CW/SSB Transceiver Basics.

Microphone

- Basic Handheld microphone usually comes with Transceiver.
- Plugs into transceiver with multi-pin connector or "Modular" connector like used on telephones.
- Microphone usually has PTT (push to talk) switch to initiate Transmit function.
- Microphone may have other button controls; eg. that change frequency up or down on radio.
- Microphone should have "perky" higher frequency response for better intelligibility (eg. 2 to 3 kHz)
- Microphones may be desk mount style popular for fixed station.
- Competitive amateur operators often use "headset" incorporating microphone / earphone combinations.

Microphone Audio Gain Control

- Most transceivers will have a Microphone Gain adjustment. This may be a physical control or menu driven feature.
- The control adjusts the gain of the Microphone speech amplifier to compensate for different microphone sensitivities and difference operating conditions (eg. loudness of operator and distance speaking from the microphone).
- Adjusting the Microphone Gain Control may be necessary to ensure you are not over-driving the "linear" amplifier that is either internal or external to the transceiver. The Microphone

gain control also effects the amount of ALC (automatic level control) action happening in the SSB transmitter while you are transmitting. **See Question B-003-012-008** . More on ALC later.

Transmit Audio Equalization

- Some transceivers provide transmit audio equalization to adjust the transmit audio frequency response. This is like a graphic equalizer on an audio sound system. For transmit audio, proper adjustment of an equalizer can compensate for different microphone responses so that even a poor quality microphone can sound good and crisp audio for better over-the-air intelligibility.

Transmit Audio Compression (or Speech Processing)

- Most SSB Transceivers have a means of RF speech processing or compression to reduce the peak to average RF power output difference. By doing this, the average output power is increased and makes better use of the peak-envelop-power capacity of the Linear RF Amplifier stage of the transmitter. The transceiver usually has controls to switch the processing ON or OFF and adjust the degree compression employed. About 6 dB of compression is optimum as shown in the diagram below.

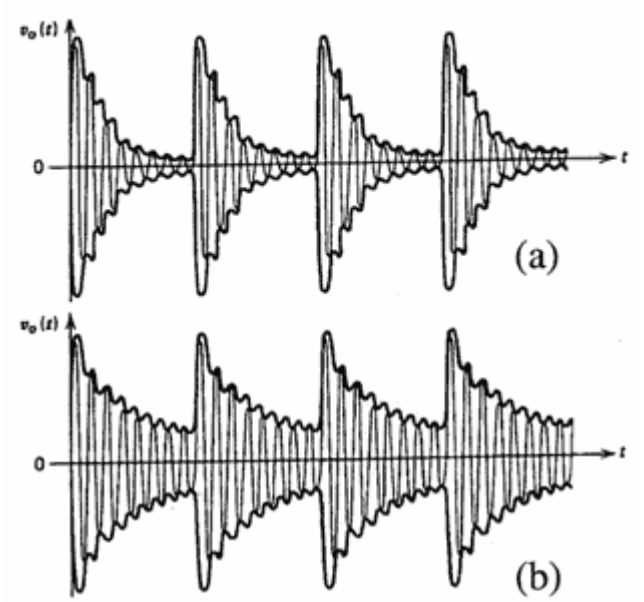


Fig.2. SSB waveforms: (a) unprocessed speech (the repeated word "three") with 16dB peak-to-average ratio; (b) the same word with 6dB of compression

Push-To-Talk (PTT)

- The Push-to-Talk function is another name for the Transmit function. Push-to-Talk originates from the push button switch (typically on the microphone) that controls the push-to-transmit function and the release-to-listen operation of the transceiver. Some amateur radio operators like to use a "foot switch" for push to talk control.

VOX Operation

- VOX is an acronym for Voice Operated Switch. It is an electronic circuit that is part of the many transceivers that responds to voice spoken into the microphone. When engaged, the transceiver with VOX will automatically transmit when the operator speaks into the microphone. Use of VOX is an alternate to using PTT operation. Associated with VOX is a sensitivity adjustment and an adjustable drop-out delay returning the transceiver to the listening mode; this drop out delay is required so the VOX remains active between momentary pauses in speech. **See Question: B-003-014-005**

VOX Anti-trip

- The Anti-Trip is necessary so that receiver audio coming out of the speaker does not "trip" the VOX. The anti-trip circuit uses the internal receiver audio waveform combined with that received by the microphone from the receiver speaker to phase-cancel the VOX response. Any other input to the microphone (like the operator speaking) will override the anti trip circuit balance and trip the VOX. There is usually an adjustment on the anti-trip circuit to set the levels properly and make it work reliably.

