# Chapter 24 - Transceivers and Transverters

Although in the early days of amateur radio transmitters and receivers were usually separate, in modern practice these are usually combined in a single piece of equipment, the 'transceiver'.

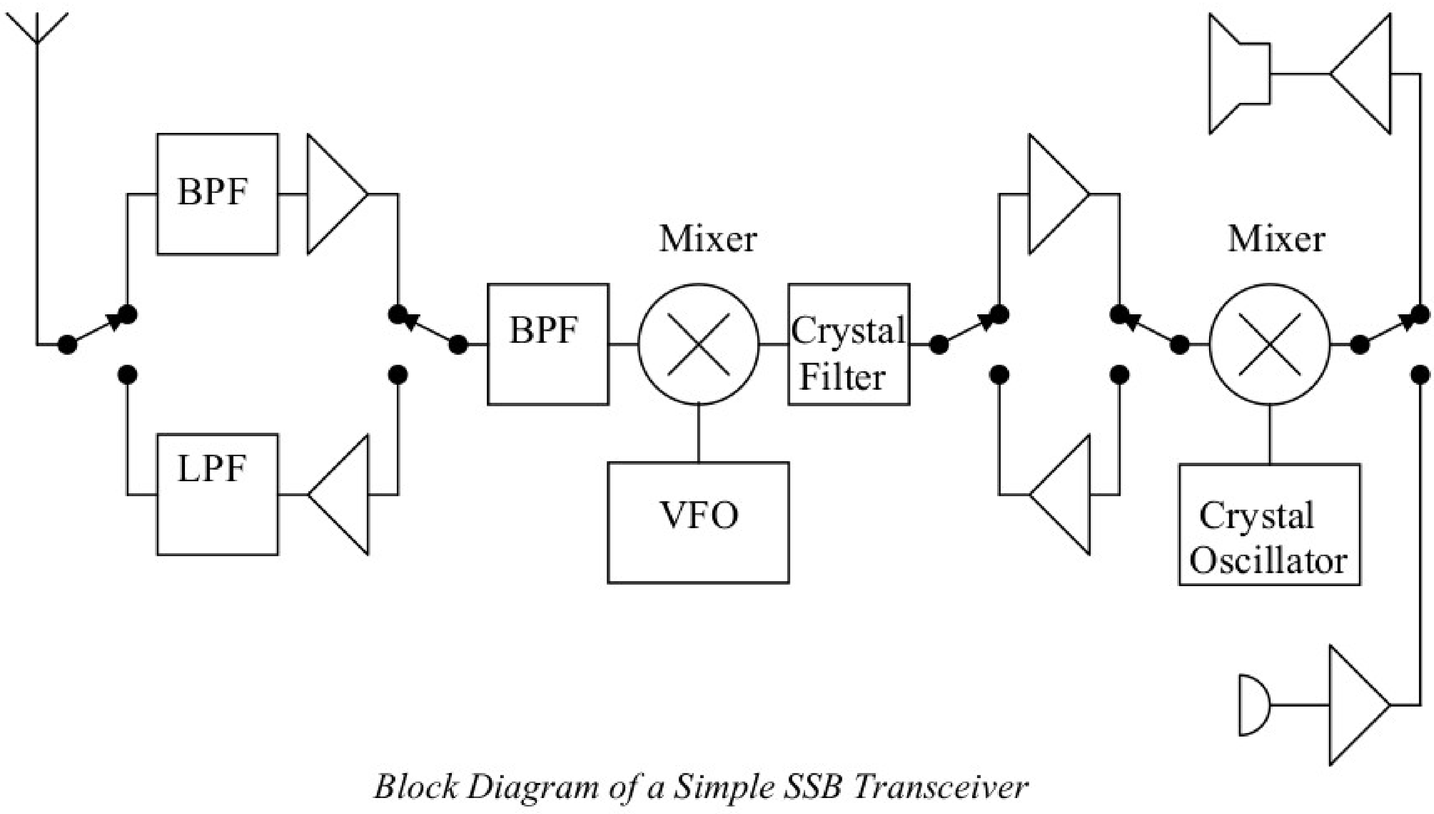
Transceivers have several **advantages** over separate transmitters and receivers:

- It is easier to make the transmitter and receiver tune together, so the user does not have to separately tune the transmitter and receiver to the same frequency.
- Much of the circuitry including the oscillators or synthesizers, filters, antenna switching, microprocessor and display can be shared between the transmitter and receiver, making transceivers less expensive than a separate transmitter and receiver.
- Installation is simpler, with less space and fewer cables required.

