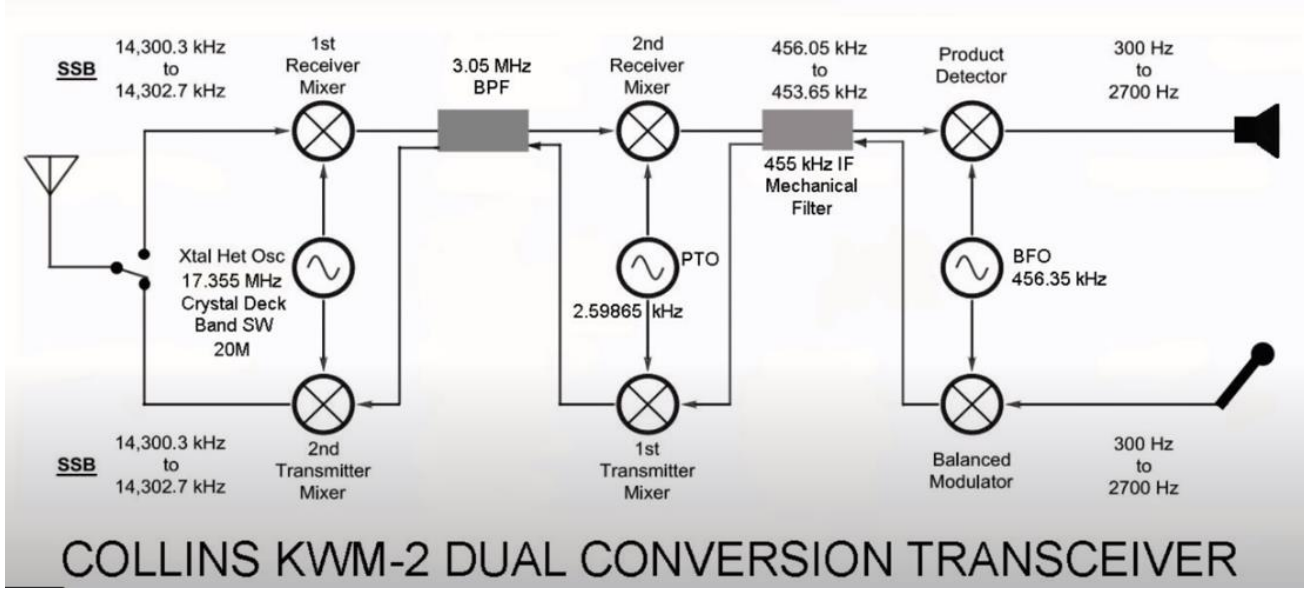
- 1950’s: Golden era
  - Post-WW2 era offered diverse options to get on air
  - Advent of homebrew and commercial SSB radio
  - Many classic amateur radio rigs produced during this period
- 1960’s: American high water mark
  - Space age advances electronics technology
  - Last decade dominated by vacuum tube technology
  - Iconic SSB transceivers introduced
- 1970’s: Japanese era begins
  - Solid state takes over vacuum tube technology
  - Impressive solid state equipment made by US producers in final hurrah
  - Japanese manufacturers displace US producers with cheaper radios
  - WARC bands introduced and 160 meters returned to hams

1950s

Golden age of Amateur Radio during post WW2 economic boom

- Homebrew no longer only option to get on air and decline of homebrew era begins
- Surplus WW2 HF and VHF radios are repurposed for amateur radio
- Amateur radio kits become widespread
- Flood of commercial radio equipment at affordable prices

- SSB homebrew articles and commercial radios (Central Electronics 20A) appear
- Radio transceivers emerge in addition to separate receiver and transmitter
  - Cheaper but more complex because of shared common circuitry



History of SSB

History*:

- 1921: John R. Carson mathematically proves superiority of SSB over AM-DSB
- 1923: ATT uses SSB for transatlantic telephony circuits
- 1934: Robert Moore ➔ first amateur radio SSB transmission
  - Detailed in R9 magazine

In 1930's, not much amateur phone activity, so AM was good enough

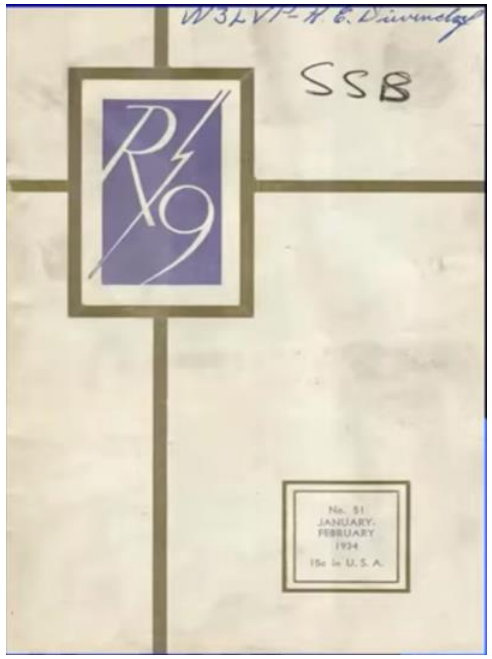
Post-WW2, amateur bands become crowded and BW efficiency of SSB becomes attractive*