RF Power Control (or Carrier Control)

- Some transceivers will have a Carrier or RF Output control to permit the transmitter power to be reduced for lower power operation. This is sometimes advantageous for qualifying for QRP contest categories for operation under 5 watts or reduced power

operation for interference avoidance or saving power while on battery power.

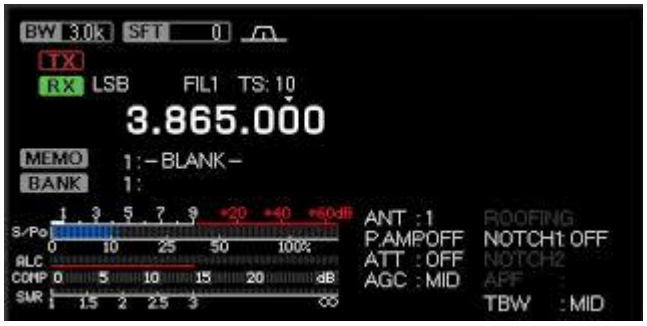
Automatic Level Control (ALC)

- Most modern SSB transceivers have an ALC feedback circuit that indicates and controls over modulation. ALC feedback is usually routed to the speech amplifier and cuts back on speech amplifier gain if the RF amplifier is forced into an non-linear operation. The ALC feedback is usually indicated by ALC metering in order that the proper adjustment of the **"microphone gain control"** is made ***"for slight movement of the ALC meter on modulations peaks"***; **see Questions B-003-012-008 and B-003-012-011** .

Transceiver Metering

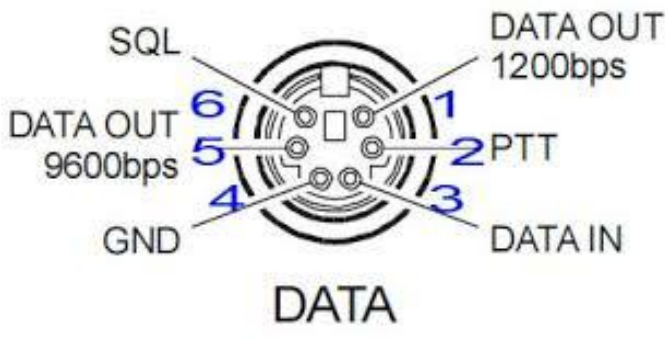
- In a transceiver there may be one multifunction meter. When receiving, the meter is an "S" meter. When transmitting, a switch may be used to select the meter function including:
    - RF power output
    - Collector Current (of the final amplifier transistors) ; this can be used to calculate final DC input power knowing final amplifier operating voltage.
    - Standing Wave Ratio (SWR) on the antenna transmission line.
    - Automatic Level Control (ALC)

- The radio may have an analogue meter or show as a bar graph on a multi-purpose display.



Data Port

- Most HF SSB and FM VHF/UHF transceivers have a data port on the rear of the radio. The data INPUT / OUTPUT connector facilitates connection of the computer sound card LINE IN and LINE OUT for operation on various digital modes. Use of the data port (connector) will typically be independent of any adjustments for normal SSB operation such as microphone sensitivity and audio volume that would come into play if the data modem (the computer sound card for example) was connected to the radio microphone and speaker connections. The data port will also have a connection for the Transmit (PTT) Function of the radio.



External Rig Control and Programming

- Most modern amateur radio transceivers have an ability for "Rig Control" through an "Accessory Port" or Computer Aided Transceiver (CAT) connector. Rig Control most often allows a two-way serial data path that can command the transceiver onto a different frequencies and modes, different bandwidths and different power levels. The transceiver can also transmit back information such as frequency, S meter reading, mode, band and other parameters of the operation that are manually set by the front dial controls of the radio. This is all used by various digital mode applications setting the radio on specific frequencies and recording mode and frequency of the radio automatically into logging programs. Rig control can also be used through appropriate application software to program the radio onto specified "channels" of operation. Rig control is typically between radio and computer with an appropriate USB or RS232 serial cable. Rig control and programming can equally apply to HF SSB/CW equipment as well as mobile and portable radios used solely on VHF / UHF FM. Some new transceivers even provide a USB port for connection into the USB port of the computer for rig

control and sound card emulation directly within the workings of the transceiver.

