Transponders:

- A transponder is the series of interconnected units which forms a single communications channel between the receive and transmit antennas in a communications satellite.
- The bandwidth allocated for C-band service is 500 MHz, and this is divided into subbands, one for each transponder.
- A typical transponder bandwidth is 36 MHz, and allowing for a 4-MHz guardband between transponders, 12 such transponders can be accommodated in the 500-MHz bandwidth.
- By making use of polarization isolation, this number can be doubled.
- With linear polarization, vertically and horizontally polarized carriers can be separated in this way, and with circular polarization, left-hand circular and right-hand circular polarizations can be separated.
- The carriers with opposite senses of polarization may overlap in frequency, this technique is referred to as frequency reuse.

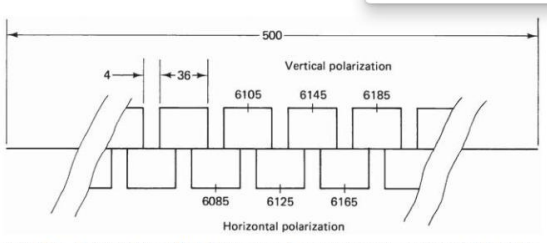

Figure 7.12 Section of an uplink frequency and polarization plan. Numbers refer to frequency in megahertz.

- Frequency reuse also may be achieved with spot-beam antennas, and these may be combined with polarization reuse to provide an effective bandwidth of 2000 MHz from the actual bandwidth of 500 MHz.
- A transponder may handle one modulated carrier, such as a TV signal, or it may handle a number of separate carriers simultaneously, each modulated by its own telephony or other baseband channel.

The wideband receiver:

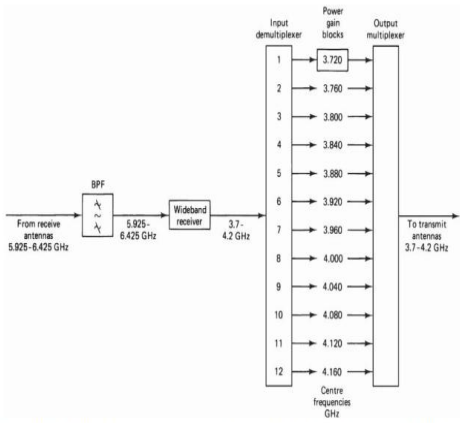

Figure 7.13 Satellite transponder channels. (*Courtesy of CCIR, CCIR Fixed Satellite Services Handbook, final draft 1984.*)

➤Fig. shows the channeling scheme for the 12 transponders.

➤The incoming, or uplink, frequency range is 5.925 to 6.425 GHz. The carriers may be received on one or more antennas, all having the same polarization.

➤The input filter passes the full 500-MHz band to the common receiver.

➤There will be many modulated carriers within this 500-MHz passband, and all of these are amplified and frequencyconverted in the common receiver.

➤The frequency conversion shifts the carriers to the downlink frequency band, which is also 500 MHz wide, extending from 3.7 to 4.2 GHz.

➤At this point the signals are channelized into frequency bands which represent the individual transponder bandwidths.

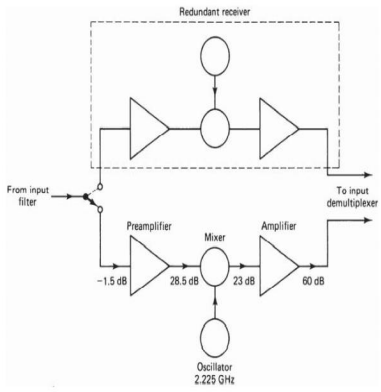

Figure 7.14 Satellite wideband receiver. (*Courtesy of CCIR, CCIR Fixed Satellite Services Handbook, final draft 1984.*)

- A duplicate receiver is provided so that if one fails, the other is automatically switched in. The combination is referred to as a redundant receiver, meaning that although two are provided, only one is in use at a given time.
- The first stage in the receiver is a low-noise amplifier (LNA). This amplifier adds little noise to the carrier being amplified, and at the same time it provides sufficient amplification for the carrier to override the higher noise level present in the following mixer stage.
- The LNA feeds into a mixer stage, which also requires a local oscillator (LO) signal for the frequency-conversion process. The power drive from the LO to the mixer input is about 10 dBm.
- The oscillator frequency must be highly stable and have low-phase noise. A second amplifier follows the mixer stage to provide an overall receiver gain of about 60 dB.
- Splitting the gain between the preamplifier at 6 GHz and the second amplifier at 4 GHz prevents oscillation, which might occur if all the gain were to be provided at the same frequency.