- 1948: Oswald Villard (W6QYT) @ Stanford University gives on-air demonstration of SSB
- 1950: Don Norgaard (W2KUJ) makes 3 x tube homebrew SSB transmitter
  - Detailed in GE Ham News magazine
- 1952: Wes Schum takes Norgaard's design and uses it as basis for
  - Central Electronics' first commercial SSB transmitters (e.g. 10A-B, 20A)
- 1956: Anthony Vitale (W2EWL) details conversion of SC4-274 Tx to SSB exciter in QST

→ Curtis Lemay (K3JUY/K4RFA) USAAF, chief of staff was a proponent of SSB

→ AM predominant mode until late 1950's

→ SSB overtakes AM in the 1960's



* Most of material for the next 3 x SSB slides was taken from Ed Gable's (W2MP) AWA SSB YouTube video (Aug 19, 2021)

History of SSB

1950: Don Norgaard (W2KUJ) makes 3 tube SSB transmitter ➔ SSB Jr.

- Like most early SSB transmitters, Norgaard uses phasing method
- Phasing method replaced by filter method as affordable crystal filters become available in late 1950's
- Circuit is the basis for Central Electronics' first SSB exciters

Uses 3 tubes + 4 x diodes

- 12AU7: Audio amplifier & RF phase shift network
- 12AT7: Audio phase shift network
- 4 x diodes: Balanced Modulator
- 6AG7: RF Amplifier (5 watts)