CW Keying

- Most HF SSB/CW transceiver include an electronic keyer to facilitate Morse code (CW) operation. The keyers do Morse code with a set of "paddles" with two switch closures that send "dits" (dots) on one side and "dahs" (dashes) on the other. The speed is adjustable with menu settings or a control on the transceiver. A straight key can also be used where the dots and dashes are manually formed. Stand alone Keyers external from the transceiver can also be used. **See Question B-003-014-001**
  Also watch youtube videos at :
- http://www.youtube.com/watch?v=D148Rv4GxhI
- Also see: http://www.youtube.com/watch?v=ZdzjvIk_aY0

Station Accessories

Crystal Calibrator

- The crystal calibrator is a crystal oscillator typically with a 100 KHz crystal that is rich in harmonic output throughout the HF range. It was sometimes an accessory built into older communications receivers. A crystal calibrator is used to provide a marker signal for calibrating receiver mechanical frequency dials every 100 kHz. For a Crystal Calibrator to be accurate, its harmonic output signal must be "Zero Beat" against a WWV standards signal at 2.5, 5, 10, 15, or 20 MHZ. Crystal calibrators are typically no longer needed with modern transceivers that use digital synthesizer technology

based on a quartz crystal oscillator time reference, however; the digital readout should still be checked occasionally again one of the WWV signals.

Antenna Analyser

- These are handy portable instruments. An **Antenna Analyser** has a tunable low power RF oscillator and frequency readout. Most cover the HF and VHF amateur bands and frequencies in between. Also, the instrument has an SWR meter and will read off impedance in terms of resistance, and reactance. Other functions include determining capacitance and inductance values of unknown devices and even determining the attenuation loss of a length of coaxial cable. The Antenna Analyser is most used by the average amateur and to facilitate the trimming optimizing the length of homemade antennas for best SWR performance.

Pictured here is an MFJ-266C Antenna Analyzer .

Modulation Scope

- A CRT oscilloscope has long been used to evaluate the RF waveform of the transmitted signal. Special purpose Oscilloscopes than be designed and sold for amateur radio although, nowadays, the workings of the modern SSB transceiver are well protected with internal circuitry to prevent over modulation. Here is a picture of a Heath Kit Modulation Scope that was designed for direct connection to the transmitter antenna feed line.

- Recall the Regulations **question B-001-019-002** that refers to the necessity for a means to indicate over-modulation if *"radiotelephony is used"* . The scope instrument above will satisfy this requirement. BTW, Radiotelephony means voice communications.

The SWR / Directional RF Power Meter

- We have mentioned the SWR meter before, but often these instruments are designed to measure RF power output with fair accuracy into a well matched load. When measuring RF power output, the meter can be "set" to measure **Average RF Power** or **Peak RF Power**. Average RF Power is good to measure when adjusting the amount of RF compression. Many premium HF SWR / Power Meters have selectable RF power range scales of 20, 200 and 2000 watts. There are SWR / Power meters designed solely for HF while others may span 1.8 to 200 MHz. There are again others designed solely to VHF and UHF operation.

- Simple inexpensive SWR meters have a single meter and a switch selecting between **Forward** and **Reflected** power with calibrations solely in **Standing Wave Ratio**. Such meters have an adjustable sensitivity that must be set at Full Scale in the Forward position before the SWR reading can be switched in and accurately read.

- Many modern HF transceiver also incorporate sensing and display of SWR. The sensing of SWR is used to "throttle back" the RF output of the transceiver so it does not suffer damage under mismatch and high SWR situations.

Pictures of Stand Alone SWR and Directional Power Meters

Antenna Tuners (Also called a Transmatch)

- An Antenna Tuner is required to impedance match the **50 ohm source impedance of the transceiver** with whatever load impedance an antenna may be (within the matching capabilities of the antenna tuner). Impedance matching of Source impedance to Load impedance is essential to maximize the transfer of power from the source (transmitter) to the load (antenna). **See questions B-003-001-006 and -008**

- Antenna tuners must be used and adjusted in conjunction with a SWR meter. Many Antenna Tuners also have a SWR meter build in. If so, a separate SWR meter is not necessary.

- Manual antenna tuners will have a Transmitter Matching and Antenna Matching adjustments as well as an Inductor selector for the different frequency bands of operation.