For these reasons, almost every modern amateur transmitter also includes receive capability, at least on the bands that it can transmit on. Many transceivers also offer “general coverage” receive, being able to receive signals outside the amateur bands.

**In order to maximize the sharing of components between the transmitter and receiver section of a transceiver, they will typically use the same frequency conversion scheme but in reverse.**

For example, if the receiver is a double-conversion superhet with IFs at 60 MHz and 9 MHz, then the transmitter will probably generate SSB using the filter method at 9 MHz (Allowing reuse of the 9 MHz crystal filter), and then mix it up to 60 MHz using the receiver’s beat frequency oscillator, and then mix it back down from 60 MHz to the actual transmit frequency (allowing the same synthesizer to be used for both transmit and receive). Circuit reuse is further enhanced since popular balanced mixers (such as the passive diode mixers) are essentially reversible – a signal injected at the RF port will mix with the local oscillator to generate a signal at the IF port, while a signal injected at the IF port will mix with the local oscillator to generate a signal at the RF port. Many filters will also work equally well in either direction. The diagram below shows a simple SSB transceiver that reuses several of its functional blocks. “LPF” stands for “Low-Pass Filter”, “BPF” for “Band-pass Filter” and “VFO” for “Variable Frequency Oscillator”.




*Block Diagram of a Simple SSB Transceiver*

**Block Diagram of a Simple SSB Transceiver [above]**

**The switch is shown in the 'receive' position.**

There are two different signal paths through the transceiver, depending on the position of the transmit/receive switches (these would probably be implemented using electronic switching or relays). With the switches in the position shown, the transceiver is in receiving mode. The signal from the antenna is filtered by a band-pass filter, amplified in the IF amplifier, fed through another band-pass filter and then mixed down to IF by the signal from the VFO. This passes through a narrow crystal filter which removes all frequencies other then the desired one, is amplified in the RF amplifier and finally demodulated in the product detector, using the signal from the crystal oscillator that serves as a beat frequency oscillator (BFO) for the receiver.

On transmit (with the switches all switched the other way) the signal from the microphone is amplified by the pre-amplifier, and then fed into the demodulator, which this time serves as a balanced modulator. The output of the balanced modulator is amplified, filtered using the crystal filter to remove the unwanted sideband, and mixed to the final output frequency using the signal from the VFO. The output is passed through a band-pass filter to remove the unwanted mixing product, then amplified by the RF power amplifier and finally filtered to remove any harmonics. This design reuses the mixer, product detector, crystal filter, VFO, crystal oscillator and one of the band-pass filters.

**Most amateur transceivers are designed to operate into an unbalanced antenna with an impedance of 50 Ω.**

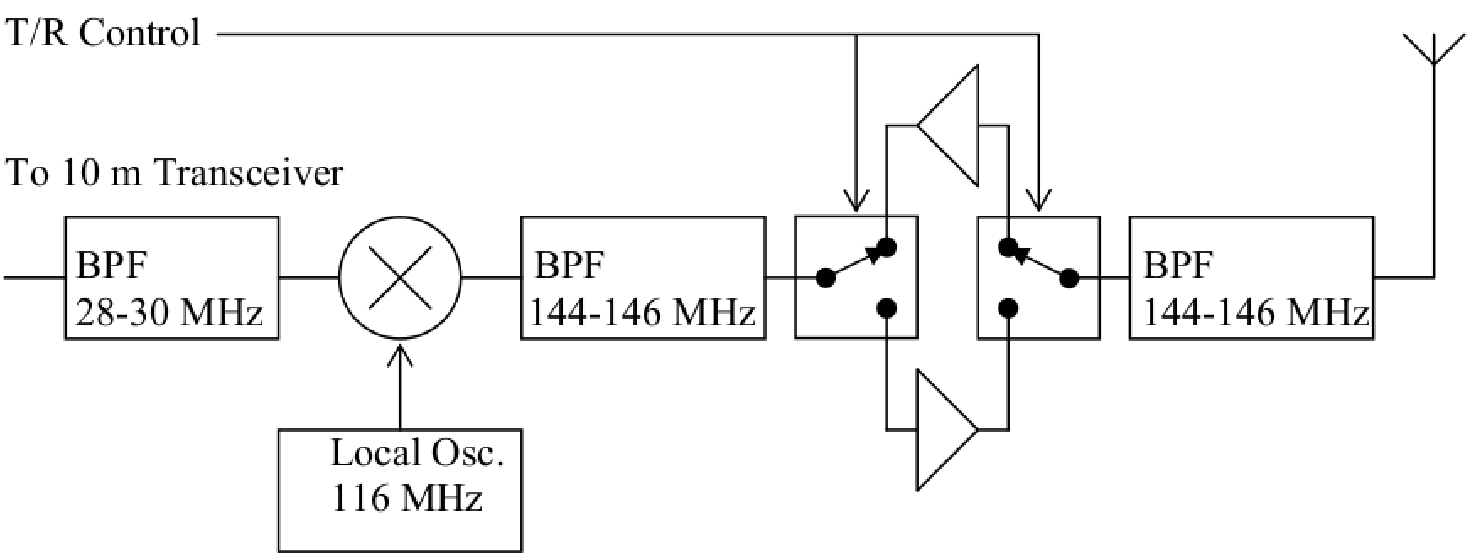
**The Transverter**
A transverter is a device that allows a transceiver to transmit and receive on a frequency band other than the ones it was originally designed for. It does this by incorporating a local oscillator and mixer that can convert the output of the transceiver to the new frequency band, and convert signals received on this band to a frequency that the transceiver can receive on.