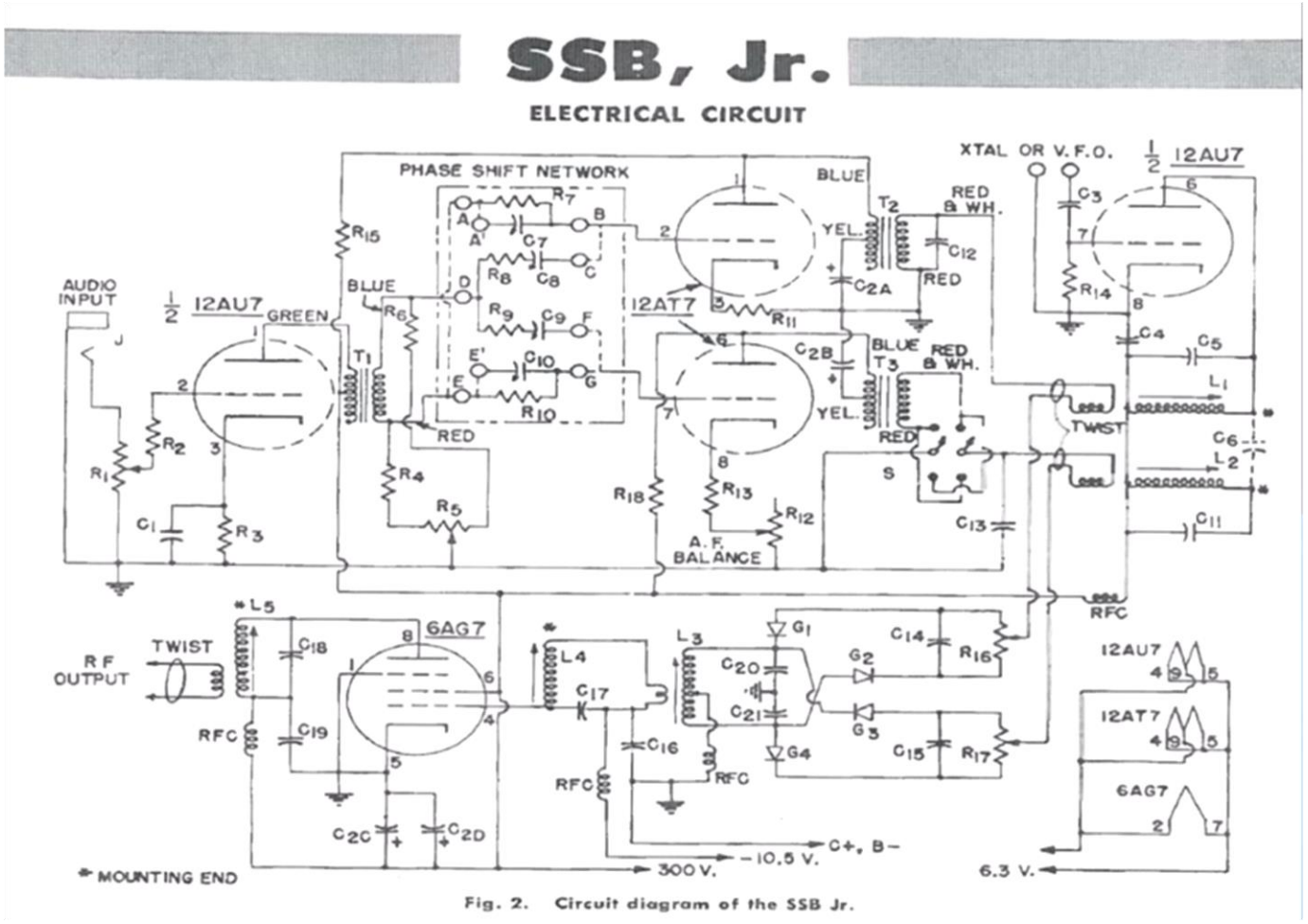


Fig. 2. Circuit diagram of the SSB Jr.

History of SSB

1956: Anthony Vitale (W2EWL) : Details conversion of SC4-274 (BC-458) transmitter to SSB exciter in QST magazine

- Retained 5.0 to 5.5 Mhz VFO
- Kept 2 x 1625 RF output stages
- Added 9 MHz exciter using 5 x miniature rubes and B&W phase shift network plugin
- Capable of 80 meters (9 – 5.0-5.5 MHz) and 20 meters (9 + 5.0-5.5 MHz)

Cheap and Easy S.S.B.

Sideband Exciter Built Around the BC-458

BY ANTHONY VITALE,* W2EWL

This two-band mobile s.s.b. transmitter is capable of up to 100 watts peak output, depending upon the power supply. Built on the chassis of a BC-458 transmitter, it uses the original VFO portion and the two output tubes. The phasing type of s.s.b. generation is used, and the audio amplifier has adequate gain for use with a crystal microphone.

On the panel, the upper knobs control output stage tuning and loading. The indicator light is used instead of a plate milliammeter, and the upper toggle switch is one of the two band switches. (The other bandswitch can be seen on the right-hand side of the chassis.) The lower left-hand knob is for the audio gain control, the toggle switch selects the sideband, and the two pointer knobs next to the switch are for carrier balance adjustments of the balanced modulator. The remaining knob tunes the VFO.

♦

• The following letter, quoted in its entirety, is self-explanatory.

Editor, QST:

Several months ago, Tony Vitale, W2EWL, was kind enough to give our radio club, the Ridgewood Amateur Radio Club, a talk on "Single Sideband."

Tony brought along a new exciter which he designed, built on a BC-458 chassis. It created a lot of interest among our members, with its compactness and very low building cost compared with the commercial exciters on the market. I was one of the many members bitten by the s.s.b. bug, and I have built this exciter. Several of our members have built them also, and they are very pleased with the results. Tony's talk was entitled "SSB Cheap and Easy," and it certainly turned out so.

My purpose in writing is to tell how pleased I am with this exciter. I have had many FB QSOs with it on very low power, and it didn't cost me over $35, including the power supply. Most all of the fellows I talked with wanted to know more about this exciter, and I think it would be an excellent article to put in *QST*. We have named it the "W2EWL Special".

73,

Frank Hernandez, W2MOF

Glad to oblige, Frank; here is the "W2EWL Special".

* East Glen Road, Dunville, N. J.

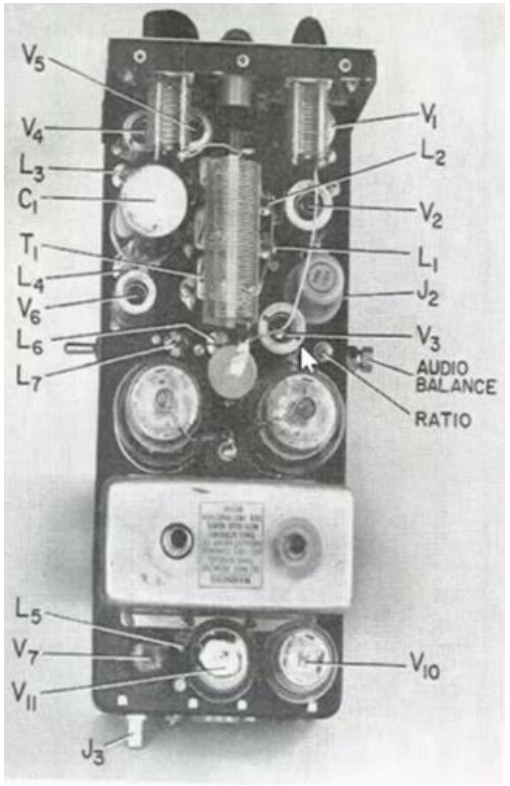
MOST AMATEURS have either heard or actually experienced the advantages of single-sideband phone. The author's interests have been directed at mobile s.s.b. operation, because the boost in "talk power" for a given power supply one gets with s.s.b. really works to advantage in mobile work. W2EWL has been on 14-Mc. mobile s.s.b. for over 3 years, and during that time has participated in four-way QSOs involving ZLs and VKs, and a 7-way involving two African countries, one European country and three W call areas. The DX currently stands at WAC and 23 countries.