- The object of tuning the tuner adjustments is to achieve a good SWR of 1.5:1 or better between the transceiver output and the input to the Antenna Tuner.

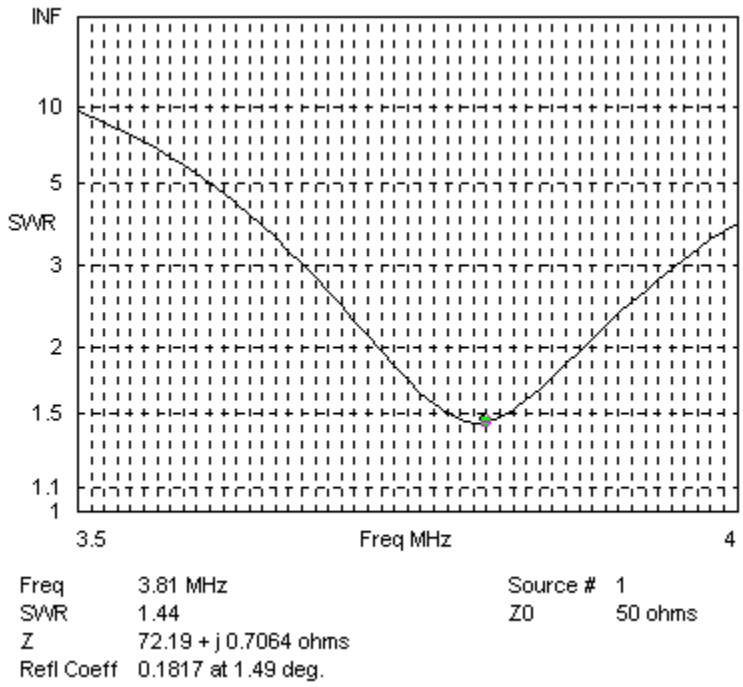
- Adjustment of an antenna tuner should always be done at reduced power or there may be damage to the tuner or transceiver due to very high RF voltages that may happen when there is a mismatch of impedances.

- Antenna tuners are designed and available for a wide range of power handling capabilities; the RF power of the transceiver must not exceed the power handling capability of the tuner.

- Wire antennas most often will require an antenna tuner, especially if they are designed for multi-band operation. Beam (Yagi) antennas for the higher HF and VHF /UHF allocations (eg. above 14 MHz) are designed to match to 50 coaxial feedlines and therefore work well without the need of antenna tuner.

- Some antennas like a half wave resonant dipole will be reasonably well matched to 50 ohms for a portion of a particular HF band but may require an antenna tuner for proper transfer of power at some other portion of the same band. For example, a half wave dipole cut for 3.6 MHz may require a tuner to properly match at 3.9 MHz.

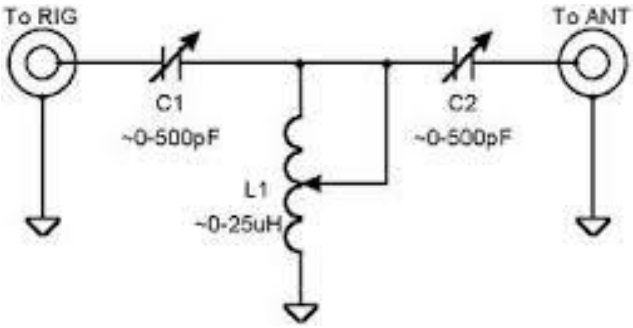
- The following is an SWR plot vs frequency of an 80 metre dipole from 3.5 to 4.0 MHz. We would want to use an antenna tuner for anything more than a 2:1 SWR.



- Automatic Antenna tuners based constant assessment of SWR on the feedline to the transceiver are commonly available nowadays; indeed many transceivers offer a limit range built-in automatic tuners as standard or optional equipment.

Pictures of Antenna Tuners

Schematic Diagram of an simple Antenna Tuner



Picture of an Automatic Pocket Sized Antenna Tuner Good for 20 Watts.

Antenna Switches

- Antenna switches facilitate connecting various antennas typically required for multi-band HF operation.

- Antenna switches are typically designed for connection to 50 ohm coaxial cables connectors.

- An antenna switch will have one common connection port and 2 or more connection ports for 2 or more antennas.

- An antenna switch should be well engineered especially if it is going to be used for VHF and UHF frequencies to minimize losses.

Pictures of Typical Antenna Coaxial Switches