For example, a 2 metre transverter might convert frequencies in the range 28 – 30 MHz (around the 10 metre amateur band) to the frequency range 144 – 146 MHz (the 2 metre band). It could do this by mixing the signals with a 116 MHz local oscillator signal. On transmit, the sum of the local oscillator and an input signal in the range from 28-30 MHz would give an output in the range 144-146 MHz, while on receive the difference between an input signal in the range 144-146 MHz and the 116 MHz local oscillator signal would give an output in the range 2830 MHz.

Most transverters are designed to operate with low powers on transmit, generally around 0 dBm (1 milliWatt), and include a power amplifier to amplify the signal. Some transceivers have a special connector for transverters, which provides a low-level RF signal to drive them.

**Otherwise an attenuator should be used on transmit to decrease the transceiver's output to a level that the transverter can safely handle.**

Like transceivers, transverters usually use components like the local oscillator, mixer and filters for both transmit and receive. Their transmit/receive switching is usually controlled by the transceiver, using its T/R control output. A block diagram of a typical 2 metre transverter is shown below. It includes both a power amplifier for transmit, and a receive pre-amplifier to amplify weak signals and compensate for losses in the mixer.




**Block Diagram of a 2 metre Transverter**
**[OLD example. Most nowadays convert to microwave bands.]**
On transmit, the low-level signal from the transceiver is filtered by the 28-30 MHz band-pass filter, and then mixed with a 116 MHz local oscillator. This generates a "sum" product in the range 144-146 MHz, and a "difference" product in the range 90-88 MHz. The band-pass filter that follows the mixer rejects the difference product. The 144-146 MHz product is amplified by a power amplifier, and passed through a final band-pass filter to remove any harmonics.

On receive, the signal from the antenna is filtered by the 146-148 MHz band-pass filter, amplified by a low-noise preamplifier, and filtered again to remove any image signals in the 88-90 MHz range. It is then mixed with the 116 MHz local oscillator, generating a "sum" product at 262-264 MHz, and a "difference" product in the range 28-30 MHz. The 28-30 MHz band-pass filter rejects the unwanted "sum" product, leaving only the 28-30 MHz signal that is fed to the transceiver.

Note that transverters typically translate frequencies from anywhere in a whole band, to the corresponding place in a different band, so the transverter does not need a tunable local oscillator – the tuning will be done in the transceiver that is connected to it. Some transceivers allow the frequency display to be offset when using a transverter so for example, the transceiver display could read 144-146 MHz while the transceiver was actually being tuned from 28-30 MHz, correctly indicating the output frequency of the transverter.

## Summary

A **transceiver** consists of a **transmitter and receiver combined into one**. They are widely used because of operator convenience and the lower cost that can be achieved by using the same components for both transmit and receive functions.

**Transverters** convert a transceiver to **transmit and receive** in a new frequency band. They work by mixing the output of the transceiver or the input from the antenna with a fixed frequency local oscillator, translating the frequency to the new band. Transverters generally require an input signal power of about 1 mW when transmitting, and care should be taken not to overdrive them.