The exciter/transmitter to be described is not a one-of-a-kind deal, but represents a design that has evolved over the years. It is built around the VFO portion and on the modified chassis of a BC-458 (or T21/ARC-5), which tunes 5.3 to 7.0 Mc. in the original unit. These units sell from $3.95 to $7.95 in the surplus market, depending upon their condition. The design to be described uses the original output stage of the BC-458; the output will vary with the available plate voltage, and will be about 100 watts peak with a 1000-volt supply. The current W2EWL rig uses only one of the two 1625s in the original output stage, with 300 volts on the plate, to drive one 807 that in turn drives four 807s in a grounded-grid amplifier. The exciter hangs under the dash of the car, and the amplifier mounts in the trunk.

The Circuit

The photographs show two different units; one is for 14 Mc. only and the other is switchable to either 14 or 3.9 Mc. If you want only 3.9- or 14-Mc. operation, you can omit the unwanted circuits and a couple of toggle switches, but the rest of the circuit remains unchanged.

16 *QST* for



B&W
Phase shift
Network
plugin

Iconic Manufacturers

- During 1945-1975, the marketplace was dominated American equipment manufacturers.

- Allied Radio (Knight)
- Barker and Williamson
- Central Electronics
- EF Johnson
- Eico
- Gonset
- Hallicrafters
- Hammarlund
- Harvey Wells
- James Millen
- Lafayette
- Meissner
- National
- RME
- SBE
- Swan
- TMC
- World Radio Laboratories (Galaxy)

We will look three manufacturers in detail:

Collins: High end radios

- Featured patented PTO (Permeability Tuned Oscillator) and mechanical filter
- High price of KWM2 ($1150) encouraged many knock offs made for 20-40% of Collins price

Drake: Middle class radios

- Copper plated chassis
- 3 x Sweep tubes PA

Heathkit: Lower end radios, but used quality parts

- Kits and factory wired radios
- Radios of choice for new and experienced hams

Collins Radio

- Collins Radio founded by Art Collins (W0CXX) in 1933
- Provided military equipment during WW2 (ART13, ARR15, ARC2) and Korean conflict (R390)
- Collins Radio supplied radio equipment to NASA:
  - Mercury, Gemini and Apollo spacecraft radios
  - Ground stations and HF links to Mission Control
  - All voice, TV and data communication from space was transmitted via Collins equipment
- Sold to Rockwell International in 1973 due to financial difficulties
  - Despite lucrative business from US military (WW2) and NASA (1960s)

ART13 Liaison TX

Used on B29: Enola Gay and Bock's Car

ARR-15 Receiver

ARC-2 HF Transceiver

R390 Receiver

Collins Radio

Generation 1: 1946-1955

- CW/AM
- 11 meters support
- Slide Rule tuning dial
- Transmitter: 32V1, V2, V3
- Receiver: 75A1, A2, A3

32V1

KWS1

KWM1

Generation 2: 1955-1959 (Gold Dust Twins):

- KWS1 SSB Transmitter
- 75A4 SSB Receiver
- Pentagon tuning dial

Generation 2.5: 1957

- KWM1, first SSB transceiver

75A1

75A4

Collins Radio

Generation 3: 1958-1978 (Iconic S line):

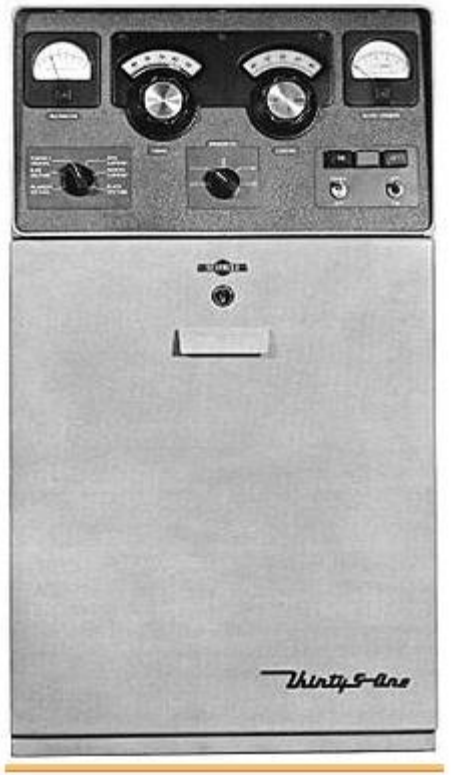
- KWM2 transceiver (successor to KWM1)
- Separate receiver and transmitter: 32S1 and 75S3
- Compact and large linear amplifiers: 30L1 and 30S1
- Also used by military for MARS bands