The input demultiplexer

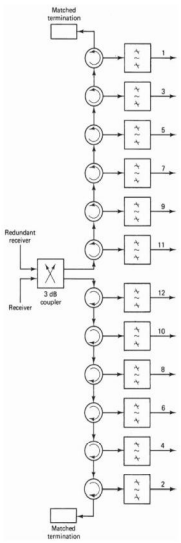

Figure 7.15 Input demultiplexer. (*Courtesy of CCIR, CCIR Fixed Satellite Services Handbook, final draft 1984.*)

- The input demultiplexer separates the broadband input, covering the frequency range 3.7 to 4.2 GHz, into the transponder frequency channels.
- The channels are usually arranged in even-numbered and odd-numbered groups. This provides greater frequency separation between adjacent channels in a group, which reduces adjacent channel interference.
- The output from the receiver is fed to a power splitter, which in turn feeds the two separate chains of circulators.
- The full broadband signal is transmitted along each chain, and the channelizing is achieved by means of channel filters connected to each circulator,.
- Each filter has a bandwidth of 36 MHz and is tuned to the appropriate center frequency, h there are considerable losses in the demultiplexer, these are easily made up in the overall gain for the transponder channels.

The power amplifier:

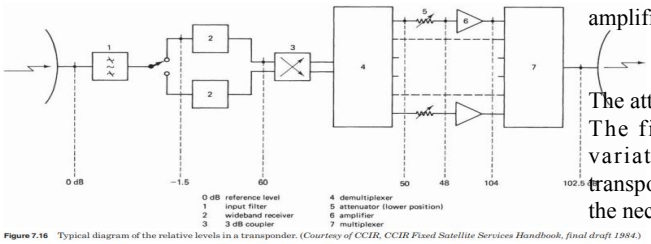

Figure 7.16 Typical diagram of the relative levels in a transponder. (*Courtesy of CCIR, CCIR Fixed Satellite Services Handbook, final draft 1984.*)

A Power amplifier provide the output power for each transponder channel. As shown in Fig each power amplifier is preceded by an input attenuator. This is necessary to permit the input drive to each power amplifier to be adjusted to the desired level.

The attenuator has a fixed section and a variable section. The fixed attenuation is needed to balance out variations in the input attenuation so that each transponder channel has the same nominal attenuation, the necessary adjustments being made during assembly.

The variable attenuation is needed to set the level as required for different types of service.

Traveling-wave tube amplifiers

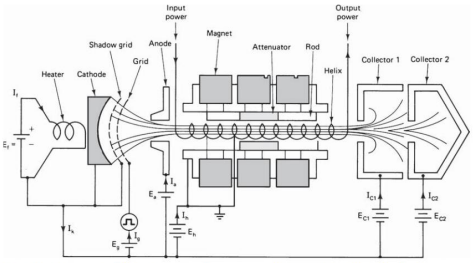

Figure 7.17 Schematic of a TWT and power supplies. (*Courtesy of Hughes TWT and TWTA Handbook; courtesy of Hughes Aircraft Company, Electron Dynamics Division, Torrance, CA.*)

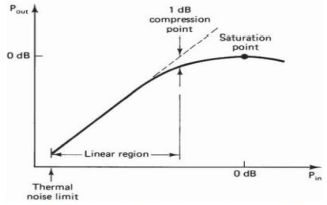

Figure 7.18 Power transfer characteristics of a TWT. The saturation point is used as 0-dB reference for both input and output.

Traveling-wave tube amplifiers (TWTAs) are widely used in transponders to provide the final output power required to the transmit antenna.

In the TWT, an electron-beam gun assembly consisting of a heater, a cathode, and focusing electrodes is used to form an electron beam.

A magnetic field is required to confine the beam to travel along the inside of a wire helix.

The magnetic field can be provided by means of a solenoid and dc power supply.

The comparatively large size and high power consumption of solenoids make them unsuitable for use aboard satellites, and lower-power TWTs are used which employ permanent magnet focusing.
The advantage of the TWT over other types of tube amplifiers is that it can provide amplification over a very wide bandwidth.

To minimize the effects of certain forms of distortion. The worst of these result from the nonlinear transfer characteristic of the TWT.