Generation 4: 1979-1983 (KWM-380):

- First new radio after Rockwell International acquisition
- Last radio in Collins amateur radio line
- Solid state technology with WARC bands

KWM-2

30L1



30S1

75S3

32S1

KWM-380

Drake Radio

- Company founded in 1943 by radio design engineer Robert L. Drake
- Main business was selling low and high filters to government during WW2
- After World War II, Drake began making amateur and maritime radio equipment
- First amateur radio products were 1 and 2 (A-B-C series) receivers
- First transceiver was the TR3 in 1963, which featured 3 x 12JB6 sweep output tubes and copper chassis
- Followed by iconic TR4 (A-B-C) series transceiver as well as separate T4 transmitter and R4 receiver

R1

R2

TR3

TR4

Drake Radio

Drake also manufactured:

- MN-2000 Antenna tuner
- L4B dual x 3-500z linear amplifier

Final amateur radio products were solid state TR5 and TR7

- TR5 used analog VFO (WARC via optional bands)
- TR7 used digital synthesizer (WARC bands)
- Many hams preferred TR5 over TR7 performance-wise

1975: R.L. Drake dies and company turned over to son, Peter W. Drake
2012: Blonder Tongue Laboratories (CATV manufacturer) acquired R.L. Drake

TR5

MN-2000

L-4B

TR7A

Heathkit

- 1911: Company founded by Edward Heath originally as aircraft manufacturer
- 1931: Heath dies during a test flight
- 1935: Howard Anthony purchased bankrupt Heath Company and focused on selling small aircraft accessories
- Post WW2, Anthony buys large quantity surplus electronic parts and starts selling kits using these parts
- 1947: Heath introduced its first electronic kit, the O1 oscilloscope
- 1954: Howard was killed with five others in a plane crash on a flight from Pontiac, Michigan to Florida
- 1955 Daystrom Inc acquired the Heath Company
- 1955: Heathkit introduces its first amateur radio kits: AT1 transmitter and AR3 receiver

Heathkit

1956-1964: Heathkit produces numerous iconic AM/CW amateur radio kits

- DX60 transmitter (crystal control) and HR10 receiver
- Mobile Cheyenne transmitter and Comanche receiver
- Apache transmitter and Mohawk receiver (SSB with external adapter)

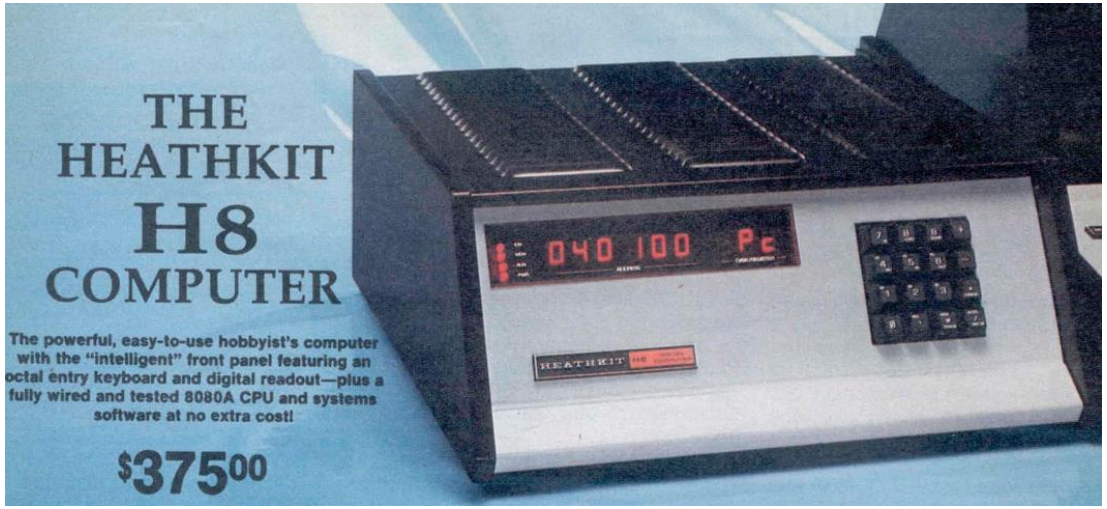
Heathkit

- 1965-1973: Heathkit SSB transceivers: HW100 and SB101 are knocks off of Collins KWM2
- Individual transmitter SB401 and receiver SB301 SSB station also available
- Amplifier line includes SB200 (2 x 572Bs) and SB220 (2 x 3-500z)

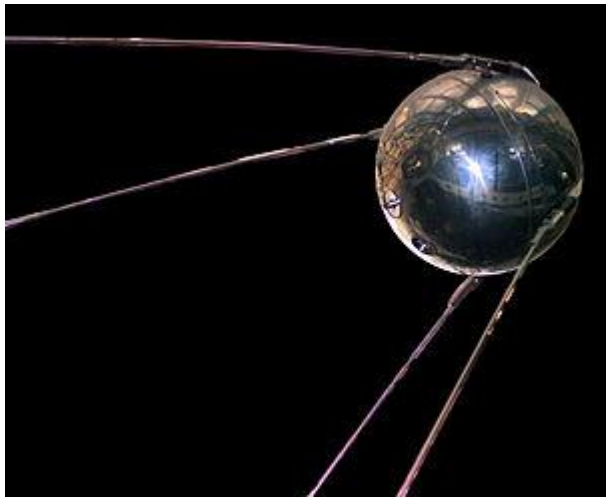
Heathkit

- 1962: Schlumberger buys the Daystrom Inc
- 1974: Heathkit introduce solid state transceiver SB104
- 1977: Heathkit starts offering computer kits
- 1979: Zenith Radio Company buys the Heath Company

- 1982: Heath Company sells last Amateur Radio the SS-9000
  - Too complicated as a kit, offered as factory assembled only
- 1992: Heathkit as kit producer ends production



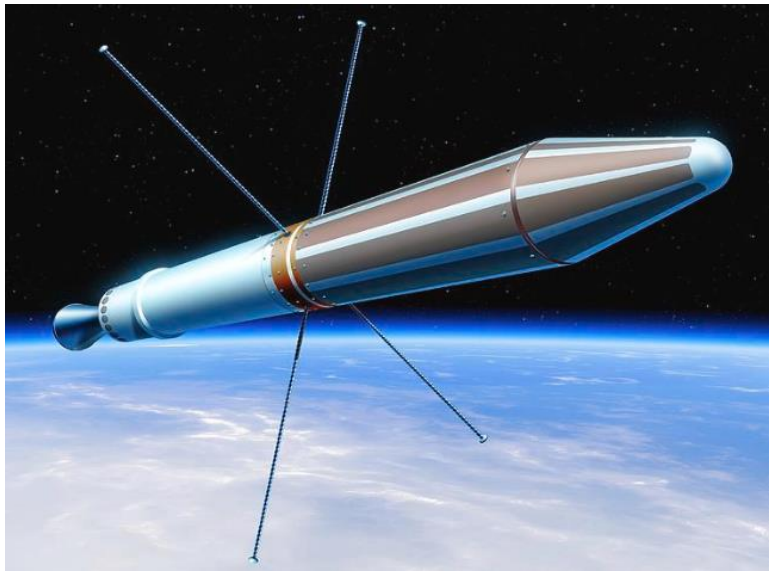
Space Age



Sputnik

Space age started 4 October 1957

- Soviet Union successfully launched Sputnik I
- World's first artificial satellite: 58 cm in diameter, 84 Kg
- Sent beacon: 1 watt on 20.015 MHz
- Circled earth every 98 minutes for 3 weeks



Explorer I

- Americans caught completely off guard by Sputnik I and II
- Vanguard 1A launch December 6 , 1957 exploded on launch pad
- Explorer 1 successfully launched on February 1, 1958

Commercial use of satellites begins in 1960's

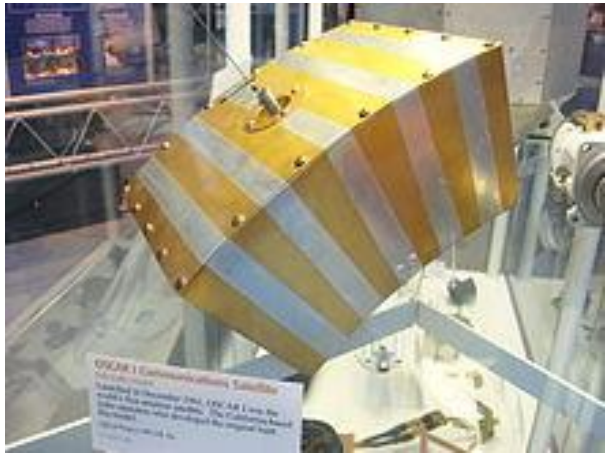
- July 10, 1962, Telstar transmits television between USA and France

Space Age

OSCAR

- Amateur Radio OSCAR 1, was launched on December 12, 1961
- “hi” beacon 140 mW transmitter operated in 2-meter band (144.983 MHz) for 22 days

- First amateur satellites contained telemetry beacons
- Since 1965, OSCARs carry linear transponders for two-way communications in real time
- Some satellites had bulletin board for store-and-forward communications
- Some satellites had digipeater for direct packet radio connections
- As of March, 2021, 101 OSCAR satellite have been launched



OSCAR 1

OSCAR 7

OSCAR 13

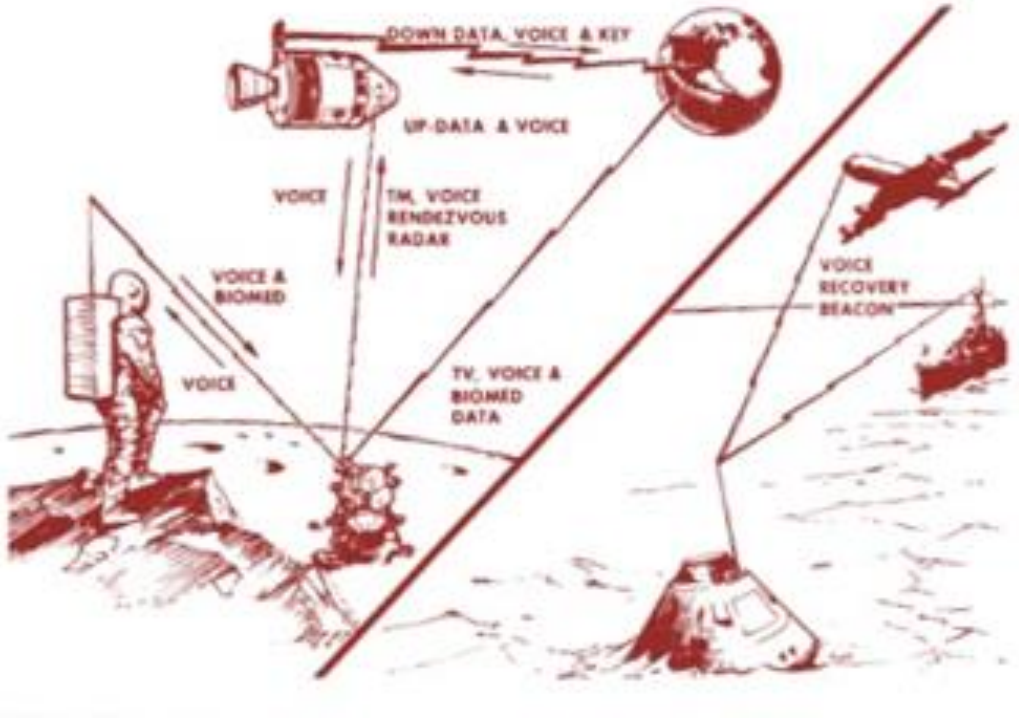
OSCAR 67

Space Age

Collins Radio supplied NASA the radio systems used in Mercury, Gemini and Apollo space programs

Apollo 11 mission used two radios systems:

- Local communication 200 MHz VHF system running 5 watts
- Long distance (i.e. moon-earth) multichannel Unified S-Band (USB) system running 15-20 watts on 2 GHz
  - USB had channels for voice, television, telemetry, range and direction finding, transponders, biometrics
  - Lunar and Command modules repeated back to earth via USB using AM, FM, PM and PSK schemes



Space Age

Wideband FM was used for video and scientific data.

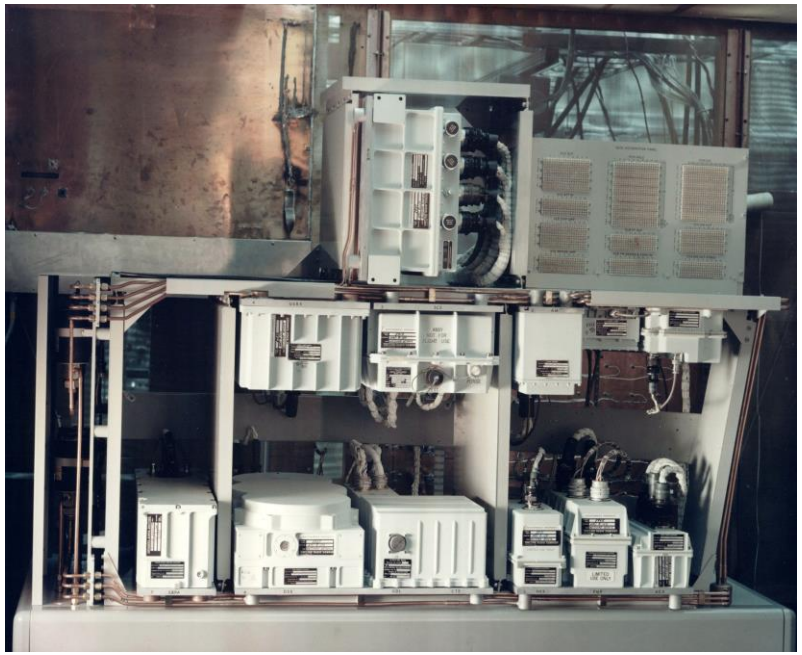
- Television link used 500 kHz bandwidth for black and white
- Television link used 2 MHz for color

Antenna systems consisted on the following dish antennas

- Command module had four 31″ dish antennas with 25 dB gain
- Lunar module had a 26 inch dish with 16-20 dB gain
- 10 foot 34 dB gain dish erected on lunar surface sent color TV pictures

Ground radio consisted 15 x tracking stations

Astronauts also had a Morse Key for emergency communications
HF equipment (10-15 MHz) as backup during recovery and landing



Japan Invasion

Between 1970 and 1980, significant change took place in amateur radio marketplace

USA

- Manufacturing costs rose significantly
- Few new offerings by early 1980's
- Many US manufacturers were still selling tube radios by 1975
- American solid state radios were superior to Japanese radios, but much more expensive

Japan

- Manufacturing costs dropped and quality rose
- Quick to adapt solid state technology
- Dominated the marketplace by early 1980s

Three principal Japanese manufacturers were:

- Kenwood
- Yaesu
- ICOM

Kenwood

Kenwood

TS-520

- Analog display
- SSB and CW, 80 - 10 meter bands
- Hybrid circuit includes 2 x S2001A (6146A) and 12BY7A tubes
- 120 watts PEP SSB and 100 watts DC CW

TS-830

- Digital display
- SSB and CW, 160 - 10 meter + 30, 17 and 12 meter WARC bands
- PA uses 2 x 6146B tubes + 12BY7A driver
- 220 watts PEP SSB and 180 watts DC CW

TS-940

- Dual digital displays
- 160 to 10 meters with a general coverage receiver
- Completely solid state
- 250 watts PEP input on USB, LSB, CW, FM and FSK
- 140 watts DC input on AM

Yaesu

Yaesu

FT-101 series
- Analog display
- SSB, AM, CW, 160 - 10 meter bands
- Hybrid circuit includes 2 x 6JSC6C and 12BY7A
- 260 watts PEP SSB and 180 watts DC CW

FT-901 DM
- Digital display
- SSB and CW, 160 - 10 meter bands
- PA uses 2 x 6146B tubes + 12BY7A driver
- 180 watts PEP SSB and 180 watts DC CW

FT-980
- Digital display + dual meter
- 160 to 10 meters + 30, 17 and 12 meter WARC bands
- Completely solid state
- 100 watts PEP input on USB, LSB, CW

ICOM

ICOM

IC-710 series
- Digital display + analog meter
- SSB and CW, 80 - 10 meter bands
- Completely solid state
- 100 watts output on USB, LSB, CW

IC-730
- Digital display + analog meter
- SSB and CW, 80 - 10 meter + WARC bands
- Completely solid state
- 200 watts PEP SSB and 40 watts AM

IC-751
- Digital display + analog meter
- 160 to 10 meters + WARC bands
- Completely solid state
- 100 watts output on USB, LSB, CW

Band Reallocation

160 meters:

- Severe 160 meter restrictions imposed between 1945 and 1980
  - Power levels, time of day, geography (coastal vs inland)
- Between 1980-1985, LORAN is decommissioned
  - 160 meters returned to amateur radio with previous restrictions removed

1979: WARC (World Administrative Radio Conference) bands added

- 30 meters (10.100 – 10.150 MHz) CW operation
- 17 meters (18.068 – 18.168 MHz) CW and phone operation
- 12 meters (24.890 – 24.990 MHz) CW and phone operation

Gentleman's agreements states that no contesting takes place on WARC bands

Conclusion

1950s : Golden age of Amateur radio

- AM era fades
- SSB emerges as dominant mode
- End of the separate big box radio era

1960s: Space age begins

- Space age accelerate electronic technology (i.e. robust and reliable solid state)
- Separate receivers and transmitters replaced by transceivers
- American amateur radio production hits the high water mark

1970s: Japanese manufacturers displace American amateur radio producers

- Radios are mostly solid state, except for driver and final tubes
- New WARC bands introduced
- Entire 160 meter band returned to hams by 1980

Questions ?